An Evaluation of the Los Angeles REgional CLean Air Incentives Market

A Group Project submitted in partial satisfaction of the requirements for the degree of

Masters of Environmental Science and Management

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June 2001

ACKNOWLEDGEMENTS

We the members of the Emissions Reduction Group would like to acknowledge those individuals who provided us with valuable information and services. We would like to thank the employees at the SCAQMD and California EPA who helped us gather information and better direct our research. In particular, we would like to thank Jack Broadbent, Sue Lieu, Danny Luong, Natalia Porche, Susan Nakamura, Susan Tsai and Lily Wong. We express further gratitude to outside advisor, Raul Lejano for enhancing our understanding of the environmental justice concerns with RECLAIM and Greg Hajic of the Alexandria Digital Library for providing GIS guidance and data. A great level of thanks must go to Donald Bren School Faculty members Antonio Bento, Chris Costello, Matthew Cahn, John Dwyer, Peter Kappas and Charlie Kolstad. Their guidance and advice was very helpful to our project analysis and in reaching our eventual findings. Finally, we would like to thank our advisors Dr. Magali Delmas and Dr. Natalie Mahowald for their invaluable recommendations, support and patience along the way.

ABSTRACT

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The Los Angeles REgional CLean Air Incentives Market (RECLAIM), is an emissions trading program implemented by the South Coast Air Quality Management District in 1994 to reduce emissions of nitrogen and sulfur oxides (NOx and SOx). There are currently 364 facilities participating in this program. Although designed to provide a more cost effective and flexible means of meeting emissions targets than command and control methods, critics of RECLAIM assert that emissions trading programs create uneven distributions of harmful toxic emissions due to the overall increase in emissions at facilities that are accumulating emission credits. In addition, there are some concerns that emissions trading programs inhibit technological innovation and pollution prevention initiatives.

The primary purpose of our research was to assess the RECLAIM program in order to address these issues. Combining emissions data from the California Air Resource Board for RECLAIM facilities with spatial demographic data from the 1990 census, we analyzed the correlation between the emission of toxics and RECLAIM target pollutants as well as the geographic distribution of RECLAIM facilities in relation to minority and impoverished neighborhoods and the trade of RECLAIM Trading Credits. In addition, we utilized a survey questionnaire to elicit information about company responses to RECLAIM trading. Our survey targeted 278 individual firms within RECLAIM, and resulted in an overall return rate of 46.4%. Our research provides evidence that correlates toxics and RECLAIM regulated emissions of certain industries in the South Coast Air Quality Management District. While we found that that there are higher percentages of minorities and impoverished residents near RECLAIM facilities than the average for the Los Angeles basin, we did not find evidence that RECLAIM facilities are accumulating credits in minority or impoverished neighborhoods. Our research also indicates that there are trends that point towards positive correlations between pollution prevention investments and the purchase of RECLAIM trading credits.

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ACRONYMS

ACE	Automated Environmental Credit Exchange
ACEMS	Alternative Continuous Emission Monitoring System
AQMD	Air Quality Management District
ARB	Air Resource Board
ASC	Area Source Credit
BACT	Best Available Control Technology
BBS	Bulletin Board System
CAA	Clean Air Auction
CAC	Command and Control
CAPCOA	California Air Pollution Control Officers Association
CARB	California Air Resources Board
CBE	Communities for a Better Environment
CEMS	Continuous Emission Monitoring System
CO	Carbon Monoxide
CPMS	Continuous Process Monitoring System
EBS	Environmental Brokerage Service
EPA	Environmental Protection Agency
ERC	Emission Reduction Credit
ESM	Environmental Science and Management
ETM	Emissions Trading Model
GIS	Geographic Information System
HAP	Hazardous Air Pollutant
HC	Hydrocarbon
LEV	Low Emission Vehicle
LRD	Longitudinal Research Database
MACT	Maximum Available Control Technology
MATES-II	Multiple Air Toxics Exposure Study-II
MSERC	Mobile Source Emission Reduction Credit
NAACP	National Association for the Advancement of Colored People
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO	Nitrous Oxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen oxides
O_3	Ozone

OEHHA	Office of Environmental Health Hazard Assessment
PACE	Pollution Abatement Costs and Expenditures
PCB	Polychlorinated biphenyls
PM	Particulate Matter
PPM	Parts Per Million
RECLAIM	Regional Clean Air Incentives Market
ROG	Reactive Organic Gasses
RTC	RECLAIM Trading Credit
SCAQMD	South Coast Air Quality Management District
SCAQS	South Coast Air Quality Study
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SMOG	Surface Meteorology and Ozone Generation
SO_2	Sulfur Dioxide
SOx	Sulfur oxides
TAP	Toxic Air Pollutant
URF	Unit Risk Factor
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

The Los Angeles REgional CLean Air Incentives Market (RECLAIM) is an emissions trading program implemented by the South Coast Air Quality Management District (SCAQMD) in 1994 as an effort to reduce emissions of nitrogen and sulfur oxides (NOx and SOx). There are currently 364 facilities participating in this program, which is intended to provide facilities with a more cost effective and flexible means to meet emissions targets than command and control regulations. However, critics feel that emissions trading programs create uneven distributions of harmful toxic emissions because of the increased overall emissions at facilities that are accumulating emission credits. In addition, there are some concerns that emissions trading programs inhibit technological innovation and pollution prevention initiatives.

The primary purpose of our research was to assess the RECLAIM program in order to address these issues. Combining emissions data from the California Air Resource Board for RECLAIM facilities with spatial demographic data from the 1990 census, we analyzed the correlation between the emission of toxics and RECLAIM target pollutants as well as the geographic distribution of RECLAIM facilities in relation to minority and impoverished neighborhoods and the trade of RECLAIM Trading Credits. In addition, we utilized a survey questionnaire to elicit information about company responses to RECLAIM trading. Individual companies received 278 of the initial 310 surveys that were sent out. Our overall return rate was 46.4%. Based on our research, we concluded the following points.

RECLAIM, toxics, and environmental justice

- On average, communities surrounding RECLAIM facilities, particularly those trading RECLAIM Trading Credits (RTCs), have higher percentages of minorities and the impoverished compared to the rest of the Los Angeles Basin.
- Analysis of RECLAIM facility emission data by Standard Industrial Classification (SIC) code showed significant relationships between the production of NOx and SOx with toxic emissions in the crude petroleum and natural gas, cotton finishing, industrial laundry, chemical and allied product, and petroleum refining industries.
- There is no conclusive evidence to suggest a relationship between minority and impoverished populations surrounding RECLAIM facilities and the net direction of RTC trades (incoming or outgoing).

Pollution prevention and RECLAIM trading

- Our analysis of the trading and pollution abatement investment activities of RECLAIM firms generated results that suggest that there is a strong, positive correlation between investments in pollution prevention and purchases of RTCs.

1. INTRODUCTION

The South Coast Air Quality Management District (SCAQMD) in the Los Angeles Basin has the some of the worst air quality in the nation. The district is currently considered the only area in the nation in "extreme" non-attainment of the National Ambient Air Quality Standards (NAAQS) for ozone which it is required to be in attainment of by 2010 (EPA, 2000). Despite making substantial progress over the past three decades in improving air quality in the Los Angeles Basin, SCAQMD officials realized in the early 1990s that further progress toward attaining these standards would be prohibitively expensive using traditional regulatory approaches (U.S. Congress, Office of Technology Assessment, 1997). In January of 1994, the SCAQMD instituted the Regional Clean Air Incentives Market (RECLAIM) in an effort to reduce emissions of nitrogen and sulfur oxides (NOx and SOx) while lowering control costs. NOx was targeted due to its role as an ozone precursor while SOx was included into the program for its role in the formation of small particulates and acid rain. The program also initially included volatile organic compounds (VOCs), which were later removed due to logistical difficulties (Lents and Leyden, 1996).

The SCAQMD designed RECLAIM as a cap-and-trade marketable emissions program where firms are allocated RECLAIM Tradable Credits (RTCs) for NOx and SOx. These allocations are then "ratcheted down" in order to eventually meet NAAQS standards. According to the SCAQMD, the benefits of RECLAIM include improving Basin air quality more efficiently and economically as firms are allowed to decide what equipment, processes, and materials they will use to meet their emission limits. The flexible regulatory approach of RECLAIM enables companies to choose the most cost-effective ways to meet emission targets, whether it be through equipment modifications, reformulated products, or purchase of RTCs (SCAQMD, 1997c).

Although RECLAIM seems to have many benefits, there are some important caveats that critics of the program feel must be addressed. One particularly contentious issue centers on the accumulation of emission credits by facilities and the subsequent impacts on local air quality. Since firms can simply buy emissions credits to meet regulatory targets rather than electing to reduce actual emissions, certain facilities with high pollution control costs may accumulate significant amounts of credits (Drury, et. al., 1999). This may, in turn, lead to increases in pollution around these specific sites although the total amount of pollution over the entire regulated area declines. In addition to concentrations of NOx and SOx, critics of emissions trading programs such as Communities for a Better Environment worry about emissions of other toxic chemicals and fear that trading programs such as RECLAIM will create toxic "hot spots," increased levels of toxic chemicals around facilities due to the accumulation of emission credits (Bansal, et.al., 1998; Bansal & Kuhn, 1998). To further complicate the issue, the demographic composition of local communities around these facilities can be such that certain ethnic and economic groups are disproportionately affected by the uneven distributions of emissions (Bansal, et. al., 1998; Chinn, 1999). If increased emissions of NOx and SOx do indeed correlate with increased emissions of other toxic pollutants, the disjunction between the regional nature of the pollution control endeavor and the local nature of the health impacts of toxic pollutants creates an environmental justice issue that must be addressed before further emissions trading programs should be implemented.

In addition to concerns related to the environmental justice of emissions trading programs, some critics of these programs question whether or not such trading systems function as they are intended. Although proponents of marketable permit systems are quick to point out the efficiencies of regulating pollution in this manner, one might question exactly what effects a program such as RECLAIM has on the pollution abatement efforts of the industries involved. According to emissions trading theory, firms with lower abatement costs should opt to install pollution control technology rather than buying emission credits. If initial allocations of credits are too large, however, the lowest cost method across the board may be to buy surplus credits and no abatement technology will be installed. In addition, critics of emissions trading programs worry that these programs will have other side effects such as inhibiting innovation in pollution control technology and reducing participation in pollution prevention endeavors if firms only opt to buy emission credits rather than reducing their own pollution levels. With the rising use of emissions trading programs as a pollution policy instrument, it is necessary to address these issues in a more comprehensive manner. This study is devoted to addressing these questions that have arisen regarding emissions trading programs with specific regard to the Los Angles RECLAIM program.

The primary objective of our research is to evaluate the RECLAIM program according to the following questions:

- What is the correlation between RECLAIM pollutants and toxic pollutants? Has RECLAIM disproportionately affected certain communities, exacerbating toxic "hotspots" around low income and minority populations?
- What is the impact of RECLAIM on company investment decisions on end-of-pipe and pollution prevention technologies?

By answering these questions, we hope to determine what impacts an emissions trading program such as the Los Angeles RECLAIM program can have on the local communities and industries. In addition, this study will illuminate the specific aspects that regulators must rigorously examine when considering implementing an emissions trading program.

Section 2 provides information on the RECLAIM program including specifics about credit allocation, trading rules, monitoring requirements, and enforcement policies. Section 3 provides background information pertinent to this interdisciplinary policy analysis. This includes information on the theories behind emissions trading programs, the reasoning behind regulating NOx and SOx, atmospheric characteristics of the Los Angeles Basin, and information on environmental justice issues. Section 4 outlines the conditions in which the RECLAIM program is currently set, including toxic pollutant levels, and health hazards of pollutants in the Los Angeles Basin. Information on the composition of the RECLAIM universe is included, as well as a brief discussion on RECLAIM's impact on labor decisions in the Los Angeles Basin. Section 5 describes our research approach, which is followed by our results. The report concludes with an analysis of the RECLAIM program's effect on local communities and industries

2. WHAT IS RECLAIM?

Federal regulations such as the Federal Clean Air Acts have played a significant role in shaping California and South Coast air quality management. The Federal Clean Air Act, was which was last amended in 1990, requires the EPA to set NAAQS for criteria air pollutants considered harmful to public health such as ozone, carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, and particulate matter. The original Act required attainment of the NAAQS by 1975, but the Act was amended in 1977 and 1990 to extend the attainment deadlines because of difficulty that some regions had in meeting the requirements. States are required to develop a state implementation plan (SIP) to attain the NAAQS by the deadlines. These SIPs are subject to approval by the Federal Environmental Protection Agency (EPA) and must contain sufficient measures to ensure the timely attainment of the NAAQS.

In California, the regulatory body responsible for the overall SIP is the California Air Resources Board (CARB). In addition to compiling the SIP for submission to the EPA, CARB is responsible for approving district air quality plans as well as the general oversight of districts. On a more regional level, Air Quality Management Districts (AQMDs) are responsible for preparing the portion of the SIP that is applicable within their boundaries as well as the actual implementation of regulations. The Los Angeles Basin is under the domain of the South Coast Air Quality Management District (SCAQMD), which includes portions of Los Angeles, Orange, Riverside, and San Bernardino counties.

Due to the intensely urbanized nature of the SCAQMD, it has been extremely difficult for the region to meet the Federal Clean Air Act requirements. The SCAQMD is the one of the only areas in the nation that has had to extend regulatory deadlines to meet national ozone and ozone precursor standards to 2010. While many command and control regulations have been implemented in the Los Angeles region to reduce air pollution emissions by stationary sources, the costs to reach further reductions have been prohibitively high. In an effort to reduce ozone precursor emissions even further at lower cost, the SCAQMD decided to follow the EPA's innovative approach to controlling acid rain and lead emissions by implementing the RECLAIM program.

2.1 Industries Involved

RECLAIM is designed to be a facility level cap and trade program. The SOx and NOx RTCs within the RECLAIM Program are recorded at the facility level. Each facility is then given the flexibility to distribute these permits between its individual pollution sources. This approach to permit management is often called a "Bubble Policy," and offers added flexibility to the management of permits within a facility or firm in that, in some cases, firms can attain air quality regulations without the need to use the trading mechanism (Tietenberg, 1992). Credits are allocated according to past peak production, multiplied by a starting emission factor based on industry type. Credits are allocated on a yearly basis and RTCs are only valid for one year (SCAQMD, 2000d).

Facilities are required to enter the RECLAIM Universe if they have annual NOx or SOx emissions greater than four tons in 1990 or any subsequent year. However, certain facilities are categorically excluded from RECLAIM, including restaurants, police and fire fighting facilities, potable water delivery operations, and all facilities located in the Riverside County and Los Angeles County portions of the Southeast Desert Air Basin (which has subsequently been divided into portions of the Mojave Desert Air Basin and the Salton Sea Air Basin). Additionally, certain other categories of facilities are not automatically subject to RECLAIM but individual facilities in these categories have the option to enter the program at their discretion. These categories include ski resorts, prisons, hospitals, and publicly owned municipal waste-to-energy facilities. An initial universe of RECLAIM facilities was developed using these criteria based on 1990, 1991 and 1992 facility emissions data. If a firm ceases operations, then they are allowed to exit the RELCAIM program, but they are still allowed to retain their allocation of RTCs, as well as to participate in normal trading activities (SCAQMD, 2000d).

2.2 Credits

RECLAIM Tradable Credits provide an authorization for RECLAIM firms to emit NOx and SOx in accordance with the restrictions and requirements of District rules and state and federal law. Each RTC has a denomination of one pound of RECLAIM pollutant, a term of one year, and can be held as part of a facility's Allocation or alternatively may be evidenced by an RTC certificate. RTCs can be obtained in four main ways (SCAQMD, 2000d):

- initial allocation by SCAQMD
- generation of RTCs
- conversion of Emission Reduction Credits (ERCs) to RTCs, and
- generation of MSERCs.

Firms are allowed to decide what equipment, processes, and materials they will use to meet their emissions limits. Some of methods of meeting emissions limits include: add-on controls, equipment modifications, reformulated products, operational changes, shutdowns, and purchase of excess RTCs. Excess RTCs are generated when firms reduce their emissions below their specified targets. These RTCs can either be circulated among facilities owned by the same parent company, retired from the market, or sold on the open market. Because facilities must hold credits equal to their actual emissions, firms can either choose to lower their emissions or buy credits from other RECLAIM participants. Due to differences in the financial and technological capabilities of firms, some firms may find it more cost-effective to purchase RTCs from firms that can lower their emissions at a comparatively lower cost. No matter who buys or sells the credits, the SCAQMD requires that total emissions from all participating companies be reduced each year according to the allocation schedule outlined below.

2.2.1 Initial Allocations and Allocation Reductions

One of the problems with the SOx and NOx credits is the difficulty in deciding on their initial allocations. During the initial discussion of the RECLAIM Program, the regional economy was in the midst of a recession. For this reason, many of the facilities in the SCAQMD were operating at a sub-optimal level, and therefore their emissions were not representative of normal production. In order to account for the recessionary production levels, the SCAQMD allowed the individual firms within the RECLAIM Universe to select a baseline year between 1989 and 1992, which would negate the negative effects (Lieu, et al., 1998). The SCAQMD then multiplied the firm's chosen peak throughput by a starting emission factor based on industry type and added credits for external offsets and ERCs.

Firms entering the program after 1993 must meet their emission limit through external offsets. Annual credit allocations are reduced according to a reduction schedule that resulting in an 80% reduction of NO_X and SO_X by the year 2000 (SCAQMD, 1997c). Allocation reductions were initially calculated by a linear reduction between the starting 1994 allocation and the year 2000 allocation, with similar reductions between 2000 and 2003. Although this method was the simplest to implement, facilities argued that this linear reduction ignored differences in starting levels of pollution control across the facilities. In order to create a more fair method of allocation reduction, the SCAQMD decided to assess each facility's equipment. The final reduction schedule sets individual rates per facility to the year 2000, and then one common rate to the year 2003 for an annual average reduction rate of 8.3% for NOx and 6.8% for SOx (Lents and Leyden, 1996).

2.2.2 Generation of RECLAIM Tradable Credits

RECLAIM Tradable Credits can be generated in four ways (SCAQMD, 2000d):

- process change
- addition of control equipment
- production decrease, or
- equipment or facility shutdown

2.2.3 Conversion of Emission Reduction Credits to RECLAIM Trading Credits

Emission Reduction Credits can be produced under Regulation XIII - New Source Review for reductions of air contaminants from the removal of equipment from service, and the additional control of mobile and stationary sources. Firms must demonstrate that all stationary and mobile source reductions are: real, quantifiable, permanent, federally enforceable, and not greater than the equipment would have achieved if operating with the Best Available Control Technology (BACT). Non-RECLAIM facilities may elect to have their Emission Reduction Credits (ERCs) converted to RTCs and listed on the RTC Listing. Such RTCs will be assigned to the trading zone (See section 2.1.3 *Inland/Coastal and Cycle Breakdowns)* in which the generating facility is located. RTCs generated from the conversion of ERCs have a zero rate of reduction for the year 1994 through the year 2000 and a cumulative rate of reduction for the years 2001, 2002, and 2003, equal to the percentage inventory adjustment factor applied to 2003 allocations. ERCs generated by non-RECLAIM facilities may not be converted to RTCs if the ERCs are based on shutdown or curtailment of operations (SCAQMD, 2000d).

2.2.4 Generation of Mobile Source Emission Reduction Credits

Mobile source ERCs can be generated by both RECLAIM and non-RECLAIM facilities based on emission reductions, which comply with all requirements of any 1600 series rule. RTCs may only be generated from vehicles registered in the South Coast Basin (SCAQMD, 2000d). Mobile source ERCs can then be converted into RTCs.

The 1600 series of rules allows for credits to be generated in the six following manners (SCAQMD, 2000d):

- credits for the voluntary repair of on-road motor vehicles identified through remote sensing devices (Rule 1605)
- credits for clean on-road vehicles (Rule 1612)
- credits for truck stop electrification (Rule 1613)
- credits for clean off-road mobile equipment (Rule 1620)
- credits for clean lawn and garden equipment (Rule 1623)

2.3 Inland/Coastal and Cycle Breakdowns

In addition to the normal trading restrictions placed on the RECLAIM Universe, the firms within the program are also given trading credits that are staggered using trading cycles. Each facility in the RECLAIM Universe receives its RTCs based on two trading cycles: cycle one, which runs from January 1st to December 31st, and cycle two, which runs from July 1st through June 30th. Researchers indicate that the AQMD intended to use these cycles in order to “smooth trading behavior” (Burnside, et al., 1996). Experimental trading activities provided evidence that if all firms were to conduct trades within the same cycle, the trend would be for them to do so towards the end of the trading period. This characteristic could theoretically produce more volatility to the trading market, and therefore the staggered cycles are intended to prevent this behavior. Firms still have the ability to purchase permits that correspond to other cycles, but regardless of net purchases and sells, the permits retain their cyclical characteristics.

Firms in the RECLAIM market have also been given geographic trading conditions, which divide the facilities into two zones: inland and coastal. Trading within either of the two zones is allowed, but trades between the zones have restrictions placed on them. Firms in the coastal zone are not allowed to use RTCs from the inland zone, but the inland zones can use RTCs from the coastal zone. This trading restriction is intended to prevent inland air quality degradation, which is the more severe of the two.

2.4 Enforcement, Monitoring, and Penalties

All of the NOx sources within the RECLAIM Universe have been divided into four categories, based on emission levels: major sources, large sources, process units, and exempt equipment. SOx sources have been divided into three categories: major units, process units, and exempt equipment (Lieu, et al., 1998). In all "Major Sources" the firm is required to install continuous emissions monitoring systems (CEMS). These CEMS are highly effective means of monitoring emissions, and they provide the emitter the convenience of directly transferring the emissions data to the AQMD. Unfortunately, the CEMS can be a particularly expensive component of the RECLAIM process (see Tables 2.1, and 2.2 below.)

Table 2.1: Monitoring Requirements for RECLAIM Sources (Lieu, et al., 1998)

Source Category	Major Sources (NOx and SOx)	Large Sources (NOx)	Process Units (NOx and SOx)	Rule 219 Equipment (NOx & SOx)
Monitoring Method	Continuous Emission Monitoring System (CEMS)	Fuel Meter or Continuous Process Monitoring System (CPMS)	Fuel Meter or Timer	Fuel Meter or Timer
Reporting Frequency	Daily	Monthly	Quarterly	Quarterly
No. of Sources	570	747	2705	Not Available
Percent of NOx Emissions in RECLAIM*	84%	8%	6%	2%
Percent of SOx Emissions in RECLAIM*	98%	N/A	1.2%	0.8%

- Based on 1996 preliminary audited emissions.

Table 2.2: Projected Annualized Cost of RECLAIM ($Mil 1995) (Luong, et al, 2000)

Year	Equipment Installation	Recordkeeping & Monitoring
1994	0.0	13.0
1995	0.6	16.8
1996	79.4	16.8
1997	102.2	16.8
1998	140.9	16.8
1999	192.0	16.8
Average Annual (94-99)	**102.0**	**16.2**

For the smaller facilities that don't have CEMS in place, the SCAQMD conducts an audit at the end of each compliance period, to make sure that all of the firms have enough RTCs to cover their emissions. In the first three years of the program, the AQMD experienced a 10% non-compliance rate, which it attributes to misunderstanding of regulations, and mistakes in calculations (Lieu, et al., 1998).

At the end of any given trading cycle, facilities within the RECLAIM Universe have a 60-day period within which to reconcile their surplus or deficit of RTCs. At the close of this reconciliation period, the firm is required to buy any additional RTCs that it needs to meet its emissions for the trading cycle. In cases where the price of RTCs rises above $15,000 per ton (or $7.50 per lb.), the SCAQMD is required to review the reasons for a price increase, and to attempt to put forth measures to reduce the price. This review committee will then present various options to the Board for approval.

2.5 Trading

The SCAQMD designed its RECLAIM permit-trading program to allow trading activities to be conducted in an efficient, flexible manner. For this reason, the SCAQMD placed very few limitations or restrictions on how RTCs can be traded. In fact, other than the zone restrictions discussed above, the only additional requirement is that all transactions must be recorded by the SCAQMD. Towards this end, the SCAQMD takes no part in approving or denying trades, and only operates a bulletin board system for RELCAIM users to list trade requests or offers.

Firms wishing to purchase or sell RTCs are free to do so at their own discretion, using private negotiations with other RECLAIM facilities, or one of several private trading systems. The first RTC broker, Cantor Fitzgerald, offers its Environmental Brokerage Service (EBS), which is an internet-based Clean Air Auction (CAA) for the RTC and ERC markets. The EBS offers Internet technologies that allow registered users to see detailed information regarding supply and demand (by quantity and price), pending transactions, and recent trades. The second RTC brokerage service is provided by the Pacific Stock Exchange in partnership with Sholtz and Associates, and is called the Automated Environmental Credit Exchange (ACE). Unlike Cantor Fitzgerald, which offers continuous trading, the ACE only operates during five days of every quarter (Burnside, et al., 1996). Like all brokerage services, the two that directly trade RTCs do so for a profit. The Chicago Board of Trade indicates that in 1996, a trade with Cantor Fitzgerald required a fixed fee of approximately $150, and a variable fee of 3.5% of the total purchase price (Burnside, et al., 1996).

One of the benefits of these trading systems is that they allow organizations and individuals who are not part of RECLAIM to participate in the market. Burnside and Eichenbaum found that many environmental groups and individuals have purchased RTCs in the past, some with the intent to retiring them from the market. For example, The Tides Foundation, an environmentally focused foundation based in San Francisco, bought 2.9 million pounds of 1994 RTCs at the 3rd Clean Air Auction (Burnside, et al., 1996). In addition to brokerage services, direct negotiations between different companies and trading that involves non-RECLAIM facilities is possible. Although this process may involve large transactions costs, it allows firms that have preexisting contracts and partnerships to honor those without having to deal with the normal brokerage mechanism.

Upon first glance at the RECLAIM trading history, it is obvious that a large percentage of the trades listed, are done so at a zero dollar price level. Fortunately, this is not a flaw in the trading system, but rather a nuance to the registration process. In these trading cases, most of which are intracompany, all zero dollar transactions must be recorded. These intracompany trades are the result of one RECLAIM facility giving its RTCs to another RECLAIM facility that is owned by the same parent company. RECLAIM views all RTCs as being allocated to facilities and not to companies; those corporations that operate a number of facilities in the SCAQMD have the ability to transfer RTCs between sources to maintain compliance. Alternatively, these zero dollar trades may have been the result of a donation of RTCs to environmental groups or to those who do not intend to use the RTCs. Burnside and Eichenbaum indicate that in these cases, the companies may have public relations or other reasons some to give credits away for no price or a very low price.

The RTC trading transactions themselves can become rather difficult to follow. All brokerage trades are recorded twice with the SCAQMD: once from the seller to the broker, and a second time from the broker to the buyer. This is done because the staff at the SCAQMD needs to know at any point in time who is holding the RTC. Unfortunately, this process often clouds the trading activity, and in all cases may appear as double counting (Burnside, et al., 1996). If Cantor Fitzgerald or the Pacific Stock Exchange are unable to find a buyer for the RTC, then they will likely transfer the RTC back to the company that owns it, again doubling the transaction without actually conducting any trading activity. In addition to recording all zero dollar trades, the SCAQMD will list the average price of any trades that include different bundles of RTCs, each at a different trade price (Burnside, et al., 1996).

Burnside and Eichenbaum note that prior to February 23rd, 1996, 12% of the trades listed were directly negotiated intercompany trades between two RECLAIM facilities; 15% of the trades were intracompany trades; the rest (73%) were intrafacility trading where emissions were shifted between sources within their facility-wide bubble (Burnside, et al., 1996).

2.6 Emissions Trading Model

In weighing the various feature options available to the RECLAIM program, the SCAQMD conducted an assessment that involved the use of an emissions trading model (ETM) in conjunction with a regional economic impact model, an airshed model, and a pollutant exposure model. California State Health and Safety codes dictate that socioeconomic assessments must be conducted whenever air quality rules are introduced or amended (Johnson, et al., 1996). The results of this analysis were then used to determine the characteristics of the RECLAIM trading model, and were later published in peer-reviewed literature. The ETM that the SCAQMD chose to use included detailed, proprietary information on credit supply and demand, the opportunity costs of owning credits, and the spatial restrictions that are unique to the South Coast (Johnson, et al., 1996). This information allowed the ETM to predict trading activity in the SCAQMD, and when linked to a general equilibrium model of the regional economy generated data that could be used in a cost-benefit analysis of the various trading rules and options.

As noted, California Health and Safety codes require socioeconomic analysis of amendments to air quality regulations. The particulars of this program analysis provide insight to the importance that decision makers within the SCAQMD place on the various potential impacts of the RECLAIM program. Above all else, this analysis indicates that population exposure, the ability to meet federal ambient standards, job impacts, and compliance costs were of the most concern.

Johnson and Pekelney evaluated six different configurations for the RECLAIM ETM, and compared those to a command and control (CAC) regulatory approach. The different RECLAIM configurations included combinations of the following:

1. Limitations of RTC available via auto scrapping (None or 30,000)
2. The % share of Non-RECLAIM ERCs (100% or 20%)
3. Modifications to the new source offset ratio (1.0 or 1.2)
4. Allowing for external offsets
5. Allowing for existing ERCs
6. Allowing for an interim end-point in the year 2000
7. Putting zone restrictions on new sources (None, 2, or 38)
8. Putting zone restrictions on existing sources (None, 2, or 38)
9. Modifying the size of the Universe of RECLAIM companies (510 facilities, 392 facilities, or all 10+ ton polluters)
10. Modifying the end year of reductions (2000 or 2003)
11. Modifying the rate of reduction for new and old sources (from 0% to 11.9%)

The results of the ETM analysis, as explained by Johnson and Pekelney, indicate that the optimal marketable permit option within the RECLAIM program will provide facilities that participate in the trading process an aggregate annual savings of $57.2 million, as compared to the CAC option. The model also predicts that there will be no difference in air quality or public health measures between the two regulatory approaches. Finally, the ETM model, in conjunction with the regional economic impact model, provided data that suggested that the RECLAIM program would result in 1,147 fewer job losses than CAC regulatory practices (Johnson, et al., 1996)

3. BACKGROUND

In this section, we provide background information that has formed much of the basis for our research. We discuss the theories behind emissions trading, the reasoning behind regulating NOx and SOx in this manner, health effects of pollutants, air circulation patterns in the Los Angeles Basin which affect the distribution of pollutants, and environmental justice concerns and efforts in Los Angeles.

3.1 Theory Behind Emissions Trading

Economists and policy makers often look to the use of standards and effluent fees in order to achieve the attainment of desired environmental conditions. Both standards and fees have the ability to reach attainment in an equitable and efficient manner, but require that the regulatory body have extensive knowledge of the value of the damages that are created by the polluting activities, and the individual costs of abatement. Ultimately, the objective of pollution regulation must be to equate the damage that the pollution causes with the cost of controlling that pollution. The emission level that coincides with equivalent allocation is the efficient outcome. If emissions were to either increase or decrease, the sum-total of costs to society (including the regulated firms,) would increase. In the case of a standard, the total pollution emitted must be at this efficient level; in the case of the effluent fee (or tax, or charge,) the fee must be equal to the marginal damage that the pollution causes, at the aforementioned efficient emission level.

Until the late 1960s, economists focused their environmental regulatory attention on the development of standards and effluent fees (Baumol and Oates, 1988). In his 1968 work "Pollution, Property and Prices", J. H. Dales proposed a novel new regulatory approach that involved a system of tradable property rights for environmental resources. Under this system, permits are generated for the "use" of an environmental attribute, such as a gas or liquid pollution emission into a natural system (Tietenberg, 1992). Polluters can then choose to use their pollution permits, or to sell them to a party with higher abatement costs, thus creating a market for pollution emissions. As the emissions permit market develops, an equilibrium price for permits will emerge, indicating the market-wide opportunity cost of emissions (Baumol and Oates, 1988). Assuming that all actors have perfect information of their own cost schedules, and there are no additional costs imposed by the trading process itself, a free market will result in a Pareto optimal, efficient allocation (Tietenberg, 1992).

The emissions trading model, like all economic regulatory tools, has its own unique advantages and disadvantages. Baumol and Oates note several of these in their classic work on the theory of environmental policy (Baumol and Oates, 1988). Traditional "polluter-pays" systems of effluent fees have no guarantees of meeting environmental quality standards. The regulatory authority can never be sure of the resulting emissions levels, and thus the potential exists for non-attainment, or inequitable environmental conditions. This condition may require that the regulatory authority adjust the effluent fee, which is unattractive to administrators, and even more unattractive to the regulated firms. Baumol and Oates indicate that a system of marketable emissions permits allows the regulatory agency to determine the exact and final emissions level by pre-allocating the total quantity of permits available. This freedom removes the uncertainty that is inherent in a fee-based system, and avoids the need for systematic adjustment costs.

As noted above, fee-based systems may require systematic modifications if regulatory standards are not being met. As the regulated industries grow and expand, and the economy grows with it, natural inflationary pressures will occur. Along with all other real values, these inflationary pressures will act to devalue the effluent fee itself. Polluters that face this devalued fee will choose to pollute more, in turn requiring an additional modification of the fee if regulatory standards are to be maintained. Baumol and Oates show that a permit-based system solves the devaluation dilemma by internalizing the inflation and growth pressures. If polluters wish to pollute more, the increased demand for a fixed number of effluent permits causes their market price to rise.

Baumol and Oates also indicate that an effluent fee system may impose higher costs to the polluting firms, when compared to a regulatory policy that includes marketable permits. The effluent fee system reduces the total cost of abatement, but it creates a much larger fee burden on the polluting firms. Baumol and Oates reference a comparison of three regulatory mechanisms: direct controls, effluent fees, and marketable permits (Baumol and Oates, 1988). Ultimately they indicate that the direct control and effluent fee systems have much higher total costs (of abatement <u>and</u> fee burden) than the marketable permits option. In some cases the marketable permit system may face the same fee burden as the effluent fee system: if an auction is used for the initial distribution of the permits, the firms bidding for the permits will face higher prices than the would if the permits had already been distributed into the market. However, regulators can get around this inefficiency by using a free initial distribution, a low-cost method of permit distribution, or through the "grandfathering" of permits based on past emission levels (Baumol and Oates, 1988).

In the case of effluent fees, in order to maintain regional environmental quality within a given range, the regulating agency will need to maintain different fees for each pollution source. If the effluent fee is set too low, then overall emissions will increase beyond the desired level, and modifications will need to be made to the regulations. This regulatory practice may be administratively impossible, and may be highly objectionable by the regulated firms. The nonuniform levying of fees may create a competitive advantage for some otherwise identical firms, and may ultimately be deemed illegal in a court of law. Alternatively, the use of marketable permits allows the regulatory body to determine the desired pollution level without the need for individual firm abatement cost information. If the environmental boundary includes unique physical characteristics, the regulatory agency can establish trading rules based solely on the location of the firms, and the desired total effluent levels. The use of computers and web-based commodities trading has become a ubiquity within the modern business community. Regulators, in tandem with the commodity markets, are able to design trading rules that incorporate the physical constraints of a market, so that the regulators themselves, as well as the buyers and sellers of the permits, need only interact with the brokers to attain an optimal, efficient outcome. The need for firm-to-firm interaction is no longer necessary, which removes the sometimes high search costs, as well as any strategic behavior that otherwise might cause inefficiencies in the market.

The use of permits may be seen as "less objectionable" to the regulated community, when compared to effluent fees or standards (Baumol and Oates, 1988). Polluting industries, and the American public for that matter, have historically been opposed to taxes and fees. Permits, on the other hand, offer a more familiar market instrument, and one that that the regulated firm can immediately integrate into a, sometimes long, list of "inputs" to production.

One argument in favor of effluent fees is that they provide a revenue source to the public sector. Regardless of the efficiency of the system, the high costs of the regulators and associated bureaucracy that oversees the industries polluting is a cost to society. By charging for the "right to pollute", the regulating agencies are able to recollect some of their costs. Baumol and Oates point out that unlike most taxes, which place an "excess burden" on the economy, effluent fees have the tendency to correct distortions in the economy (Baumol and Oates, 1988).

Some argue that it is the right of the public, the owners of the environmental attributes that are being degraded by the polluters, to demand restitution for the damages inflicted by the polluters. In this case, the rights have been allotted to the public under the supervision of the governmental regulating group, and the effluent fees are merely compensation for their use. In the case of a marketable permit system, the firms involved are given the "right to pollute", which some environmentalists view as a misappropriation of rights.

Under the marketable permit system, if a firm is given more permits that they might otherwise need (ie: if the "grandfathered" total is incorrect), then the final pollution outcome may be worse than before the marketable permit system we implemented. If the aforesaid firm finds that the permits that it owns but doesn't use are of value, then it will use the market to sell those permits to a firm that will use them. In short, without careful analysis of the number of permits provided to each firm, the outcome could be more pollution that before the permit system was introduced.

3.2 Why Target NOx & SOx?

There were three chief rationales when choosing NOx and SOx as the foci of an emissions trading program in the Los Angeles Basin. First, smog is directly linked to NOx and SOx emissions. Aside from this aesthetic deterioration, NOx and SOx emissions present health effects in the form of respiratory illnesses. They, along with the NOx-byproduct, tropospheric ozone, present long-term health risks when citizens are exposed to ambient concentrations. Additionally, SOx emissions are attributed with the formation of small particulates and acid rain/fog in the area. The environmental and health issues regarding acid rain give further incentive for air quality managers to use NOx and SOx as target pollutants. Additionally, the Los Angeles Basin is the appropriate forum to combat these problems due to the topographic features and subsequent meteorology of the basin. These features augment the usual concerns over NOx and SOx induced smog in an urban environment. Simply put, the severe smog and resulting health impacts inherent to the sprawling SCAQMD require that strict action be taken to reduce NOx and SOx concentrations.

Second, both pollutants are logistically easy to monitor. Because they are both prevalent byproducts of industrial activity in a traditionally coal/petroleum fuel based economy, control technologies are fairly well established from attempts to reduce emissions. These pollutants have been injected into the Los Angeles Air Basin at alarming rates. Total NOx emissions in Los Angeles County alone for mobile and stationary sources were 908 tons/day in 1985 and 849 tons/day in 1990 (CARB, 2000). Of these emissions, 79% come from mobile sources (CARB, 1999). Estimated stationary NOx and SOx emissions for the year 1990 were 193.79 tons NOx/day and 37.33 tons SOx/day. Estimated basin wide emissions for 1990 were 1300.56 tons NOx/day and 95.39 tons SOx/day (CARB, 2000). More illustrative of the high NOx emissions were the 184 days exceeding 0.009-ppm ozone state standards (SCAQMD, 2000).

Third, the transport qualities of these pollutants make them applicable to a bubble type emissions trading program such as RECLAIM. The effects of these pollutants are regional, not just local. As a result, it creates a distinctive basin-wide problem. Because any attempt to account for the specific source of a particular deleterious impact of NOx and SOx emissions is near impossible, a regional, aggregate emissions trading program is most suitable to this area.

Although the Los Angeles basin suffers from the effects of more than just NOx and SOx pollution, these two pollutants were the only ones to be included into the RECLAIM program. Volatile organic compounds (VOCs) were initially considered for the project but were removed due to difficulties measuring and monitoring all the different sources of VOCs (Chinn, 1999). The evaporative qualities of VOCs complicate the monitoring of sources (Lents and Leyden, 1996). In addition, the local toxic nature of some VOCs made a regional regulatory approach inappropriate (Chinn, 1999).

3.3 Health Impacts of Pollutants

California State regulations place maximum ambient one-hour average standards at 0.25 ppm for both nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). Research indicates that at this level and above, NO_2 and SO_2 can have detrimental chronic health effects and increase morbidity and mortality (SCAQMD, 1997a). While other forms of nitrogen oxides (NOx) and sulfur oxides (SOx) are present in emissions from RECLAIM facilities other than NO_2 and SO_2, once entering the atmosphere, other species of NOx and SOx rapidly convert to NO_2 and SO_2 (Schlesinger, 1994). Critics of RECLAIM, however, assert that the that NOx and SOx create or exacerbate hazardous hot spots, particularly in neighborhoods of color (Lejano, Piazza, and Houston, 2000).

In 1997, SCAQMD monitored NO_2 at a maximum ambient measurement of 0.20 ppm (1 hour average), falling below the state standard of 0.25 ppm; and maximum ambient measurements of SO_2 at 0.015 ppm (24 hour average) and 0.10 ppm (1 hour average), both falling below state standards of 0.04 ppm and 0.25 ppm respectively (SCAQMD, 1997a). The Office of Environmental Health Hazard Assessment lists NO_2 and SO_2 as having chronic non-cancer risks for levels commonly emitted (OEHHA, 2000). Nitrogen dioxide and sulfur dioxide have associated cancer risks, but at levels far above regulated levels. Studies of rats and mice show mutagenesis in lung cells in vivo and in vitro due to NO_2 at levels of greater than 15 ppm (Isomura, et al., 1984; Walles, Victorin, and Lundberg, 1995).

Extensive studies, both in the Los Angeles Basin and other metropolitan areas have indicated a high correlation between hospital admissions for cardiopulmonary problems and days with high ambient NOx and SOx levels (Goldsmith, et al., 1983; MacPhail, 2000; SCAQMD, 1997a). Unfortunately, few of these studies distinguish NOx and SOx from the cumulative effects of these along with ozone, particulates, and toxics. Synergistic effects have been found in the combination of relatively high levels of NO_2 and ozone in the severity of lung structural damage. Correlations have also been made between SO_2 and fine particulates in terms of morbidity and mortality effects, though it remains unclear whether this is due to a synergism between the emissions or simply because similar combustion methods generate the same pollution index for the chemicals when measuring morbidity and mortality (SCAQMD, 1997a).

Isolating NOx from the other criteria pollutants, studies have shown NO_2 at low levels to aggravate chronic respiratory diseases and symptoms in sensitive groups such as children, the elderly, and those with chronic respiratory problems. Nitrogen dioxide exposures of <0.3 ppm for periods of over three hours produce cellular changes associated with allergic, inflammatory responses and interference with detoxification processes in the liver (SCAQMD, 1997a). Mutagenesis studies performed on mice and rats used high levels of NO_2 for periods of between four and forty-eight hours, the studies do imply risk to public health in the form of cellular and structural changes to the heart and lungs from long-term exposure to NO_2 (Isomura, et al., 1984; Walles, Victorin, and Lundberg, 1995; SCAQMD, 1997a). Short-term exposure to NO2 decreases lung capacity and increases airway restriction and resistance to air flow (SCAQMD, 1997a; MacPhail, 2000). Long-term exposure to NO_2 at 0.25 ppm lowers T-cells in the immune system and can result in other non-specific structural changes to other cells in the immune system (SCAQMD, 1997a).

While healthy subjects have failed to demonstrate functional respiratory changes in response to levels of SO_2 up to 1.0 ppm over a period of one to three hours, in asthmatics, exposure of only a few minutes to less than 0.25 ppm SO_2 can result in bronchial constriction, causing wheezing, shortness of breath, and a tightness in the chest. Similar acute effects in healthy individuals, however, are rare even with exposure to higher concentrations of SO2. Very high levels of exposure can result in lung edema and sloughing of epithelial cells in the respiratory tract (SCAQMD, 2000c). Though having no measurable acute or chronic toxicity effects in healthy individuals, SO_2 acts as a respiratory irritant. The EPA Office of Air Quality Planning and Standards (1997) likens exposure to "repeated sunburns of the lungs."

Population-based studies indicate that by themselves, NOx and SOx, particularly at the levels encountered in the Los Angeles Basin do not produce acute or cancer-causing effects (SCAQMD, 2000c). Indirectly and combined with other air pollutants, NOx and SOx, increase mortality and morbidity (MacPhail, 2000). Synergistic effects between NOx, SOx, and other chemicals continue to be a source of extensive research (Walles, Victorin, and Lundberg, 1995; SCAQMD, 1997a). Additional areas of concern for the health hazards of NOx and SOx in regard to RECLAIM include the potential for individuals to receive greater than maximum allowable levels due to cumulative impacts.

Similarly, as SO_2 has been positively correlated with particulates (SCAQMD 1997a), other hazardous or toxic chemicals may also be associated with NOx or SOx. Areas with increased exposure to airborne toxic chemicals, particularly from petroleum, metal, plastics, paint, and solvent industries, exhibit increased incidence of death and illnesses such as cancer, respiratory diseases, and birth defects including miscarriage and neural disorders (Bansal, et al., 1998). While Los Angeles Basin facilities may emit levels of toxics below the maximum allowable limits, which the SCAQMD has recently reduced the limit to 25 cancer case developed in one million affected individuals from 100 in one million, cumulative impacts from multiple facilities may increase cancer and non-cancer risks above allowable limits (CBE, 1998).

3.4 Los Angeles Basin Characteristics

In this section we provide background information on characteristics of air circulation that affect the distribution of pollutants in the Los Angeles Basin. This information is important in two ways; first, the basin meteorology can be used to evaluate RECLAIM trading designations and other geographically significant protocols. Second, and most importantly for our study, is the suitability of the basin's physical characteristics for the use of the RECLAIM program to solve air quality problems in the Los Angeles Basin. As is described below, the basin characteristics allow for the implementation of a program such RECLAIM to combat NOx and SOx emissions.

As more attention is given to toxic emissions however, increased considerations of local airflows are made. The MATES-II study performed by the SCAQMD indicates that the highest concentration of toxics from stationary sources tend to be located within a few kilometers of the source. The distribution of toxics was not a consideration when designing the RECLAIM program, however, thus micro scale airflow considerations were not significantly incorporated into its design.

Meteorological characteristics of the Los Angeles Basin outlined here, are findings from the 1994-1996 Surface Meteorology and Ozone Generation (SMOG) model. This model was used to analyze the distributions of ozone (O_3) from the 1987 Southern California Air Quality Study (SCAQS).

The major horizontal and vertical meteorological processes that take place within the Los Angeles Basin are closely defined by the basin topography and persistent sea breezes. Also of importance is the secondary, though nonetheless important, effect of an inversion layer formation.

The Los Angeles Basin is contained on three sides by mountain ranges and open to the ocean on the other. Predominantly, winds arrive from the west and blow across the basin towards the mountains (Lu and Turco, 1995). A majority of the pollution sources (NOx and ROGs) that produce O_3 are in the western portion of the basin. This creates a west-east pollution flow trend. In order to fully understand the subsequent circulation of ozone throughout the basin, the characteristics of an inversion layer must be identified.

An inversion layer is a condition that occurs when stable cool air lies below warmer air. The inversion in the Los Angeles Basin is caused primarily by the subsiding of air as a result of the Pacific subtropical high onto the turbulent surface. The surface cools the offshore breezes at night, effectively reinforcing and solidifying the inversion layer. This mixed layer deepens during the day as it encroaches upon the surface and thins at night as the inversion layer stabilizes (Edinger, et. al., 1972).

The meteorological processes taking place in the Los Angeles Basin are best explained with the use of a chronological simulation. In the early morning, ozone concentrations are very low on the surface of the entire Los Angeles Basin. As the morning progresses however, the ozone increases at the surface. This is in part due to the deepening of the inversion layer and subsequent mixing of aged polluted air from aloft. Into the afternoon, photochemically driven ozone, generated from NOx and VOC emissions, spread inland from their primary sources and add to ozone concentrations in the eastern basin. The mountains to the east act as a barrier confining polluted air within the basin. With the onset of evening, the stable inversion lowers and the cool sea breezes sweep the western basin effectively clean of many pollutants (Lu and Turco, 1996).

It is important to note that the characteristic life span of a pollutant plays an important role in where it resides. Pollutants that are converted by photochemical reactions (such as NOx) tend to be found in both newly contaminated air and in aged, polluted air aloft. Aside from ozone, carbon monoxide (CO) is an example of a pollutant that under goes minor photochemical transformations and can be found near the surface and in polluted layers stabilized aloft (Lu and Turco, 1996).

Air is entrained above the upper, stable inversion layer by three primary mechanisms. The first process, a convergence of air masses, is a common cause of uplift. In the Los Angeles Basin, there are two major convergence zones that allow polluted air to be ventilated above the inversion layer. One convergence zone lies in the San Fernando Valley and is essentially a result of an easterly and westerly sea breeze converging behind the Santa Monica Mountains. The air mass from the east is heated more by the surface, and provides the energy needed to move the polluted surface air into or above the inversion layer. The other takes place near Lake Elsinore where there is a similar sea breeze convergence. One air mass experiences more thermal forcing than the other prior to their convergence and results in vertical pumping (Smith and Edinger, 1984).

The second vertical pumping mechanism is mountain slope wind action. These winds, originating as sea breezes, drive air into the inversion layer via orographic lifting. As these winds hit the eastern mountainous Los Angeles Basin boundaries they are forced upslope and into the upper inversion strata. From here, the pollutants are spread back west within the elevated layers, blanketing the basin aloft. This air is stabilized in the evening hours and reintroduced to the surface air as the mixed layer thickens during the following morning and afternoon (Lu and Turco, 1996).

The third process involves a very deep mixed layer. Surface pollutants can be absorbed into the mixed layer during its deepest levels and dragged into the inversion layer as it thins. It is important to emphasize that for all of these mechanisms, aged, polluted air is often recirculated and entrained downward into the boundary (surface) layer as the mixed layer deepens with increased solar heating.

The entrainment of air into the inversion layer is not confined to just the eastern mountains. The Santa Ana Mountains for example, demonstrate these mechanisms and lead to a 'coastal' inversion layer blanket throughout the evening (McElroy and Smith, 1992). As a result, the new NO_x and hydrocarbons merge with old polluted subsiding air to create early morning, poor air quality levels along the coast. It is also interesting to note the nonlinear interactions of NO and O_3. At night NO is low in the elevated layers where O_3 has high concentrations, but NO and NOx concentrations are high at the surface layers where there is an absence of O_3. This is a product of NO titration (Jacob, 1999).

Not all of the pollution is trapped in the Los Angeles Basin. There are two main dispersion pathways that effectively take the polluted air away from the Basin. One pathway is by venting into the free troposphere above the inversion layer and the other is through advection over the high mountain passes. Polluted air is vented by a 'chimney' effect that is in simplest form an extreme version of the upslope wind lifting mechanism. Under intense solar heating the pollutants are entrained into the free troposphere above the inversion layer. Upslope winds can also carry polluted air out of the air shed; most notably where topographic 'soft spots' occur such as the major mountain passes (Cajon, Newhall and San Gorgonio) (Keith and Selik, 1977).

In sum, the largest pollution ozone precursor sources occur in the west while ozone pollution problems are heaviest to the east. Upslope residents on the San Bernardino and San Gabriel Mountains and residents in the San Fernando and Lake Elsinore Valleys suffer the worst ozone pollution conditions. Much of the ozone pollution in the Los Angeles Basin can be attributed to recirculation of old pollutants that have been thrust into the inversion layer, stored and reintroduced with the deepening mixed layer the following day. Of course, all pollutants do not function the same way. We can find this model useful, however, because it illustrates how a geographical setting such as the Los Angeles Basin (enclosed by ocean and mountains) continues to persist with poor air quality despite massive efforts to ameliorate the problem.

3.5 Environmental Justice Issues in Los Angeles

The environmental justice movement coalesced as the civil rights and grass roots environmental movements of the 1960s and 1970s began finding common ground in issues of disproportionate distributions of pollution. Disproportionality of negative environmental effects became a key focus of the environmental justice movement as social justice and environmentalism collided (Tietenberg, 1992). Dominant aspects of concern by the movement can be broken into three main areas (US Congress, Office of Technology Assessment, 1995):

- Disproportionate risk for environmental contamination
- Disproportionate effects of environmental nuisance
- Disproportionate access to the policy- and decision-making process

Executive Order 12898 defines environmental justice as "the fair treatment of people of all races, income, and culture with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (Chinn, 1999).

The evolution of modern environmental decision-making has spanned over four decades. Before the environmental regulations of the 1960s, the principle decision-makers dealing with pollutants were the polluters themselves. Industries held a monopoly on the health and safety information of their products and manufacturing processes. Companies determined the fate of their own hazardous and toxic substances. Rachel Carson's 1962 *Silent Spring* initiated the first investigations into the damage done by largely unregulated industries. The Clean Air Act and Clean Water Act lay the groundwork for public participation in environmental decision-making, but legalistic and technical documentation limited public involvement. The Right-to-Know Acts of the 1980s provided the environmental movement with access to the information it needed to effectively act in the environmental decision-making process (Tietenberg, 1992; Bullard, 1995).

The course of the civil rights movement towards the environmental decision-making process began to converge with the environmental movement as civil rights activists recognized that minority and low-income communities generally had different environmental concerns than middle- and upper-income communities, but that the "green" movement was predominately white. In 1983 after a series of protests in

African-American communities in North Carolina against the siting of a PCB waste facility, the U.S. General Accounting Office produced a study finding statistically significant relationships between the location of landfills, race, and socioeconomic status of communities (Bullard, 1995). The 1987 report "Toxic Waste and Race," by the United Church of Christ's Commission on Racial Justice, acted as the foundation for the burgeoning environmental justice movement (Bullard, 1995). Gaining numbers and momentum, the movement organized the First National People of Color Environmental Leadership Summit in 1991, prompting the Environmental Protection Agency (EPA) to create the Office of Environmental Equity (later to become the Office of Environmental Justice) (Tietenberg, 1992; Bullard, 1995).

President Clinton recognized the disproportionate impacts on minority communities as a federal priority, and in 1994 signed Executive Order 12,898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." Executive Order 12,898 called for all federal agencies to incorporate environmental justice into their missions. Agencies were directed to ensure that all federal and federally-funded programs affecting the environment would not "discriminate on the basis of race, color, or national origin" in accordance with Title VI of the Civil Rights Act. The EPA was given the particular duty of reviewing the effects of emissions regulations on minority and low-income communities under the Clean Air Act which reviews and approves state implementation plans (Chinn, 1999).

3.5.1 Communities for a Better Environment vs. The South Coast Air Quality Management District

In 1997, a coalition of environmental justice advocates made up of representatives from Communities for a Better Environment (CBE), the NAACP Legal Defense and Education Fund, and the Center on Race, Poverty, and the Environment became the first group to challenge the fairness of an emissions trading program on the grounds that it violated Title VI and Executive Order 12,898. The coalition contended that mobile source emission trading created toxic hotspots that disproportionately impacted low-income communities, specifically the Latino communities in the South Bay Area (Chinn, 1999).

The South Coast Air Quality Management District (SCAQMD) designed the mobile source emission trading rules to alleviate a credit shortage and contribute to bringing the Los Angeles Basin into attainment for ozone. Communities for a Better Environment specifically targeted the use of mobile source emission reduction credits (MSERCs) under Rule 1610 and Rule 1142 as being in violation with Title VI. Rule 1610 allows the scrapping of pre-1981 cars in exchange for VOC, NOx, CO, and particulate matter MSERCs. Mobile Source Emission Reduction Credits can subsequently be used to comply with Rule 1142, which requires marine tanker vessels to limit VOCs released during loading and maintenance. If the process exceeds the VOC threshold, Rule 1142 requires a 95% reduction in total VOC emissions. To keep emissions under the VOC threshold, oil companies needed to install vapor recovery systems costing from $4 to $30 million dollars each. Under Rule 1610, however, companies could purchase VOC credits from car scrapping to meet the required 95% reduction, costing an estimated total of $6 million for the combined companies (Chinn, 1999; Bansal, et. al., 1998).

Under this combination of rules, VOC emissions increased at the South Bay terminals and surrounding Latino communities while the air basin overall VOC reductions (Chinn, 1999). Communities for a Better Environment filed federal lawsuits against the four oil companies trading under Rules 1610 and 1142 on the grounds that the companies violated the Clean Air Act. Communities for a Better Environment's challenge of the constitutionality of Rules 1610 and 1142 along with their administrative complaint of SCAQMD is pending with the EPA's Civil Rights Office as of February 1999 (Chinn, 1999). SCAQMD attempted to overhaul Rules 1610 and 1142 and submit them to the EPA for inclusion in the SIP, but recent communication with SCAQMD indicates that while the 1997 SIP has finally been approved, Rule 1610 was not included (it is not known if Rule 1142 was also omitted) (Bansal and Kuhn, 1998; Drury et. al., 1999; Porche, 2000).

3.5.2 Tools for Finding Less Discriminatory Alternatives

In her paper, "Can the Market be Fair and Efficient?" Lily Chinn (1999) proposes, "The creation of a database mapping the demographic and marginal cost profiles of communities surrounding pollution sources should be a precondition to implementing any...proposed alternatives." SCAQMD created an Environmental Justice Task Force in response to Communities for a Better Environment's suit. The Environmental Justice Task Force delineated a ten-point plan, looking specifically at hot spots and cumulative impacts from multiple sources (Chinn, 1999; Porche 2000). Chinn suggests that demographic data of communities surrounding stationary pollution sources should be collected along with marginal abatement cost data to determine which sources will be most likely to purchase emission credits and which communities will be most affected. This analysis would provide the basis for a protocol to be used by SCAQMD when investigating emissions trading alternatives (Chinn, 1999).

3.5.3 Community Participation in RECLAIM

Traditionally, the environmental justice concerns of communities and advocacy groups can be broken down into three areas: distributional outcomes, effective participation, and freedom from bias in policy implementation (U.S. Congress, Office of Technology Assessment, 1995). In the case of RECLAIM, community concerns focus around the first two categories in very specific ways, while viewing biased policy implementation more generally. Due largely in part to the successful lobbying of the Regulatory Flexibility Group for suspension of industrial air quality regulations while the South Coast Air Quality Management District (SCAQMD) developed

RECLAIM, communities and environmental justice advocates felt that SCAQMD strongly favored the needs of industries in the implementation of policy over those of communities (Drury, et al., 1999). In an effort to ensure the tradability of emission credits in RECLAIM and reduce the transaction costs of industries utilizing the market, SCAQMD crafted the RECLAIM market such that trades can be made freely between companies without prior review by outside agencies (Bansal and Kuhn, 1998). Communities have criticized this aspect of RECLAIM as preventing public participation in the regulatory process (Drury, et al., 1999; SCAQMD 1999). The distributional impacts of RECLAIM came under heavy fire in 1997 as Communities for a Better Environment (CBE), the NAACP Legal Defense and Education Fund, and the Center on Race, Poverty, and the Environment filed suit against SCAQMD and five oil companies under Title VI of the Civil Rights act due to the unequal distribution of toxic emissions created by the trade of emissions credits under Rules 1610 and 1142 (Chinn, 1999).

While the Los Angeles Basin as a region may worry about the effects of NOx and SOx, local communities view toxic emissions as their primary concern, not ozone or acid rain (Drury, et. al., 1999). In the wake of the lawsuit against SCAQMD, communities have turned to looking at how the cumulative impacts of toxic co-pollutants to NOx and SOx are distributed due to the trade of RECLAIM credits (Drury, et al., 1999; Porche 2000). Most communities expressing environmental justice concerns regarding air quality in the Los Angeles Basin are not directly concerned with RECLAIM itself, but like the Philippine Action Group of Carson, Concerned Citizens of South Central Los Angeles, Casablanca of Riverside, and Madres of East Los Angeles exhibit fears over the emissions of specific companies in their neighborhoods (Porche, 2000). Few groups have the technical and legal expertise to address the issues and so join with larger groups such as Communities for a Better Environment which actively spearheads (among other issues) a campaign against pollution trading and cites that RECLAIM prevents active participation by the public in the regulatory process, favors the industries involved, and allows for unregulated cumulative toxic "hot spots" (Drury, et al., 1999).

Public Participation in Trade Related Decisions

Sunstein, Ackerman, and Stewart argue that pollution trading, as a form of market-based regulation for industries, allows for greater inclusion of the public in regulatory decision-making and encourages comprehensive deliberation of environmental goals on the part of publicly elected officials (Ackerman and Stewart, 1988; Sunstein, 1991). Under RECLAIM, however, industry management decides whether or not to purchase and use pollution credits without the overview of a regulatory agency. While SCAQMD audits industries on their trades on a regular basis, there is no review process involved in whether or not a company is allowed to increase their emissions. This is contrasted to permitting procedures used by other states in which affected community members can advocate pollution control measures during an industry's permit application process. In the majority of trades, the public has no knowledge of the transfer and no opportunity for comment (Drury, et al., 1999).

Following the lawsuit by Communities for a Better Environment against the SCAQMD, the SCAQMD governing board developed a list of ten environmental justice initiatives which included launching a series of town hall meetings and creating a task force to investigate local environmental justice concerns, specifically looking at disproportionate impacts created by emission trading programs (SCAQMD, 1997). While the task force has been commended on drawing together a diverse group of individuals working towards community outreach, the SCAQMD continues to receive strong criticism for lacking accessibility not only for public input, but even more simply for providing information to the public (Bansal, et al., 1998; Drury, et al., 1999; SCAQMD, 1999). While groups like CBE advocate a public comment and hearing procedure for major trades of emission credits, economists argue that such review would increase the transaction costs of emissions trading and reduce the viability of the program (Bansal and Kuhn, 1998; Bryner, 1997).

Bias Towards Industry

From the outset of the development of RECLAIM, communities have contended that the program favors the economic welfare of industries over the physical health of community members (Bansal, et al., 1998; SCAQMD, 1999). Drury, et al. assert that the SCAQMD significantly inflated the initial amounts of emission reduction credits allocated to facilities, estimating that the agency issued over 40,000 tons of NOx and SOx credits more than it should have based on actual emissions (Drury, et al., 1999). Community members criticize for RECLAIM allowing industries to avoid emission reductions while the health of individuals suffer.

Community critics further denounce RECLAIM as giving industries the moral right to pollute as much as they can pay for. Many feel that instead of treating pollution as a social ill to be stigmatized, RECLAIM makes pollution a commodity to be bought and sold instead of something to be penalized for (Drury, et al., 1999).

Community Participation Regarding Distributional Impacts

More than either public participation or industry bias, community groups are concerned with the unequal distribution of toxics due to the transfer of RECLAIM emission credits (Drury, et al., 1999). As the chemicals traded under RECLAIM, however, are non-toxics and non-carcinogens their link to toxic "hot spots" is indirect, yet important to examine. While RECLAIM allows for the trade of NOx and SOx, the production of these emissions in facilities is not distinct and separate from the production of other hazardous co-pollutants such as particulate matter or formaldehyde (Drury, 1999). The SCAQMD reports that over 70,000 people in the Los Angeles Basin face exposure to maximum individual cancer risk levels of over 100 in one million from an individual facility and over 1,300,000 face exposure to risk levels of between 10 and 100 in one million from an individual facility (SCAQMD, 1996). Comparatively, California's Proposition 65 requires public notification of exposure to carcinogenic substances with a cancer risk of over 10 in one million while the Clean Water Act and Superfund cleanups permit a cancer risk of one in a million (Bansal, et. al., 1998). Under the initial adoption in 1994 of the SCAQMD's Rule 1402 which regulates allowable limits of toxic air contaminants, the allowable threshold was set at a cancer risk of 100 in one million (Porras and Tapia, 2000). Between 1994 and 1998, only one facility exceeded the threshold and was required to notify the public. Critics from communities with facilities purchasing RECLAIM credits point out that by combining the ability of a facility to trade for additional NOx and SOx emissions with cancer thresholds that the SCAQMD has set too high endangers residents of neighborhoods where people are exposed to toxic emissions from not just an individual facility, but from numerous facilities (Bansal, et al., 1998; Porche, 2000).

While the SCAQMD reduced the cancer threshold allowed by Rule 1402 to 10 in one million in June 2000, community advocates complain that RECLAIM and other policies do not capture enough major polluters and allow many firms to go unregulated (Porche, 2000). Residents of impacted areas further point out that RECLAIM only regulates the largest companies and that RECLAIM trading exacerbates the cumulative impact of toxics produced by smaller facilities which make up the majority of firms and are not covered by the scope of RECLAIM (Bansal, et al., 1998).

Community members acknowledge the progress made on the part of the SCAQMD in the development of the environmental justice initiatives and the creation of the agency's environmental justice task force (Bansal, et. al, 1998). Some further recommendations that have come to the SCAQMD to modify RECLAIM to better safeguard the health of low-income, minority neighborhoods include prohibiting the trade of credits into already overburdened communities; prohibiting trading out of Reasonably Available Control Technology (RACT) requirements; allowing for community review and comment on proposed trades; developing a cumulative risk threshold; and developing a more accurate means of determining emission allocations to prevent the inflation of emission credits (Bansal and Kuhn, 1998; Bansal, et al., 1998; Drury, et al., 1999). Moral opposition to emissions trading notwithstanding, communities appear to see emissions trading as a regulatory tool with distinct problems, but with the possibility of working well with the right safeguards in place.

4. CURRENT RECLAIM SETTING

In this section, we provide information on the current setting of the RECLAIM program. This includes information on the current state of toxic pollutants in the Los Angeles Basin, the size and make-up of the RECLAIM Universe of facilities, and effects of RECLAIM on the labor demand of RECLAIM regulated facilities.

4.1 Toxics in the Los Angeles Basin

The criteria emissions regulated under the RECLAIM program are not the only emissions of concern in the Los Angeles Basin. Due to the Basin's large and diverse number of pollution sources, a wide variety of toxic pollutants are generated. Nearly all of the Toxic Air Pollutants (TAPs) that were included in our evaluation are members of the 188 ‘hazardous’ air pollutants (HAPs) in the 1990 Clean Air Act, Section 112 (Waxman, 1999). These represent those pollutants that present, or may present, through inhalation or other routes of exposure, a threat of adverse human health effects (including substances which are known to be, or may reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic, which cause reproductive dysfunction, or which are acutely or chronically toxic). Also outlined in the list of 188 hazardous air pollutants (HAPs) are those with adverse environmental effects whether through ambient concentrations, bioaccumulation, deposition, or otherwise (Clean Air Act, 1990). (For the purpose of our study, we assigned risk factors that only pertain to health impacts.)

Because of the harmful nature of these pollutants, this catalog of hazardous air pollutants is used to establish initial lists of source categories for which EPA would be required to establish technology based on emissions standards. Management of hazardous air pollutants would result in regulated companies sharply reducing their routine emissions of toxic air pollutants (OAQPS, 2000). Although toxic emissions from mobile and stationary sources have decreased, basin wide concentrations still exceed EPA health standards (Refer to Table 4.2). In light of these considerations, it can be stated with confidence that further toxic accumulations under RECLAIM trading would likely be harmful to local citizens.

According to the MATES-II study, overall carcinogenic emissions in the Los Angeles Basin have decreased significantly since 1990 (See Table 4.1) (MATES-II, 1999). Interestingly, these results do not include diesel particulates, which were not considered a carcinogen in 1990 and thus are not included in the current study (MATES-II, 1999).

Table 4.1: Decrease in carcinogenic emissions by city (SCAQMD, 1997a)

City	Burbank	Los Angeles	Long Beach	Rubidoux	Simi Valley	Upland
Decrease In Carcinogenic Emissions	63%	44%	56%	48%	56%	48%

Studies suggest that 71% of basin wide cancer risk is associated with diesel particulates, a major pollutant of mobile sources (MATES-II, 1999). As mobile source emissions are not a part of our study however, these numbers can hold more merit without diesel particulate values included. On the other hand, in 1993 mobile sources were responsible for 68% of butadiene emissions, 51% of formaldehyde formation, and 67% of benzene emissions (Waxman, 1999).

Focusing solely on stationary sources, the major contributing factor to the decrease in toxic and thus carcinogenic emissions has been twofold. The increased attention paid to toxic release concerns has heightened public awareness. Each year the EPA's National Toxic Inventory and AB 2588 programs outline the emissions of over 650 toxics into the air. Environmental justice leagues and non-profit organizations have raised a red flag over these emissions, labeling them as a high priority negative impact on neighborhoods. In response the SCAQMD has created environmental justice task forces and opened the 1401 rule (Control of Toxic Air Contaminants from Existing Sources) and 1402 rule (New Source Review of Carcinogenic Air Contaminants) to public input (Air Toxics Control Plan, 2000). As of 1999, the EPA has established more stringent standards for 47 major sources of hazardous air pollutants under the Clean Air Act's maximum available control technology (MACT) program in conjunction with emission standard setting by the National Emission Standards for Hazardous Air Pollutants (NESHAP) and guidelines from Rules 1401 and 1402 (Waxman, 1999).

Despite the evidence of decreased carcinogenic risks in the Los Angeles Basin, there is also statistical support for prevailing unsatisfactory ambient carcinogenic levels. Table 4.2 illustrates a 1995-1998 study performed at three sites in the Los Angeles Basin whereby 9 of the 10 compounds exceeded EPA health goals. Trichloroethylene equaled the desired concentrations.

Table 4.2: Average Concentrations of air toxics in Los Angeles (Waxman, 1999)

Compound	Number of Samples Collected	Average Concentration (μg/m³)	Max. Concentration (μg/m³)	EPA Benchmark Concentration (g/m3)
Benzene	282	6.32	23.3	0.13-0.34
Formaldehyde	196	5.57	16.0	0.077
Methylene Chloride	254	4.06	15.1	2.1
Perchloroethylene	254	2.69	11.6	0.17
1,3-Butadiene	257	0.93	4.44	0.0036
1,4-Dichlorobenzene	254	0.87	4.85	0.091
Carbon Tetrachloride	228	0.60	1.27	0.067
Trichloroethylene *	254	0.52	2.87	0.5
Chloroform	253	0.27	3.14	0.043
Chromium VI	297	0.00029	0.02	0.000083

* meets target concentrations

With the help of exposure data, potential cancer risks were calculated. Table 4.3 shows that the level of cancer risk aggregated over the 3 monitoring sites was well above the Clean Air Act health goal. These calculations outline the need for further efforts to reduce carcinogenic emissions. It should be noted that the risk estimates presented in this report represent what could be described as the "upper bounds" of the risk. Moreover, the hazardous air pollutants examined in this analysis have, in general, not been as well studied as ozone, carbon monoxide, and other "criteria" air pollutants subject to national ambient air quality standards.

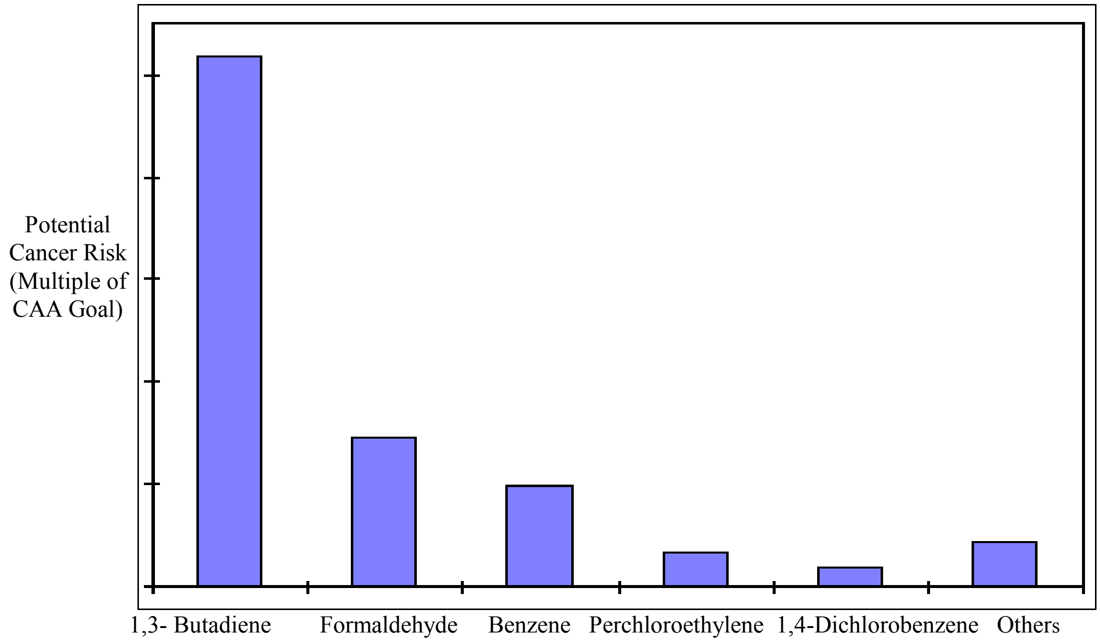
Table 4.3: Potential Cancer Risk by City* (Waxman, 1999)

Monitoring Location	Potential Cancer Risk ($X10^{-6}$)
Burbank	483
Los Angeles	470
Long Beach	323
Average Potential Cancer Risk	426
Clean Air Act Health Goal	1

*Potential cancer risks were above Clean Air Act health goals at all three monitoring locations in Los Angeles County

The most notable cancer risk associated pollutants in the Los Angeles Basin are 1, 3 Butadiene, Benzene and Formaldehyde. Figure 4.1 illustrates the potential cancer risks for each of the pollutants.

Figure 4.1: Potential Cancer Risk (Waxman, 1999)
Three compounds account for a large majority of cancer risks from hazardous air pollutants in Los Angeles



Because these concentrations and risks take into account mobile source emissions, we must assess them with a fair amount of caution when evaluating solely stationary source emissions. However, these major mobile source toxics are also significant stationary source pollutants in the Los Angeles Basin. Consider Table 4.4, where national emissions totals for the three most prolific toxics are separated into mobile and stationary source emissions.

Table 4.4: National Toxics Inventory Emissions Estimates (Waxman, 1999)

Compound	Mobile Sources: On-Road Vehicles	Mobile Sources: Non-Road Vehicles	Stationary and Other Sources	Total 1993 Emissions
1,3-Butadiene	36,660 tons (46.9%)	16,630 tons (21.2%)	24,940 tons (31.9%)	78,230 tons
Formaldehyde[17]	96,810 tons (35%)	26,860 tons (10%)	156,130 tons (55%)	279,800 tons
Benzene	207,300 tons (47%)	90,000 tons (20%)	145,100 tons (33%)	442,400 tons

Table 4.4 illustrates the prevalence of 1,3-butadiene, benzene, and formaldehyde in stationary source emissions. 1,3-butadiene and benzene are major byproducts of the petroleum industry and contribute heavily to the risk-weighted emissions of SIC 2911 in the Los Angeles Basin. Formaldehyde is a severe health risk and major byproduct

of combustion equipment in refineries and electric utility facilities (MATES-II, 1999). Appendix D lists the other toxic air contaminants that have been determined by the EPA.

Efforts have been made in the SCAQMD to reduce toxic emissions from all sources. Programs such as the Low Emission Vehicles (LEV) program and conversions to cleaner-burning, low-sulfur gasoline (which has substantially reduced benzene emissions from automobiles) have been implemented. Because of stringent regulations mandated in the Clean Air Act and NESHAP, stationary source emissions have decreased steadily since 1990 and are estimated to continue decreasing as well (See Table 4.5) (Waxman, 1999). Despite these efforts, there are still concerns over the state of toxic emissions in the Los Angeles basin.

RECLAIM has been assigned the duty of generally reducing the flow of pollution into the troposphere so as to create healthier air for the citizens to breath. The targeted pollutants under RECLAIM are NOx and SOx. These criteria pollutants were chosen primarily due to their widespread and intensive emissions throughout the basin. They also aid in the production of tropospheric ozone, acid rain and brown haze. While they are extremely important pollutants, other chemical constituents also contribute to these air quality problems over the Los Angeles basin including CO and VOCs. Very different from the atmospheric chemistry for NOx and SOx or CO and VOCs are the toxic pollutants, including organics and metals. All told, this mosaic of pollutants helps to elucidate the very difficult nature of managing an entire air basin such as that of LA with its wide variety of industrial activities. The pollutants vary in their atmospheric concentrations, residence times and health risks making a management scheme limited in its efficacy.
Not only is the efficacy of RECLAIM brought into question with respect to its comprehensive and widespread improvements in air quality (criteria and toxic pollutants alike), it is also questioned in its presumed propensity to accumulate emissions in local areas. Of most concern are the toxic emissions, especially because they are already considered above acceptable EPA health standard levels, and as such, they may present increased health risks to citizens in exposed neighborhood.

Table 4.5: Comparative Inventory of 9 Significant Toxics for Major Stationary/Area Sources in the SCAQMD for Years 1998 and 2010 (Tons/ day) (SCAQMD, 1997a)

Source Category	1,3 Benzene	p-Dichloro Butadiene	Perchloro-chloride	Trichloro-ethylene	Formalde-ethylene	Acetalde-hyde	Diesel PM	Hex Chromium	Nickel
1998 Stationary and Area Sources	1.489	.080	6.234	14.842	1.276	.140	.410	7.25×10^{-4}	.055
***2010 Stationary and Area Sources**	1.198	.115	6.187	14.510	1.042	.143	.399	7.35×10^{-4}	.042

* Based upon 1997 South Coast Air Quality Management Plan (SCAQMP) estimations. Data from SCAQMD Air Toxics Control Plan

4.2 The RECLAIM Universe

Early proposals for a NOx trading program outlined 390 sources in the SCAQMD, which represented over 65% of the stationary NOx emissions (Burnside, et al., 1996). It was intended that each of these sources would be provided with a target emission level, which would include detailed reductions through the year 2003. These emission reductions were developed so that the total emissions for the SCAQMD would be reduced by 80 tons per day. Over 84% of the emissions of the 390 sources were generated by 38% of the facilities (148 out of 390), which are lumped into four SIC groups: electricity, gas, and sanitary services; oil and gas extraction; stone, clay and glass; and petroleum and coal products (Burnside, et al., 1996).

When the RECLAIM Program was adopted in 1993, 394 firms were included in the RECLAIM Universe of sources. The initial allocations of SOx and NOx RTCs were 10,365.02 tons and 40,127.18 tons, respectively, which were based on 1990, 1991 and 1992 facility emissions data (Lieu, et al., 1998). Recent analyses by the AQMD indicate that there are approximately 512 facilities that are not currently in the RECLAIM program that have the potential to participate (Lieu, et al., 1998). Historically, certain types of facilities have been excluded from the program; these facilities include police and fire facilities, water delivery facilities, restaurants, ski resorts, hospitals, prisons, and waste-to-energy facilities (Lieu, et al., 1998).

By late 1995, the RECLAIM Universe had been reduced from 394 firms to 346 (Burnside, et al., 1996; Lieu, et al., 1998). Approximately 61 of the initial RECLAIM Universe were excluded from the program along with their allocations, and 14 facilities ceased operations due to factors other than RECLAIM (Lieu, et al., 1998). Many of the firms that were initially in the program were found to be exempt because the initial emissions calculations were incorrect (and lower than 4 tons per year). In addition, a few new firms entered the program because of underestimation of initial emission levels, or because new processes or pollution sources were brought online. The AQMD has made it clear to firms that once they are in the program, they may not elect to drop out or discontinue their participation. As noted in Table 4.6, by the end of the 1996 compliance year, the number of facilities in the RECLAIM Universe had dropped from 394 to 329 facilities (Lieu, et al., 1998).

Table 4.6: RECLAIM Universe Changes for the First Three Compliance Years (Lieu, et al., 1998).

	NOx Facilities	SOx Facilities	Total Facilities
Start of Program	**392**	**41**	**394**
Inclusions - 1994	14	2	14
Exclusions - 1994	54	3	55
Shutdowns - 1994	5	1	5
End of 1994 Compliance year	**345**	**39**	**346**
Inclusions - 1995	2	2	2
Exclusions - 1995	6	1	6
Shutdowns - 1995	9	1	9
End of 1995 Compliance year	**334**	**39**	**335**
Inclusions - 1996	0	0	0
Exclusions - 1996	0	0	0
Shutdowns - 1996	5	2	6
End of 1996 Compliance year	**329**	**37**	**329**

4.3 RECLAIM's Impact on Labor Demand

A serious concern of companies and regulators alike is the impact of regulation on the labor demand within the regulated industries, otherwise known as an employment effect. Unfortunately, this measurement is difficult to predict because of the influence that all other aspects of business operations have on employment levels. The National Bureau of Economic Research attempted such a study in the South Coast region in 1997, and presented surprising results (Berman and Bui, 1997).

The general premise behind environmental regulation and labor demand is twofold: first, environmental regulation increases the abatement costs within an industry, in turn decreases revenues, which ultimately leads to decreased labor demand; second, environmental regulation leads to increased abatement, which may complement labor, and increase labor demand. Because these two forces pull labor demand in different directions, the final outcome is difficult to predict. Berman and Bui conducted an evaluation of the SCAQMD RECLAIM program, comparing the labor demand of similar unregulated facilities in Texas and Louisiana to those in the highly regulated SCAQMD. By using Census data (the Pollution Abatement Costs and Expenditures Survey [PACE], and the Longitudinal Research Database [LRD],) to control for exogenous changes in plant, industry, and regional employment, Berman and Bui were able to reliably calculate the impact of RECLAIM on employment in the SCAQMD.

Berman and Bui found that new regulations induce a per-plant abatement investment of $500K, whereas an increase in the stringency of regulations induces per-plant abatement investments by $1.8M. In response to these abatement investments, they found a loss of 2.2 workers per plant for new regulations, and a gain of 2.6 workers per plant for increased stringency of regulation. The net results of the analysis indicated that because of the RECLAIM program, there were approximately 8,500 jobs created in the SCAQMD (Berman and Bui, 1997). The results (8,500 jobs in the SCAQMD is roughly .06% of the population,) are likely due to three factors: first, the RECLAIM regulations affect capital-intensive plants with low employment levels differently than they do non capital-intensive plants, or those with high employment levels; second, the scope of the market is limited to the local area, and all competitors are subject to identical regulations; third, all abatement inputs are complements to employment (Berman and Bui, 1997).

5. RESEARCH QUESTIONS

The purpose of our project was to evaluate the RECLAIM program according to two very different research questions.

- What is the correlation between RECLAIM pollutants and toxic pollutants? Has RECLAIM disproportionately affected certain communities, exacerbating toxic "hotspots" around low income and minority populations?
- What is the impact of RECLAIM on company investment decisions on end-of-pipe and pollution prevention technologies?

The different focus of these two questions led us to divide our research efforts into the two areas, Environmental Justice and Investment Decisions. In this section, we outline the research methodology use to answer each question and present and discuss our results. Due to the differences in research methodology and data analysis used to answer the two questions, this section has been divided into two parts, one for each question, in order to more clearly understand the research processes and results.

5.1 Air Quality & Environmental Justice - Has RECLAIM had an impact on the distribution of pollutants?

While the public values the economic gains, employment provided by industry, and health benefits of overall reductions in NOx and SOx concentrations, they also have fears that RECLAIM is creating disparate distributions of toxics in different communities (Bansal, et. al., 1998; Drury, et. al., 1999). In order to comprehensively evaluate RECLAIM for environmental justice impacts, we must answer the following question: What is the correlation between RECLAIM pollutants and toxic pollutants, and has RECLAIM disproportionately affected certain communities, creating toxic "hotspots" around low income and minority populations?

This study examines the potential for hotspots and cumulative impacts in three main ways: correlating the production of RECLAIM target pollutants with toxic risk-weighted emissions; using GIS to examine the relationship between the physical geography of RECLAIM facilities, their emissions, and the minority and impoverished composition of neighborhoods surrounding facilities; and using GIS to examine the relationship between RECLAIM facilities, their trade patterns, and the surrounding communities.

5.1.1 Methodology

The first criteria question concerns the impact of RECLAIM on the air quality of the SCAQMD. Reductions in facility NOx and SOx emissions have been clearly documented in Los Angeles due in part to the implementation of RECLAIM. The question this study seeks to answer is: What, if any, are the effects of RECLAIM upon the distribution of toxic emissions within the basin? As credits to emit NOx and SOx are traded, toxic emissions accumulate around facilities and aggregate locally within neighborhoods and districts. Because toxic pollutants may have acute health affects, questions concerning the accumulation of toxic emissions in certain local areas may arise. Since RECLAIM facilities are the most prominent polluters in the basin, this question is of great significance. How have accumulations of toxics accompanied the overall shifts in NOx and SOx emissions at certain facilities under the RECLAIM program?

In order to answer these questions regarding RECLAIM's role in the distribution of toxics, we examine the total toxic emissions of each facility and the toxic emission characteristics of each industry with respect to NOx and SOx emissions. The toxic emissions for each facility are assigned a toxic risk or "risky emissions" number. Industries are also evaluated to help see if certain types of RECLAIM facilities have a high correlation between NOx/SOx and toxic emissions. This information is important because it will help to identify the exposure of certain neighborhoods to toxic hotspots under RECLAIM. Particular facilities within industries that have high NOx/SOx to toxic emission correlations can be flagged as potential high-risk emitters or high-risk health hazards. In other words, under RECLAIM trading, an accumulation of credits by these facilities may be considered more risky to local community health than that of other more benign polluters.

5.1.2 Pollution Producer Patterns

Combining the emissions data collected in 1998 for RECLAIM facilities with GIS maps of cities in the Los Angeles Basin, patterns of NOx and SOx production can be examined in terms of geographic location. The meteorology of the Los Angeles basin makes this analysis particularly important for understanding where NOx and SOx are dispersed to after their production. In the design of RECLAIM, the South Coast Air Quality Management District recognized that the off-shore winds coming across the coastal area pick up emissions such as NOx and SOx and blow them inland, where they are trapped against the base of the mountains, making smog particularly bad in cities such as Riverside. For this reason, they divided the RECLAIM trade area into a coastal and inland zone and specified regulations to alleviate the accumulation of NOx and SOx in the inland areas.

A simple analysis was performed to examine the geographic patterns of NOx and SOx producers in the Basin. The emissions data collected for the RECLAIM facilities were tabulated by city, providing total annual emissions of criteria pollutants and toxics for each city in 1998. These totals were layered into a GIS containing the cities of the Los Angeles Basin. Boundary data for the SCAQMD, basin cities, and coastline were all obtained from 1995 U.S. Bureau of Census TIGER® data in the

ArcData Online Database (ArcData Online 2000). From this combination of data maps were produced showing the levels of NOx and SOx production in cities throughout the basin.

As Figure 5.1 indicates, with the exception of one city in San Bernardino County, all of the largest producers of NOx lie along the coastline in Los Angeles or Orange Counties. Of the top ten NOx producers in RECLAIM, responsible for 10,800 tons of over 21,000 tons of NOx per year, all but one lie within the AQMD Coastal Region. The vast majority of production, over 15,000 tons, originates from Los Angeles County. Figure 5.2 shows similar patterns in cities containing SOx producing industries. The largest SOx producers in the basin reside in the Coastal area in Los Angeles County. With the exception of the city of Riverside in Riverside County and Fullerton in Orange County, all facilities producing more than 25 tons of SOx per year lie in Los Angeles County.

This geographic analysis illustrates the importance of the designation of the Coastal and Inland trade areas and the inclusion of the trade restrictions regulating movement of RTCs between the two trade areas. With the Basin's meteorology, the trade restrictions between Coastal and Inland facilities would be important if NOx and SOx production were evenly distributed throughout the basin. The bulk of criteria pollutant production lying along the coastline, however, makes the Coastal/Inland rules even more crucial for reducing the impact of traded emissions on the Inland communities. The scope of our study, unfortunately, does not allow for evaluation of the effectiveness of the Coastal/Inland rules in terms of pollution reduction in Inland areas. The effectiveness of the Coastal/Inland trading restrictions could be examined, however, by combining Coastal and Inland trade data with monitored ambient NOx and SOx data and analyzed in a GIS to determine if the regulations on RECLAIM facilities in the Coastal areas have affected smog levels in inland regions.

Figure 5.1: Map of cities producing NOx in the SCAQMD with amounts of NOx produced.

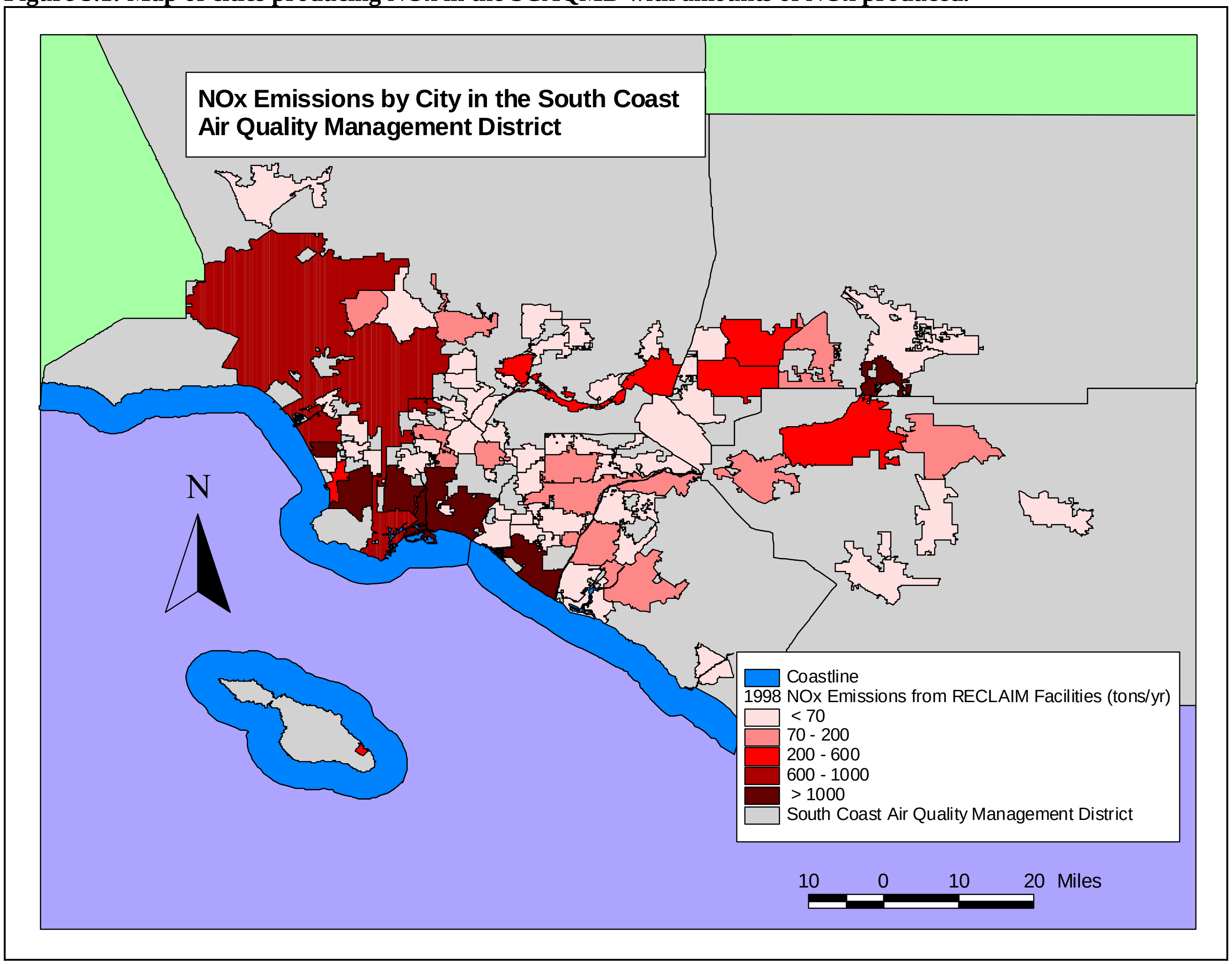
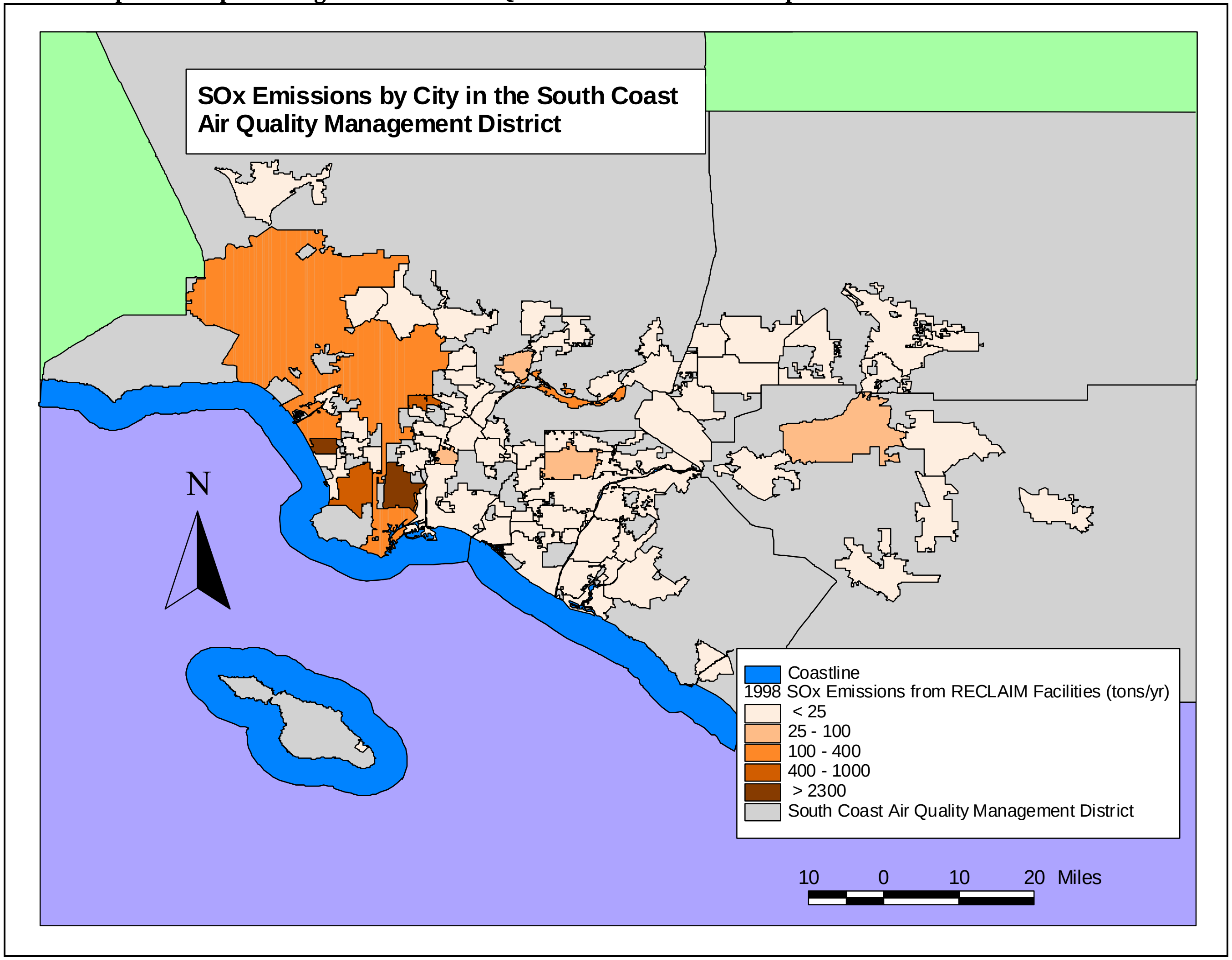


Figure 5.2: Map of cities producing SOx in the SCAQMD with amounts of SOx produced



5.1.3 Correlation of Toxics to RECLAIM Pollutants

The fears expressed by community members over toxics and possible cumulative impacts created by the RECLAIM program raises a key question for the trading of NOx and SOx credits: Is a purchase of NOx or SOx credits a de facto purchase of increased toxic emissions? Posing this question, it is recognized that the purchase of RTCs in no way allows facilities to emit toxics over set limits. Community groups criticized the SCAQMD, however, for originally setting allowable limits of cancer risk from toxics at 100 cancer cases per million individuals even when industry advocates suggested a limit at 50 per million (CBE, 1998). Both communities and the SCAQMD have concerns over the cumulative impact of toxic emissions and recognize that increasing toxics, even below set limits, could cause adverse health impacts in areas affected by emissions from numerous facilities (Drury, et al., 1999; Porche, 2000). If RTC trading does indirectly allow for increases in toxic emissions and toxic risks, then RECLAIM could exacerbate toxic hotspots.

To examine if RTC trading can change toxic risk levels, correlations were run between the NOx and SOx emissions and risk-weighted toxic emissions for RECLAIM facilities. RECLAIM participating facilities were evaluated by aggregating non-cancer weighted risks from 91 toxic air pollutants (TAPs) and cancer weighted risks from 43 TAPs. (The TAPs used in this study are listed in Appendix D) The process by which these pollutants were chosen is two fold. First, using the Air Toxics Hot Spot Program and criteria emissions database (CARB, 2000), the toxic air pollutants emitted by RECLAIM participating facilities were identified. From here, facility emissions were multiplied by the OEHHA/ARB Approved Risk Assessment Health Values in the form of Unit Risk Factors (URF) for both cancer and non-cancer risks. As exposure data would be necessary to find the probabilistic risk factors for the toxic emissions, multiplying the toxic emissions (in tons per year) times the URF gives a standardized risk-weighted toxic emission that can be summed along with the standardized emissions of the other emitted toxics. The sum of the risk-weighted toxic emissions gives a combined risk-weighted emissions total for each facility which can be used for relative comparisons among facilities (it cannot be used to calculate risk to an individual).

The CARB database provided 130 toxic species, the URFs of which were determined for 117 species (OEHHA, 2001; CARB, 2001). The remaining 13 toxic species comprise less than 1% of total emissions. Lead chromate and strontium chromate are treated as chromium compounds in our analysis; aluminum, aluminum oxide, and carbon black extract as particulate matter; and isocyanates as methyl isocyanates. Polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons, while not differentiated by CARB in their database of facilities' toxic emissions, are given a range of risk values by CAPCOA (Leon, 1997; OEHHA, 2001). Analysis replicates were performed using both the minimum and maximum unit risk factors for both emission types. To prevent autocorrelation, NOx and SOx were initially left out of the combined risk-weighted toxic emission factors but were later added for the analysis by industry. Of the other criteria pollutants, CO and particulate matter were also included in the combined emission factors along with the listed toxic emissions.

The analysis consisted of performing a series of bivariate correlations, first using annual NOx emissions (in tons per year) as the independent variable and non-cancer risk-weighted emissions and cancer risk-weighted emissions as the dependent variables in separate correlations. For each pairing, correlations were calculated for both the minimum and maximum risk values used in the toxic emission weighting. This process was repeated using SOx as the independent variable.

Table 5.1: Statistical Results from the Correlation of NOx and SOx with Risk-Weighted Toxic Emissions

Independent	**Risk-Weighted**	**R^2 Range**	**R^2 Range**	**Correlation Slope**	**Correlation Slope**
Variable	**Emission Type**	**(Min. Risk Values)**	**(Max. Risk Values)**	**(Min. Risk Values)**	**(Max Risk Values)**
NOx	Non-Cancer	0.3290	0.3334	132845	138381
NOx	Cancer	0.1642	0.2994	0.0242	0.0351
SOx	Non-Cancer	0.5225	0.5438	269114	284107
SOx	Cancer	0.4827	0.6479	0.0668	0.0830

The coefficients of determination for the non-cancer correlations for both NOx and SOx appeared to remain fairly consistent between the minimum and maximum risk treatments. Similarly, the slopes between the minimum and maximum risk treatments for the non-cancer correlations also exhibited little difference. The correlations between NOx and SOx and the risk-weighted toxic emissions for cancer risk showed greater variability, however, both in their coefficients of determination and their slopes. All cases show clusters of points near the origin and along the axes, indicating that many facilities producing low levels of NOx or SOx produced relatively high risk-weighted toxic emissions and that many facilities producing greater levels of NOx and SOx often produced relatively low amounts of risk-weighted toxic emissions (See Appendix B). A pattern of this type would be unlikely to produce the positively sloping correlations calculated in our analysis.

The slopes for each correlation appear significantly influenced by five major outliers. Examining the points in greater detail, the outliers belong to the top five NOx and SOx producers. To see how much influence the outliers have on the trends calculated in the analysis, the outliers were removed from the correlation.

Table 5.2: Statistical Results from the Correlation of NOx and SOx with Risk-Weighted Toxic Emissions

Independent	**Risk-Weighted**	**R^2 Range**	**R^2 Range**	**Correlation Slope**	**Correlation Slope**
Variable	**Emission Type**	**(Min. Risk Values)**	**(Max. Risk Values)**	**(Min. Risk Values)**	**(Max Risk Values)**
NOx	Non-Cancer	5×10^{-5}	5×10^{-5}	-2150.7	-2172.4
NOx	Cancer	0.0031	0.0636	0.0007	0.0077
SOx	Non-Cancer	7×10^{-5}	7×10^{-5}	4486.3	4470.6
SOx	Cancer	0.0103	0.22552	0.0021	0.0256

While the coefficients of determination and slopes for the non-cancer treatments in the correlations without the five outliers nicely agree with each other for both the minimum and maximum risk values, the coefficients of determination indicate that the slope does a particularly poor job of explaining the relationship between the points. The cancer risk treatments also see poor coefficients of determination without the outliers. The lack of explanation for the pattern without the outliers indicates that the five outliers influence the slope trends to a high degree.

The outlying points, representing the five facilities emitting the most NOx and SOx, produce a pattern with all the facilities that, at first glance, would suggest that higher production of NOx and SOx generally correlates with higher toxic risk-weighted emissions. Closer inspection reveals, however, that this may only be the case for a subsection of the RECLAIM facilities, and in fact may only be the case for the five greatest NOx and SOx emitters. Removal of the outliers suggests that for many RECLAIM facilities increased production of NOx or SOx does not correlate with toxic risk-weighted emissions or could actually correlate with lower toxic risk-weighted emissions. This analysis suggests that further correlations should be performed on categories of RECLAIM facilities determined by industry type.

5.1.4 Correlation Analysis by Industry

The South Coast Air Quality Management District assigns industry codes to all facilities. These industry codes or Standard Industrial Classification (SIC) Codes are used by AQMDs to manage the diverse spectrum of facility types under their jurisdiction. Similar facility processes, technologies and effluents occur within single industry types. In response, AQMDs can regulate SIC codes with a blanket approach. This broad management scheme is effective because of its efficiency to the regulator and its equity across industry facilities. Under RECLAIM management, NOx and SOx emissions are added across all SIC codes into an aggregate basin wide total. Focusing on the SIC totals can be very illustrative when trying to assess which facilities are the major NOx and SOx emitters. These SIC subtotals can also be useful when trying to assess the relationship between NOx/SOx emissions and toxic emissions. They serve to divide the RECLAIM participating industries into a logical structure for analysis. Evaluating a relationship between NOx/SOx and toxic emissions by SIC code uses the similar attributes of the facilities to support any final conclusions.

As mentioned, there are numerous types of facilities operating in the Los Angeles Basin with some industries producing more NOx/SOx than others. The SIC codes are expressed in a four digit fashion where the first two digits indicate the broad industry type and the last two express the specific aspect of that industry a facility operates in. For example if we examine the code 3312 we find that 33 is the number for the primary metal industry and 12 the number for blast furnaces and steel mills.

The petroleum refining industry (SIC 2911) accounts for the most NOx emissions by RECLAIM facilities in the SCAQMD for the year 1998. (See Appendix E for a detailed analysis of this industry) The petroleum refining SIC produced the most NOx emissions per facility at 496.66 tons/year for all SIC codes containing more than 5 facilities. This SIC code also produced the most aggregate NOx emissions for any industry code. The cement/hydraulics industry (SIC 3241) had the highest NOx emissions per facility in at 992.778 tons/year, although this only accounts for two facilities.

The facilities in the petroleum refining industry SIC produced far and away the most SOx emissions in 1998 of any other RECLAIM facilities. At an average of 395.99 tons per year per facility, SIC 2911 emitted more than the industry with the next emissions by over 4,500 tons per year.

There is an important point to consider when evaluating these statistics in an effort to identify correlations in toxic emissions with respect to higher NOx and SOx emissions. It is not so much the amount of toxics or NOx/SOx emitted that is important. Rather it is the industry correlation between toxic (and subsequent cancer and non-cancer risk-weighted emissions) and NOx/SOx emissions. If we assume that equipment and processes are similar between facilities within a single SIC code, then we can argue that the performance of one facility will be similar to another facility of similar size. We can only make this conclusion however, if there is a strong industry correlation between non-cancer/cancer risk-weighted emissions and NOx/SOx emissions for all size facilities. If a strong analysis is made, then one may make the assumption that a facility, which accumulates emissions credits to emit NOx or SOx, will increase cancer/non-cancer risk-weighted emissions at a rate that is similar to the industry ratio. It is important to note that a facility may not use all of their credits for reasons such as improper production forecasting and an inability to set off extra credits.

When examining the relationship between NOx/SOx emissions and cancer/non-cancer risk weighted emissions in 1998, only a few SIC codes showed a statistically significant relationship. Industries with a significant connection between variables can be used to examine the effects on toxic emissions of facilities accruing credits to emit NOx or SOx. Table 5.3 charts the industries or industrial sectors that demonstrate a strong overall relationship.

A major assumption to all conclusions is that particular toxic emissions are associated equally between NOx or SOx producing activities. Another shortcoming of these results is the treatment of cancer risk. Exposure variables associated with cancer risk are omitted because of the complex pathways by which they travel in and settle out of the atmosphere. Our analysis does not account for such pathways. It is important to note that the increased risk-weighted emissions described in tons should include the omitted exposure factor to determine a proper increase in tonnage. Strong relationships should tend to take place in industries where there is homogeneity amongst the facilities' procedures and equipment. If a particular SIC code contains facilities of a varying nature then a correlation between size and emissions characteristics will be difficult to find. Hence, the chosen industries and their accompanying high R^2 and p-stat values represent industries of a reasonably homogenous nature.

The crude petroleum and natural gas industry (SIC code 1113) demonstrates a very strong correlation between SOx and cancer risk-weighted emissions. The slope of the regression line is 0.2961, indicating that a one ton increase in SOx will result in 1.48×10^{-04} (0.2961 lbs/2000 lbs) cancer risk-weighted tons of emissions by RECLAIM participating facilities in this industry. The primary toxics with associated cancer risks emitted by industry 1311 and thus the contributing toxics to any increase in the cancer risk-weighted emissions include: acetaldehyde, benzene, formaldehyde, H_2S, napthalene, propylene, tuolene and xylene.

Table 5.3: Relationship between NOx/SOx and toxics.

1) Statistically significant relationships between NOx/ SOx and Cancer/ Non-Cancer risk-weighted emissions by industry. 2) Cancer and Non-Cancer Risk-Weighted Emissions Increase Factors From a One Ton Increase in NOx or SOx emissions

		Ton Increase in Risk-Weighted Emissions/Ton NOx/ SOx Emission Increase											
Industry Type	**SIC**	**NOx/Cancer**			**NOx/Non-cancer**			**SOx/Cancer**			**SOx/Non-cancer**		
		R^2	**Sig***	**X****	**R^2**	**Sig***	**X****	**R^2**	**Sig***	**X****	**R^2**	**Sig***	**X****
Crude Petroleum and Natural Gas	1113							0.90	0.000	1.48×10^{-04}			
Finishing Plants-Cotton	2261	0.74	0.027	7.08×10^{-08}	0.49	0.122	92.12						
Chemicals and Allied Products	28				0.50	0.001	58.55						
Petroleum Refining	2911	0.39	0.018	2.77×10^{-05}	0.71	0.000	113.39	0.69	0.000	5.25×10^{-05}	0.81	0.000	169.83
Industrial Laundry	72	0.99	0.001	9.19×10^{-9}	1.0	0.000	0.24	0.93	0.046	1.29×10^{-6}	0.91	0.038	32.95

*** Significance refers to Probability statistic**

**** X refers to slope of regression line**

Finishing plants, notably those associated with cotton, scored a high R^2 in both NOx categories. Cancer risk-weighted emissions will increase at a rate of 7.075 X 10^{-08} tons per ton increase in NOx. Non-cancer risk-weighted emissions will increase at a rate of 92.12 tons per ton increase in NOx emissions. The results from this statistical analysis are the result of one particular facility with approximately twice the NOx production but with ten times the cancer risk-weighted emissions. The assumption here is that increased output and subsequent increased releases of NOx would lead to the implementation of technology and process requirements that greatly increase toxic emissions.

A similar conclusion can be made for trends in the chemicals and allied products industry. For a one ton increase in NOx emissions by RECLAIM participating facilities in this industry, a 58.55 ton Non-cancer risk-weighted emissions increase would be expected. Like SIC code 2261, this result is based upon the performance of one facility with a significantly higher overall emission output than the rest. The petroleum and coal industry, SIC 29, on the other hand provides the most comprehensive results to analyze.

The major influence on these strong correlations occurs with respect to RECLAIM participating facilities in the petroleum refining industry (SIC 2911) simply because it accounts for over 98% of the total NOx and SOx emissions. The entire petroleum and coal products industry (SIC 29) however, maintains a high correlation also due in part to the asphalt paving and roofing materials (SIC 2951,2) where significant R^2 scores are found. Nontheless, industry 2911 provides the clearest illustration of the potential for increased risk-weighted emissions with augmented NOx and SOx emissions due to RECLAIM trading amongst similar facilities.

Cancer risk-weighted emissions, according to our regression results, should increase at a rate of 2.77 X 10^{-05} tons per ton of NOx emissions and 5.25 X 10^{-05} tons per ton of SOx emissions in the petroleum refining industry (2911). Non-cancer risk-weighted emissions should increase at a rate of 169.83 tons per one ton increase in NOx emissions and 113.39 tons per one ton of increased SOx emissions by RECLAIM participating facilities in this industry.

The marked increase in non-cancer risk-weighted emissions per ton NOx/SOx emissions compared to the lesser increase in cancer risk-weighted emissions for the facilities of SIC 2911 has a simple explanation. The four largest petroleum-refining plants emit approximately 10-100 times more NOx and SOx than the other refineries in the industry but emit nearly 1000 times the amount of non-cancer risk-weighted emissions. There seems to be a trend in the petroleum industry (SIC 2911) whereby the processes and technologies needed to operate at a high capacity (>1000 tons NOx/yr and >500 tons SOx/yr) will also lead to a higher output of toxics. Table 5.3

shows a clear trend exists in that the Non-cancer risk-weighted emissions increase at a greater rate per increased NOx/SOx emissions than cancer risk-weighted emissions. These significant relationships become of greater consequence when accounting for the numerous toxics being emitted and the high rate at which they are being produced by these facilities. Citizens living in close proximity to these facilities are already exposed to large amount of risk-weighted emissions and with a further increase in NOx and SOx production will be exposed to an even greater amount. (Stated with some confidence in light of the high R^2 scores)

To further elucidate the tendency for some larger industries, and facilities therein, to emit more toxics as NOx and SOx emissions increase, we can examine the industrial laundry sector or SIC 72. There are only four RECLAIM participating facilities in this industry but their emissions ratios are intriguing never the less. The four facilities, three of which are from the same company, deliver an R^2 of one when comparing NOx emissions to Non-cancer risk-weighted emissions. In a linear fashion, these four facilities increase their Non-cancer risk-weighted emissions by 0.24 tons per ton of increased NOx. All other ratios score with an R^2 of greater than 0.9 indicating that there is a uniform emission factor by which all SIC 29 facilities are growing within. Under these conditions, elevated toxic emissions can be easily determined from increased facility production of NOx in the case of an accumulation of RECLAIM emission credits.

5.1.5 Using GIS to Evaluate the Potential for Toxic Hotspots Among Minority and Impoverished Neighborhoods

In evaluating the environmental justice impacts of RECLAIM, the areas of impact must first be identified (Glickman, 1999). While other research has documented income and race as being primary factors in the relationship between housing and toxic emissions in Los Angeles County (Burke, 1993; Szazs, et al., 1993; Boer, et al,. 1997), this study looks at these factors in regards specifically to RECLAIM facilities. In 1999, Theodore Glickman proposed that proximity-based measurements of environmental justice are insufficient for examining the threat of industrial hazards to surrounding communities and suggested that they be combined with risk-based measurements to provide a more comprehensive investigation of hazards. This study spatially analyzes the demographic data of the South Coast Air Quality Management District in regard to RECLAIM facilities and combines it with a comparison of risk-weighted emissions estimates to determine if minority and impoverished communities are at risk from the RECLAIM trading program.

Census data for all four counties in the South Coast Air Quality Management District was U.S. Bureau of Census TIGER® 1995 (census data obtained through the ArcData Online database and analyzed in ArcView, ArcData Online 2000). The 1998 RECLAIM facilities the study had emissions data for were mapped on top of the demographic data. Out of the 367 facilities the study for which we were able to collect emissions data for, 320 were successfully mapped onto the demographic data. An imaginary circle one-half mile in diameter was constructed around each facility (henceforth called the "impact area") in ArcView (see Figure 5.3 for an example). Glickman's own study of Allegheny County, Pennsylvania used circles of one-half mile, one mile, and two miles (1994). A study using similar methods by James Sadd of Los Angeles County used circles of one mile radius, but concedes that circles of one-half mile radius would achieve the same results (1999). In order to consider hotspots, this study examines the demographics within one-half mile of the RECLAIM facility as the impact area.

Glickman's paper defined equity as the proportion of non-whites or poor within the combined impact areas equaling the proportion of non-whites or poor outside of the total impact area (1994). Using this methodology, average proportions of non-whites and impoverished in impact areas around RECLAIM facilities throughout the Los Angeles Basin (henceforth called the "RECLAIM-wide impact area average") were compared to the average proportions of non-whites and impoverished outside of the impact areas for all RECLAIM facilities. Non-white populations were calculated for each census block by subtracting the "white" populations from the total census block population. The U.S. Census Bureau defines "white" as a self-defined classification of race. It should be noted that the Census Bureau defines "race" as being significantly different from "ancestry". The definitions of "race" and "ancestry" used by the census and the debate surrounding them are discussed in great detail by Edmonston and Schultze in their article, "Data on Race and Ethnicity" (1995). This study does not claim to make any categorizations regarding race or ancestry and uses the census figures for these categories for the sake of simplicity. Census blocks were used for the comparison of non-white populations in and outside of impact areas.

We also used the U.S. Census Bureau's definition for "poverty" which is based on a set of factors including total family income, number of family members, the Consumer Price Index, number of children, and debt. From these factors a two-dimensional matrix consisting of family size and number of family members under age 18 is constructed and threshold levels are set for each class in the matrix. The Census Bureau revises poverty thresholds on an annual basis. Family income is compared to the threshold for the appropriate section of matrix. The number of individuals below the poverty line is the sum of people in families whose income falls below the threshold for their category (ArcData Online, 2000). To use income information, however, census block group data, the combined census data from a number of blocks, had to be used for the comparison of impoverished populations in and outside of impact areas.

Based on the discussion by Sadd et al. (1999) of the use of one mile versus one-half mile radius impact areas, when census blocks or census block groups were partially contained within the radius of the impact areas, the blocks and block groups were still considered within the impact area. Comparisons were then made for the top five cities producing the greatest amounts of NOx and SOx. El Segundo, Carson, and Wilmington, all in Los Angeles County, were each in the top three cities producing both NOx and SOx for 1998. Colton, in Riverside County, placed fourth in NOx production and Long Beach, in Los Angeles County was the fifth largest contributor of NOx in 1998. Torrance and Vernon, both in Los Angeles County placed fourth and fifth respectively in SOx production in 1998. The City of Los Angeles, Huntington Beach, and Avalon were also examined, rounding out the top ten producers of NOx. The paired proportions were then statistically compared using a two-tailed C-test with a 0.05 percent significance level (see Appendix C for sample calculations).

The aggregated Los Angeles Basin, consisting of Los Angeles, Riverside, Orange, and San Bernardino Counties shows 7.57% more non-whites proportionally in populations in impact areas (defined as the area within the 0.5 mile radius of a given facility) with a high level of significance. The cities of El Segundo, Carson, Colton, Long Beach, and Torrance all show significantly higher proportions of non-whites within the impact areas than outside the impact areas. As Table 5.4 shows, the differences between the proportions of non-whites ranged from 1.68% in Carson to 15.1% in Torrance. Wilmington, Huntington Beach, and Los Angeles shows significantly lower proportions of non-whites in impact areas with differences ranging from 0.87% in Los Angeles to 1.83% in Huntington Beach. Vernon shows no significant difference between proportions of non-whites within and outside of impact areas.
The aggregated Los Angeles Basin again sees highly significant differences in the 1.82% greater proportion of impoverished residents in the impact areas of RECLAIM facilities. El Segundo, Wilmington, Colton, and Long Beach, exhibit significantly greater proportions of impoverished residents in impact areas, showing differences ranging from 2.22% in El Segundo to 11.6% in Long Beach. Carson and Los Angeles show significantly lower proportions of impoverished residents with differences ranging between 0.76% in Los Angeles to 0.99% in Carson. Huntington Beach and Torrance show no significant difference in proportions. In Vernon, all census block groups were within a one-half mile radius of RECLAIM facilities and so no comparison could be made with impoverished Vernon residents outside of impact areas. Avalon, the tenth largest producer of NOx in the Los Angeles basin, could not be analyzed for differences in either non-white or impoverished populations as the RECLAIM facilities impacting Avalon's air qualities are offshore oil platforms and were not included among the facilities mapped in the GIS.

Table 5.4: Minority composition of around RECLAIM facilities.
The Proportion of Non-Whites in and outside Impact Areas of RECLAIM Facilities in the Aggregated Los Angeles Basin, Top 10 NOx Producing Cities, and Top 5 SOx Producing Cities. Significance tested using a two-tailed C-test.

City	Proportion Within Impact Area	Proportion Outside Impact Area	Significance (* indicates significance)	NOx Production Ranking	SOx Production Ranking
Aggregated L.A. Basin	0.3871	0.3114	0.000*		
El Segundo	0.1088	0.0912	0.000*	#1	#3
Carson	0.6193	0.6025	0.000*	#2	#1
Wilmington	0.0699	0.0893	0.000*	#3	#2
Colton	0.5275	0.4160	0.000*	#4	
Long Beach	0.5543	0.4054	0.000*	#5	
Torrance	0.0280	0.1787	0.000*	#6	
Huntington Beach	0.1236	0.1419	0.000*	#7	
Los Angeles	0.2945	0.3032	0.000*	#8	
Vernon	0.5763	0.5294	0.314	#9	
Avalon				#10	

Table 5.5: Composition of impoverished communities around RECLAIM facilities.
The Proportion of Impoverished in and outside Impact Areas of RECLAIM Facilities in the Aggregated Los Angeles Basin, Top 10 NOx Producing Cities, and Top 5 SOx Producing Cities. Significance tested using a two-tailed C-test.

City	Proportion Within Impact Area	Proportion Outside Impact Area	Significance (* indicates significance)	NOx Production Ranking	SOx Production Ranking
Aggregated L.A. Basin	0.1461	0.1279	0.000*		
El Segundo	0.0530	0.0308	0.000*	#1	#3
Carson	0.0677	0.0776	0.000*	#2	#1
Wilmington	0.1512	0.1110	0.000*	#3	#2
Colton	0.2299	0.1757	0.000*	#4	
Long Beach	0.2653	0.1493	0.000*	#5	
Torrance	0.0496	0.0509	0.272	#6	
Huntington Beach	0.0562	0.0531	0.042	#7	
Los Angeles	0.1805	0.1881	0.000*	#8	
Vernon	0.3543	0.0000		#9	
Avalon				#10	

The analysis indicates that although the difference between the proportions of non-white and impoverished residents within and outside Los Angeles Basin RECLAIM facility impact areas will, on average, be less than 10%, there is a statistically significant greater proportion of non-whites and impoverished residents nearby RECLAIM facilities.

Error in this analysis can be attributed to a number of areas: 1) accuracy of the census data, 2) accuracy in mapping RECLAIM facilities, and 3) summarizing the demographic data with relation to the RECLAIM facilities.

- **Accuracy of census data -** Unfortunately, by the time of this study, the 2000 census data was not available for use, meaning that all of the demographic information is at least ten years old. In this time, the Los Angeles Basin has seen demographic shifts throughout its neighborhoods (Elnecave, 1999). Furthermore, the topic of errors racial demographics in census data have a field of literature to themselves, so discussion of their problems will not be included here for the sake of brevity (Edmonston and Schultze, 1995).
- **Accuracy in mapping RECLAIM facilities -** Of the data collected on RECLAIM facilities for the 1998 trade year, many facilities provided incomplete addresses for their location, often making it difficult or even impossible to map their location in ArcView. With a database of 367 facilities to map, and only 320 facilities matching addresses in the census data street layer, a significant number of facility locations could not be identified and analyzed. This study also fails to include any facilities entering the RECLAIM program after 1998 and fails to remove facilities which have gone out of business since 1998.
- **Summarizing the demographic data with relation to the RECLAIM facilities -** As none of the census blocks or census block groups formed perfect circles, a certain amount of overlap outside the one-half mile radius impact area must be accounted as a source of error for summarizing the numbers of non-white and impoverished residents in impact areas. The relatively small physical size of the census blocks produced areas better fitting to the circular impact areas than the larger census block groups. This problem is exemplified in the analysis of Vernon. The census blocks were small enough to have a populations both inside and outside the impact areas within the Vernon city limits. The large size of the census blocks groups in Vernon, however, meant that at least a portion of every census block group in Vernon was within one-half mile of a RECLAIM facility, thus preventing a comparison with Vernon populations outside the "impact area."

As the significance of the toxic risk weighted emissions are largely dependent upon the industry type emitting, increases and decreases in toxic weighted emissions may be unreliable for looking at city-scale emissions unless the cohort of RECLAIM facilities all have NOx or SOx strongly correlated with toxics. Examining specific facilities, however, within an industry type with strong NOx/SOx/toxic correlations could prove valuable for evaluating RECLAIM's impact on aggravating hotspots particularly for minority and poor communities.

This study uses the facilities in the city of Wilmington as a case study for applying the combination of trade data, emissions correlations, and GIS demographic analysis. Wilmington was chosen for this example as it is one of the top producers of NOx and SOx in the Los Angeles Basin, the demographic analysis shows that there are disproportionately large impoverished communities around its RECLAIM facilities, and trade data was collected and compiled for the majority of the RECLAIM facilities in the city. (See Appendix E for a case study applying these methods to evaluate potential environmental justice impacts in the city of Wilmington.)

5.1.6 Using GIS to Evaluate the Potential for Environmental Justice Issues

To determine if RTC accumulation can aggravate hot spots that create environmental justice issues, we examine the relationship between the movement of RTCs and the proportions of minorities and the impoverished in neighborhoods surrounding RECLAIM facilities. This analysis provides a crucial link between the relation of RECLAIM target pollutants traded with RTCs to other toxic emissions and the minority and impoverished populations around RECLAIM facilities. By examining the flow of RTCs into and out of facilities, we can determine if environmental justice issues may arise from the trade of credits. Environmental justice issues arise from largely minority and impoverished populations receiving disproportionately higher risks from hazardous and/or toxic emissions. (U.S. Congress, Office of Technological Assessment, 1995). In theory, this could occur in a neighborhood surrounding a RECLAIM facility with greater than average percentages of minorities and impoverished in which the RECLAIM facility has received a net positive balance of RTCs and is of the industries discussed in this study to have a significant correlation between RECLAIM target pollutants and toxic risk-weighted emissions. The positive balance of RTCs allows the facility to produce more NOx or SOx and in turn, create a hot spot by emitting more toxics into the disproportionately large minority/impoverished community.

To examine this, we look at the proportions of minorities and the impoverished surrounding RECLAIM facilities in reference to trade patterns of the facilities. We divided the RECLAIM facilities mapped in our GIS into five categories: those with a net positive RTC balance for both NOx and SOx, those with a net negative RTC balance for both NOx and SOx, and those with a RTC balance of zero. Percentages of minorities and impoverished in a 0.5 mile radius of these facilities were compared to percentages outside the 0.5 mile impact area and compared to the Los Angeles Basin averages calculated earlier for both impact and non-impact areas. This analysis again used the U.S. Bureau of Census TIGER® 1995 Census data obtained through the ArcData Online database, the 320 RECLAIM facilities mapped in ArcView, and

1998 trade data collected through the AQMD database (ArcData Online 2000). We compared the proportions of minority and impoverished populations with Basin averages using a two-tailed C-test with a 0.05 percent significance level (see Appendix C for sample calculations).

Table 5.6: Trading activity and minority and impoverished communities.
Minority and impoverished proportions of communities in and outside of the 0.5 mile impact area surrounding RECLAIM facilities that have positive RTC balances, negative RTC balances, and zero-balance/non-trading. The percentages are compared with the averages for the Los Angeles Basin calculated previously in this text.

Sample Type	Sample Area	Facility Category	% of Population	Diff. from Avg.	Significance (* indicates significance)
Minority	**Within 0.5 mi.**	Basin Average	38.71		
		+ NOx RTC Balance	40.90	2.197	0.000*
		+ SOx RTC Balance	52.18	13.478	0.000*
		- NOx RTC Balance	41.09	2.388	0.000*
		- SOx RTC Balance	43.71	5.000	0.000*
		No Trade or Net Zero RTCs	38.13	-0.573	0.000*
	Outside 0.5 mi.	Basin Average	31.14		
		+ NOx RTC Balance	31.49	0.352	0.000*
		+ SOx RTC Balance	31.72	0.232	0.000*
		- NOx RTC Balance	31.60	0.460	0.000*
		- SOx RTC Balance	31.77	0.631	0.000*
		No Trade or Net Zero RTCs	31.56	0.419	0.000*
Impoverished	**Within 0.5 mi.**	Basin Average	14.61		
		+ NOx RTC Balance	15.80	1.185	0.000*
		+ SOx RTC Balance	20.88	6.269	0.000*
		- NOx RTC Balance	15.29	0.681	0.000*
		- SOx RTC Balance	18.47	3.861	0.000*
		No Trade or Net Zero RTCs	15.28	0.671	0.000*
	Outside 0.5 mi.	Basin Average	12.79		
		+ NOx RTC Balance	12.88	0.094	0.000*
		+ SOx RTC Balance	13.03	0.237	0.000*
		- NOx RTC Balance	12.99	0.204	0.000*
		- SOx RTC Balance	13.04	0.251	0.000*
		No Trade or Net Zero RTCs	12.90	0.113	0.000*

Analysis of the communities surrounding facilities with net *positive* balances of both NOx and SOx RTC credits revealed significantly higher percentages of minorities within the 0.5 mile impact area compared to the RECLAIM-wide impact area average. As Table 5.6 illustrates, our calculations show that minority populations surrounding RECLAIM facilities with a positive NOx RTC balance comprised 40.9% of the population in the impact area, a difference of 2.2% over the RECLAIM-wide impact area average of 38.7%. Similarly, facilities with positive SOx RTC balances showed minorities making up 52.2% of the population immediately surrounding the facilities, 13.5% greater than the RECLAIM-wide impact area average. Our analysis shows that the minority population *outside* the impact areas to be 31.5% for NOx-buying facilities and 31.7% for SOx-buying facilities, compared to 31.1% of the population for the RECLAIM-wide impact area average. All of these differences, including those between proportions outside the impact area (differences of as little as 0.4%), proved to be significant in our analysis.

As Table 5.6 illustrates, the results for impoverished populations proved similar to minority populations. Impoverished populations around NOx-buying facilities make up 15.7% of the total populations in the impact areas and 20.9% of the populations in the impact areas around SOx-buying facilities. Our analyses show these proportions to be significantly greater than the 14.6% RECLAIM-wide impact area average for impoverished populations. Outside the impact areas, the percentage of impoverished in communities looked similar to the Basin average with 12.9% around NOx-buyers and 13.0% around SOx-buyers, compared to the Basin average of 12.8%. Statistical analysis of these proportions again show these small differences to be significant.

Table 5.6 shows that the percentage of minorities in communities surrounding facilities with net *negative* balances of both NOx and SOx are significantly higher than the RECLAIM-wide impact area average. Our analysis shows that minorities make up 41.1% of populations in the 0.5-mile impact area around net NOx-selling facilities and 43.7% of populations around net SOx-selling facilities. Outside the impact area, minority proportions are between 31%-32%, with 31.6% outside of NOx-selling facilities and 31.8% outside of SOx-selling facilities. Comparison to the RECLAIM-wide impact area average of 31.1% for communities outside of facility impact areas shows these percentages to be significantly greater (Table 5.6). Thus just as communities surrounding NOx/SOx-buying facilities have greater minority and impoverished populations, so to do communities surrounding NOx/SOx-selling facilities.

Table 5.6 further shows that populations surrounding net *sellers* of RTCs have impoverished populations significantly above the RECLAIM-wide impact area average of 14.6%. In communities around facilities with net *negative* NOx balances, the impoverished populations comprise 15.8% of the total populations in the impact area, while facilities with negative SOx balances appear to be surrounded by communities where 20.9% of the population is in poverty. Outside of impact areas, the impoverished make up 12.9% and 13.0% of communities around NOx-selling and SOx-selling facilities respectively, holding close to the Basin average of 12.8%. All differences between sample treatments and the Basin average, whether inside or outside of impact areas are shown by our analysis to be statistically significant (Table 5.6).

As table 5.6 shows, RECLAIM facilities which either did not trade or had a net balance of both NOx and SOx RTCs of zero, exhibited neighborhoods within the 0.5 mile impact area with a significantly lower than average minority percentage at 38.1%, but an above average percentage of the impoverished with 15.3%. Outside the impact areas of non-trading or zero-balance facilities, the impoverished were significantly above average with 12.9% and minority populations were also significantly above the Basin average with 31.6%.

The analysis indicates no conclusive relationship between the direction of RTC trading and the percentage of minorities and impoverished. This is not to say that these communities are not already at risk. Our analysis shows that even without emissions trading there are more minorities and impoverished in neighborhoods surrounding RECLAIM facilities than average. A variety of other studies have also shown the disproportionate risk to low-income and non-white communities in the Los Angeles Basin (Bansal, et al., 1998; Bansal and Kuhn, 1998; Chinn, 1999; Drury, et al., 1999; Sadd, et al., 1999). Our analysis of emissions trading, however, gives no conclusive evidence that RTC trading does or does not exacerbate hotspots in minority and impoverished communities.

The fact that minority percentages surrounding non-trading and zero-balance RECLAIM facilities are below average, however, indicates that facilities in communities with greater than average populations of minorities chose trading of RTCs as a significant portion of their strategy to comply with regulation in 1998. More analysis is required, however, to make this generalization any broader than for the 1998 trade year. This could be examined through the analysis of the net RTC trades over all the trading years for RECLAIM facilities or examining trade data from other RECLAIM trading years to look for patterns.

In addition to the sources of error previously cited for our analysis of the communities surrounding RECLAIM facilities in specific cities, other sources of error particular to this analysis can be found in the sample population sizes. The population sizes used in the statistical comparison of the minority and impoverished proportions strongly influences the significance of the results. For the city-by-city analysis performed previously in this study, the population sizes were low enough that differences between percentages of 0.1 to 5 percentage points showed no significant difference between the two proportions. In this analysis, however, the population sizes of the samples were an order of magnitude larger and so differences between proportions as low as 0.1 percentage points showed significant differences in the proportions. For this reason, the magnitude of differences between the sample proportion and the Basin average should be carefully examined and size of the aggregation of samples should be taken into consideration.

The trade data used may also prove to be a source of error for this analysis. As mentioned earlier, this analysis only accounts for 1998 trades. Without analysis of other trade years, any conclusions based on this evidence hold only for 1998 and should not be extrapolated to other years. This is particularly important considering the efficiency of the RTC market. Emissions trading programs rely on market efficiency to distribute emission credits and equalize marginal costs of abatement across market participants (Bryner, 1997; Drury, et al., 1999). Recent studies of the RECLAIM market show that allocations of RTCs have been above what facilities had been producing for years, creating a glut in the marketplace of credits, and it has only been in the last two years that the number of credits has been ratcheted down to a level that matches facility emission levels that require abatement technologies (Burnside and Eichenbaum, 1996; Luong, et al., 2000). This has recently caused a sharp increase in the price of RTCs. With the clearinghouse system of selling credits, facilities sell their credits to the clearinghouse and if the clearinghouse cannot sell the credits, the selling facility must buy back its credits. These transactions are often at zero cost, but are still considered a trade for accounting purposes. For the purposes of this analysis, this confuses the difference between facilities that did not trade at all, those that tried to sell credits and failed, and those that sold some number of credits for a non-zero amount and later bought the same number of credits for a non-zero amount. Facilities that have a net RTC balance of zero do not necessarily mean that they have traded no RTCs. For this reason, our analysis can be considered an end-of-trade-year snapshot and cannot account for the effects of trades over the course of the year if the facility's ending balance is zero.

5.2 What is the impact of RECLAIM on pollution control decisions?

One goal of a marketable emission permit system is to generate conditions by which firms can take advantage of least-cost pollution abatement measures. The firms with low costs of abatement will be able to profit from their actions by way of the permit market. One way to measure the success of the RECLAIM program is to see if, in fact, firms are able to take advantage of these least-cost options. For this reason, we felt that our analysis needed to analyze pollution abatement and permit trading activities, and in particular, to see if RECLAIM has impacted the pollution control decisions of the firms which it regulates. The main questions that we hoped to answer with our analysis of the firms within RECLAIM was: How are firms responding to trading opportunities? Are some firms meeting their pollution allocations through the trading mechanism, while others are installing pollution abatement technologies? With these questions in mind, we designed a survey and collected data directly from the AQMD.

5.2.1 Survey Overview

The original trade dataset, downloaded from the AQMD BBS on May 18th, 2000, contained all historical information on the trades that had taken place within the RECLAIM community, ordered by date, price, quantity, and facility identification number, over the history of the program. This list accounts for, as of the 21st of April, 2000, 7,935 individual trades. In addition, a facility list (without contact information) was also downloaded. This original facility list accounted for 534 facilities within the SCAQMD RECLAIM Universe.

Additional RECLAIM Universe information was obtained from the AQMD. The dataset was the result of a database programming effort by the AQMD Public Records office. The dataset contained information on 519 facilities, which was then reduced to 483 by removing duplicate entries and facilities with the same air quality manager. This facility dataset was then modified to represent only firm-level data, and was reduced to 310 firms, which included only individual companies, as opposed to facilities. If multiple air quality managers/contact persons were listed for the different facilities within a company, they were all included in the list.

The RECLAIM Universe data was particularly difficult to access. Firstly, the trade dataset is still housed on a BBS, which requires direct dial-up access. There is relatively little data pertinent to a study of trading and/or regulatory efforts on the SCAQMD web site. Secondly, the company information (SIC codes, contact names, addresses, phone numbers, and facility-level data,) requires a "special programming" effort by the SCAQMD Public Records Department. The first request for data was submitted to the SCAQMD Public Records Department in June of 2000; a secondary (identical) request was submitted on September 8th, 2000, and the final dataset was provided by the Public Records Department on the 17th of November, 2000.
It is important to note that a small fraction (~10%) of the companies within RECLAIM have either gone out of business, or no longer participate. In these cases, the SCAQMD has indicated that they do not keep facility information, nor is it available to the general public. For these companies, we have trade information but no other corporate information, nor contact information. Therefore the greater list of past and present RECLAIM Universe companies is much larger than the list of current RECLAIM Universe companies.

Because we were interested in corporate information, rather than information at the facility level, we needed to eliminate the repeat entries from the datasets. From the original dataset, we deleted any multiple sources within the same facility, or multiple facilities under the same company and/or facility manager, thus arriving at the final list for our first mailing. Of the original dataset of 310, only 278 firms are represented. This list DID include repeat listings for different facilities within the same company ONLY IF they were under the jurisdiction of a different air quality manager. In this case, it was our hope that one of the surveys would make it to the correct person, and would be returned. We only received duplicate survey responses for five companies, and the survey responses were identical- regardless of original facility information. For this reason, the survey pool is slightly larger than the RECLAIM company pool.

The survey was originally designed to collect much of the information that the SCAQMD made available to us after responding to our second Public Records request. After that information became available (in particular, the SIC data and firm location data,) we were able to focus the on individual firm characteristics, details of the firm's participation in the RECLAIM program (as well as other regulatory programs,) and self-evaluated levels of pollution prevention and abatement. Paired with the aggregated trade information, the total dataset would give us a robust picture of the firm, as well as its pollution strategy.

In order to gauge the appropriateness of the questions on our survey, phone interviews were conducted with two of the potential participants of the survey. They verified the validity of the questions, and made recommendations on the wording and phrasing of the questions. Additionally, the survey was reviewed internally by the four group members and two faculty advisors, as well as by two PhD students in the ESM program.

5.2.2 Survey Questions & Data

It was a goal of the survey design process to keep the survey simple. For this reason the length was limited to the front of a single page, with no more than fifteen questions. If at all possible, the question responses were prompted with check-boxes, or yes/no options. A copy of the final survey and survey cover letter are provided in Appendices G and H. The survey itself was comprised of the eleven primary questions that are outlined below:

1. Year of entry into RECLAIM

The year of entry question was included as a control variable, to differentiate between firms who have been in RECLAIM since the beginning, and those that are more recent entrants.

2. Initial allocation of RTCs (Tons/Year)

The initial allocation question was included to differentiate between the levels of permits that were acquired from year to year, and those that the firm had to begin with. Ultimately, this question should provide better understanding of firms that have chosen to drastically reduce pollution levels through process control.

3. Total number of employees in the Company

The number of employees in the Company will act as a control variable, to help to differentiate between the smaller, local companies, that those that have a more global market presence.

4. Total number of employees responsible for Air Quality Management

The number of employees dedicated to air quality management will shed like on the importance that the company places on maintaining air quality regulations, or the difficulties associate with doing so.

5. Frequency of meeting with AQMD representatives

Frequency of meeting with air quality representatives may allow for differentiation between firms that are able to easily manage air quality and those that have more of a difficulty, or those that place a high premium on maintaining air quality regulations.

6. Participation in informational AQMD meetings

Again, participation in the informational meetings may shed light on the effort that the firm is directing at meeting air quality regulations, or at adopting more innovative pollution abatement technologies.

7. ISO-14001 Certification

ISO-14001 compliant companies have made an effort to implement environmental management standards in some portion of their facilities, which may indicate more concern for environmental quality.

8. Participation in any additional Voluntary Environmental Quality (VEQ) programs

Firms that participate in VEQ programs may be more proactive with the installation of air pollution abatement equipment.

9. Scope of end market

Firms that sell within the AQMD are likely to have competitors that do so as well, and therefore may act differently than those who sell their products or services outside of the AQMD.

10. Investment in End-of-Pipe Pollution Abatement Solutions

The self-measured investment in technology will serve as one of four potential dependent variables (the others being investment in pollution prevention solutions, using the trading market, and transferring permits between facilities,) and is a measure of the firm's investment in this category as compared to their competitors.

11. Investment in Pollution Prevention Solutions

The second of four dependent variables, which is a self-measure of the firm's investment in these technologies, as compared to their competitors.

5.2.3 Non-survey Data

As noted earlier, additional facility information was provided by the AQMD, and trade information was collected from the AQMD BBS. From those two information sources, the following data was used to construct variables that will be used in our estimation procedures:

Inland/Coastal Location

A dummy variable for coastal location was constructed from this information. The coastal location places trading restrictions on the facilities in that they can only acquire permits from other coastal sources. For this reason, we thought that it would be an important modifier of our analyses.

Cycle information

Firms in the RECLAIM Universe are divided into two cycles, and this variable corresponds with the cycle within which they operate and thus purchase permits.

Public/Private Classification

From the original mailing list, a search was conducted to determine which of the firms were publicly or privately held. The information was then used to create a dummy variable for those firms whose stock is traded on the open market.

4-digit SIC information

The RECLAIM dataset that was provided by the SCAQMD included four digit SIC codes for each of the facilities. This information was then combined to form dummy variables for five different sector classifications, as well as a dummy variable for the combination of these five sectors. The dummy variables include: metal, and metal products; stone, clay, glass, rubber, plastic, and paper products; electric, gas, and sanitary services; petroleum, chemicals, oil, and gas extraction; and finally the transportation sector.

Positive-Dollar Permit Trades

This data will serve as the basis for one of the dependent variables, as well as an independent variable. The positive-dollar permit trades variable is the sum of trading activity (RTCs purchased – RTCs sold) over the 1994-1999 trading periods. This variable has been recoded into binary format where net buyers of permits = 1, and net sellers or non-active firms = 0.

5.2.4 Survey Analysis

The survey was designed to provide information on two of the proposed dependent variables, end of pipe investment (EOP) and pollution prevention investment (PP), as well as company-specific data that would allow us to differentiate between individual firms. The first two of the three dependent variables attempt to qualify the facility's investment in end-of-pipe pollution abatement technologies and investment in pollution prevention technologies, as compared to their competitors. These variables were self-measured, using a five-point scale, with responses of "significantly less", "less", "about the same", "more", and "significantly more".

The last of the three dependent variables, the permit trading activity variable TRADES, was calculated from the RECLAIM BBS trade dataset that was downloaded on May 18th, 2000. The data was aggregated to provide company-level trading numbers for the first six years of the RECLAIM program.

Prior to analyzing the data, there were certain correlations between data entries that we expected to find. Between the Electric/Gas/Sanitary Industries dummy variable (DUM_ELEC) and the trading variable (TRADES), we anticipated a positive correlation. These industries sell their products and services predominantly to the LA communities, as do their competitors, so they are better able to internalize the costs of permit acquisition. There is no way to systematically predict general trading patterns from the initial allocation of RTCs, because some firms within the same industry have lower abatement costs, and some have the ability to trade RTCs to other self-owned facilities with higher abatement costs. For this reason, we anticipate a correlation between large polluters and permit trading activity, but not between any particular form of trading activity; these differences will be more prominent between the different industry dummy variables and trading activities. Likewise, we expect firms in the inland trading region (COASTDUM) to be more active in both forms of trading activity than the firms in the coastal trading region. The coastal firms are only able to accept RTCs from other coastal firms, but the inland firms are able to acquire RTCs from both coastal and inland firms. Unlike RTC trading, we are not sure of the potential correlations between the technology self-response variables (PP and EOP) and the individual industries' dummy variables. It would seem that those corporations with larger demands for permits would be more likely to install these technologies, but because of the ample early supply of permits this may not be the case.

Between the Electric/Gas/Sanitary Industries dummy variable and the market scope variable (SCOPE), we expect a negative correlation. As noted, the market for these goods and services is relegated to the LA area, and therefore creates a negative correlation. We expect the companies with a wide (global) market scope (SCOPE), and those that are publicly traded (PUBLIC) to have more ISO-14001 certified

facilities (ISO_4K), and therefore a strong positive correlation between the variables. These firms are also more likely to participate in other voluntary programs (VOL_PGRM). Likewise, the firms that have more of a global market (SCOPE) are expected to have more effort dedicated to air quality management (AQMS), as are they expected to participate more in informal meetings (INF_MTGS) with the SCAQMD. The actual correlations from the survey data are provided in Appendix I.
It was our belief that although the RECLAIM trading market was organized to represent a perfectly competitive trading regime, that in fact there might be a few large emitters that held monopoly power on emission reductions. For the smaller polluters, the installation of abatement technologies would either be too expensive or technologically impossible, and therefore their only hopes of compliance are through the trading market. On the other hand, the marginal costs of abatement or pollution prevention for the large polluters may rival the permit prices, and therefore conflict arises when they try to balance the long-term benefits of new technologies with the often-large short-term costs. This conflict forces the smaller emitters are forced to modify their production of end goods in order not to exceed their permit levels. The larger emitters who compete in local markets, and whose competitors compete in the same markets, are able to incorporate the marginal abatement costs of increased permit prices into the prices of their goods and services.

5.2.5 Survey Results

The first mailing of the survey went out on December 11th, 2000, to 310 firms, and had 62 returns, for a return rate of 20%. Eight of the surveys were returned by fax. There were also 23 surveys mailed to incorrect addresses/closed businesses in the first mailing. The timing for this initial survey was particularly bad, because it occurred directly before the Christmas holidays. This may explain why many of the surveys "trickled" in after the stated deadline - air quality managers were returning from extended holidays.

The second mailing, with a slightly altered cover letter to take into account the previous mailing, and to reflect that this was a follow-up survey, went out on January 11th, 2001, to 253 firms, and had 52 returns, for a return rate of 20.6%. Thirteen of the second set of surveys were returned by fax. The larger than expected size of the second mailing was due, in part, to the fact that several of the first mailing's surveys trickled in after the mailing date of the second survey (29 surveys). If the 29 late survey returns were deleted from the second survey pool of 253, the return rate for the second mailing would have been 23.2%. For this reason, any survey responses in duplicate were double-checked for consistency, but not added to the list. There were also 10 surveys mailed to incorrect addresses/closed businesses in the second mailing. It was surprising to find that there were surveys returned for incorrect addresses/closed businesses even though those contacts were deleted from the initial mailing. One explanation for this aberration was that the first set of returns took longer to make it back to us, and therefore were not deleted from the second mailing. We did not cross-reference the returned envelopes to see if this was the case.

A few days after the mailing of the second batch of surveys, the four members of this thesis team followed up with phone calls to the various firms in the total survey sample. Each team member took a random list of 50 companies, and attempted to make contact or to leave a voicemail for them, urging them to return the survey, and to let us know via phone, email, or fax, if they had any questions. This follow up phone practice may have improved the response of the second round of surveys.

The third mailing went out on January 31st, 2001, to 183 firms, and had 20 returns, for a return rate of 10.9%. Three surveys were returned by fax. There were also 3 incorrect addresses in the third round of mailings. This third mailing included a reduced list of companies (because of bad addresses or closed businesses,) but also included a reduction for companies that responded, but were represented in the sample more than once (See above: firms with more than one air quality manager received surveys for each of the individual managers, even though they were not entered in duplicate if returned.)

In aggregate, we received 134 responses to the survey, 129 of which came from unique companies; the 129 responses represent a return rate of 46.4%. Not included in the survey response rate estimates were the 36 surveys that were returned because of bad addresses, or business closures (one of the expectations of the RECLAIM program). If these returned surveys were removed from the original sample pool, then the overall return rate for our survey effort would approximate 53.3%. Of the returned surveys, 82 respondents (or 63.6%) requested copies of the results of the survey, and provided return contact information in the form of a cover letter, hand-written note, fax number, or business card.

In order to begin analyzing the survey data, it was first necessary for us to recode the variables so that they were all between 0 and 1. We chose to recode the variables because we wanted to avoid allowing any one variable to skew the statistical analysis because of the differences in ranges present in the data set. The variables which were significantly recoded were “initial allocation of permits”, “total number of employees”, and “total number of Air Quality Managers”. The range of the “initial allocation” variable (0-2333) was divided into distribution percentiles and recoded as follows: 0-2.935 tons = 0, 2.936-5.776 tons = 0.2, 5.777-10 tons = 0.4, 10.0001-18.2 tons = 0.6, 18.20001-45.215 tons = 0.8, and 45.21501 tons and up = 1.0. “Total number of employees” was treated similarly, while the “total number of Air Quality Managers” was recoded as follows: 0-1 managers = 0, 1.5 to 3 managers = 0.5, and 3.5 managers and up = 1. In the case of the dependent variables, end-of-pipe investment and pollution prevention investment, we chose to recode the variables into a binary variable to simplify the results. (See Table 5.7 for the Descriptive Statistics)

Over 75% of the 129 survey responses fell into the five industry segments that we were most concerned about (Electric/Gas/Sanitary Services; Metal and Metal Products; Petroleum and Refining; Stone/Clay/Glass/Rubber; Transportation). 95% of these responses were used in our final regression analyses; the breakdown of industry segments is presented in Appendix J. Roughly 40% of the firms responding to the survey had stocks that are publicly traded, and over 15% have more than 650 employees. These statistics are provided in Appendix K. The market scope response provided below, indicates that respondents are more heavily weighted towards the larger market scopes, with over 30% of the firms having their focus on the global market.

As for environmental management, the vast majority of firms only have a single air quality manager. This may explain why close to 80% of the respondents meet with their SCAQMD representatives yearly or less. Only 21.7% of the sample survey responded that they had participated in the SCAQMD's occasional informal community meetings, only seven percent participate in other national voluntary environmental quality programs, and only five percent of the survey sample indicated that their company had facilities that were ISO 14001 certified.

Table 5.7: Descriptive Statistics for Survey Results

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Dummy for Coastal Location	129	0	1	.73	.45
Publicly Traded Company	129	0	1	.39	.49
Electric/Gas Binary	129	0	1	.12	.32
Petroleum Binary	129	0	1	.16	.37
Metals Binary	129	0	1	.20	.40
Initial allocation	129	.0	1.0	.498	.341
Total employees	128	.0	1.0	.494	.340
Air Quality Managers	129	.0	1.0	.326	.357
Frequency of AQMD Meetings	128	.00	1.00	.2656	.1823
Participation in Informal Meetings	129	0	1	.78	.41
ISO-14001 certified	129	0	1	5.43E-02	.23
Voluntary program participation	129	0	1	6.98E-02	.26
Market scope	129	.0	1.0	.650	.326
End-of-Pipe Binary	115	0	1	.37	.49
Pollution Prevention Binary	117	0	1	.56	.50
Positive Dollar Trades 94-99 Binary	129	.0	1.0	.527	.501
Valid N (listwise)	114				

5.2.6 Regressions

For our analysis of the survey data, we chose to use the logit statistical model. The logit model was chosen because we felt that the firms' decisions were discrete in nature: either to purchase permits, or not, and either to invest in pollution abatement, or not. Within the logit models, the choice probabilities were defined by the following function, with the predicted probability being the facilities' production decisions with regards to meeting emissions levels (D_i) :

1) $P_i = F(\mathbf{x'_i}\, \boldsymbol{\beta}) = F(D_i)$

The logit analysis provides the distribution defined by the following equation:

2) $P_i = 1/(1+e^{-\mathbf{x'_i}\boldsymbol{\beta}})$

Our variable selection procedure resulted in the exclusion of three variables from our initial estimations. These variables were excluded because we found that the survey responses for them were strikingly similar; we feared that the error vectors for the individual samples may also be correlated, leading to autocorrelated error matrices and biased results. We found that the variable for the number of employees in the company was strongly correlated with the business scope variable (SCOPE). For this reason, and because we felt that the scope of the firm may have more impact on its pollution attainment policies, we excluded the employment variable. Fortunately, the inclusion of the SCOPE variable improved the fit of the regressions, and the inclusion of both did not add additional explanatory power to the analysis. Secondly, we found that there was a high correlation between the different pollution reduction variables, pollution prevention (PP) and end of pipe pollution prevention (EOP). For this reason, we needed to remove one of the two variables when modeling the trading behavior (TRADE) in order to avoid similar problems with autocorrelated error matrixes. We decided to include the PP variable because it seemed to be the long-term lowest cost method of attaining the same pollution reductions, outside of purchasing permits. As mentioned earlier in the paper, permit prices in the SCAQMD have remained relatively low in comparison to other pollution reduction strategies. For this reason, we felt that EOP investment would have the most explanatory power in modeling the firms' trading behavior.

Presented below in equations 1-3 are the three logit models that were estimated using the SPSS regression and analysis software package, version 10.0.0; the results for the models, including goodness of fit, predictive ability, and an analysis of variance, are summarized in tables 5.7-5.15:

Equation 1

$$\textbf{TRADE}_i = \alpha + (x_1 * COASTDUM_i) + (x_2 * PUBLIC_i) + (x_3 * DUM\_ELEC_i) + (x_4 * DUM\_PETR_i) + (x_5 * PERM_i) + (x_6 * DUM\_STON_i) + (x_7 * DUM\_MTL_i) + (x_8 * AQMS_i) + (x_9 * FREQREC_i) + (x_{10} * INF\_MTGS_i) + (x_{11} * ISO\_4K_i) + (x_{12} * VOL\_PRGM_i) + (x_{13} * SCOPE_i) + (x_{14} * PP_i)$$

Equation 2

$$\textbf{PP}_i = \alpha + (x_1 * COASTDUM_i) + (x_2 * PUBLIC_i) + (x_3 * DUM\_ELEC_i) + (x_4 * DUM\_PETR_i) + (x_5 * PERM_i) + (x_6 * DUM\_STON_i) + (x_7 * DUM\_MTL_i) + (x_8 * AQMS_i) + (x_9 * FREQREC_i) + (x_{10} * INF\_MTGS_i) + (x_{11} * ISO\_4K_i) + (x_{12} * VOL\_PRGM_i) + (x_{13} * SCOPE_i) + (x_{14} * TRADE_i)$$

Equation 3

$$\textbf{EOP}_i = \alpha + (x_1 * COASTDUM_i) + (x_2 * PUBLIC_i) + (x_3 * DUM\_ELEC_i) + (x_4 * DUM\_PETR_i) + (x_5 * PERM_i) + (x_6 * DUM\_STON_i) + (x_7 * DUM\_MTL_i) + (x_8 * AQMS_i) + (x_9 * FREQREC_i) + (x_{10} * INF\_MTGS_i) + (x_{11} * ISO\_4K_i) + (x_{12} * VOL\_PRGM_i) + (x_{13} * SCOPE_i) + (x_{14} * TRADE_i)$$

The large sample critical value using a χ^2 -distribution, at a 0.05 level of significance and one degree of freedom is 3.84. This significance test is also known as the Wald test statistic, and was conducted for all parameters in the estimation. Likelihood ratio tests have also been conducted on the equations estimated, to test if the null hypothesis that all of the parameters in the model are zero. This likelihood ratio test statistic, which also follows a χ^2 -distribution, is approximately 23.68 at the 0.05 level of significance, with 14 degrees of freedom.

Table 5.7: Model 1. Summary of Fit of TRADES

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	143.553	.129	.173

Table 5.8: Model 1. Predictive Ability of TRADES

Classification Table[a]

			Predicted		
			TRADES		
Observed			No Trades or Net Seller	Net Buyer	Percentage Correct
Step 1	TRADES	No Trades or Net Seller	30	22	57.7
		Net Buyer	15	49	76.6
	Overall Percentage				68.1

a. The cut value is .500

Table 5.9: Model 1. Analysis of Variance of TRADES

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	COASTDUM	.541	.461	1.379	1	.240	1.718
	PUBLIC	-.026	.444	.003	1	.953	.974
	DUM_ELEC	.933	.814	1.315	1	.251	2.543
	DUM_PETR	-.177	.671	.069	1	.792	.838
	PERM	-.845	.669	1.598	1	.206	.429
	DUM_STON	.443	.617	.515	1	.473	1.557
	DUM_MTL	.339	.581	.339	1	.560	1.403
	AQMS	.096	.585	.027	1	.869	1.101
	FREQREC	2.378	1.260	3.562	1	.059	10.780
	INF_MTGS	.415	.537	.596	1	.440	1.514
	ISO_4K	-.223	.867	.066	1	.797	.800
	VOL_PRGM	.304	.867	.123	1	.726	1.355
	SCOPE	1.222	.745	2.688	1	.101	3.393
	PP	.825	.414	3.964	1	.046	2.281
	Constant	-2.233	.889	6.309	1	.012	.107

a. Variable(s) entered on step 1: COASTDUM, PUBLIC, DUM_ELEC, DUM_PETR, PERM, DUM_STON, DUM_MTL, AQMS, FREQREC, INF_MTGS, ISO_4K, VOL_PRGM, SCOPE, PP.

Table 5.10: Model 2. Summary of Fit of PP

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	150.767	.069	.093

Table 5.11: Model 2. Predictive Ability of PP

Classification Table[a]

Observed			Predicted		
			PP binary		Percentage Correct
			The Same or Less	More	
Step 1	PP binary	The Same or Less	26	25	51.0
		More	17	48	73.8
	Overall Percentage				63.8

a. The cut value is .500

Table 5.12: Model 2. Analysis of Variance of PP

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	COASTDUM	-.024	.450	.003	1	.957	.976
	PUBLIC	-.021	.430	.002	1	.962	.980
	DUM_ELEC	-.130	.738	.031	1	.860	.878
	DUM_PETR	.736	.677	1.185	1	.276	2.089
	PERM	.035	.632	.003	1	.955	1.036
	DUM_STON	.019	.592	.001	1	.975	1.019
	DUM_MTL	.062	.556	.012	1	.911	1.064
	AQMS	.238	.565	.178	1	.673	1.269
	FREQREC	-.619	1.211	.261	1	.609	.539
	INF_MTGS	.057	.515	.012	1	.912	1.058
	ISO_4K	.853	.937	.829	1	.363	2.346
	VOL_PRGM	-1.063	.877	1.468	1	.226	.345
	SCOPE	.047	.717	.004	1	.947	1.049
	TRADES	.820	.411	3.986	1	.046	2.270
	Constant	-.281	.812	.120	1	.730	.755

a. Variable(s) entered on step 1: COASTDUM, PUBLIC, DUM_ELEC, DUM_PETR, PERM, DUM_STON, DUM_MTL, AQMS, FREQREC, INF_MTGS, ISO_4K, VOL_PRGM, SCOPE, TRADES.

Table 5.13: Model 3. Summary of Fit of EOP

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	137.712	.111	.151

Table 5.14: Model 3. Predictive Ability of EOP

Classification Table[a]

Observed			Predicted: EOP binary: The Same or Less	Predicted: EOP binary: More	Predicted: Percentage Correct
Step 1	EOP binary	The Same or Less	61	10	85.9
		More	25	18	41.9
	Overall Percentage				69.3

a. The cut value is .500

Table 5.15: Model 3. Analysis of Variance of EOP

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	COASTDUM	.181	.484	.139	1	.709	1.198
	PUBLIC	.282	.453	.387	1	.534	1.325
	DUM_ELEC	.386	.818	.222	1	.637	1.471
	DUM_PETR	.639	.687	.865	1	.352	1.894
	PERM	.013	.681	.000	1	.985	1.013
	DUM_STON	-.161	.661	.059	1	.808	.851
	DUM_MTL	1.252	.592	4.468	1	.035	3.497
	AQMS	.011	.602	.000	1	.985	1.011
	FREQREC	-.343	1.245	.076	1	.783	.709
	INF_MTGS	.387	.550	.495	1	.482	1.472
	ISO_4K	.358	.942	.144	1	.704	1.430
	VOL_PRGM	-2.028	1.181	2.950	1	.086	.132
	SCOPE	.241	.829	.085	1	.771	1.273
	TRADES	.677	.443	2.339	1	.126	1.967
	Constant	-1.858	.912	4.152	1	.042	.156

a. Variable(s) entered on step 1: COASTDUM, PUBLIC, DUM_ELEC, DUM_PETR, PERM, DUM_STON, DUM_MTL, AQMS, FREQREC, INF_MTGS, ISO_4K, VOL_PRGM, SCOPE, TRADES.

5.2.7 Regression Analysis

Overall, we found that our analyses did a good job of predicting trading and pollution abatement investment activities. The likelihood ratio tests indicate that the analyses were robust, and the individual variables of most concern generated significant results. The control variables in the equation (COASTDUM, PUBLIC, PERM) were not significant in any of our analyses, nor were the majority of the environmental management variables (AQMS, ISO_4K, VOL_PRGM).

Our original hypothesis was that the firms that applied more resources towards environmental management would be more likely to invest in pollution prevention or end of pipe solutions, as opposed to their competitors. The different forms of environmental management investments that we measured were the number of air quality managers on staff (AQMS), the frequency of meeting with SCAQMD representatives (FREQREC), ISO 14001 participation (ISO_4K), and participation in voluntary programs (VOL_PRGM). The regression analyses indicate that there is not strong support that this hypothesis is true.

As for the industry control variables, our hypothesis that firms in the electricity production (DUM_ELEC) and petroleum refining (DUM_PETR) sectors would be more likely to purchase permits was not validated. These results may be explained by undetected firm behavior, particularly the closure of certain facility capacities. Conversations with many of the larger, more recognized firms in the SCAQMD indicated that the negative implications of conducting business in the SCAQMD have encouraged them to move the more polluting functions of their business model outside of the area. For the petroleum firms, the transfer of the refining segments of their business may reduce their need for RTCs, and therefore explain the negative sign on the variable. Our analysis was unable to catch these conditions; a more thorough analysis would need to incorporate individual facilities' emission levels to determine if in fact the business segments had been moved outside the SCAQMD.

Our analysis did find that firms in the metal and metal fabrication industries (DUM_MTL) are more likely to invest in end-of-pipe solutions to meet their emissions targets. This result was significant, but was the only such variable in the end of pipe (EOP) analysis. In neither the end-of-pipe (EOP) analysis nor the pollution prevention (PP) analysis did the market scope (SCOPE) variable provide significant results. Although not significant at the χ^2 0.05 level, the trading model (TRADES) indicated that firms with a larger market scope are more likely to participate or invest in RTCs. Economic theory would dictate that firms with a larger market scope and more competitors are less likely to pass along the increased costs of production to their customers. Unless they have monopolistic market power, they will have little ability to affect the price of the goods that they sell, and therefore must aim to minimize their costs of production in order to compete at the global level. If the least cost method of meeting air quality regulation is through the trading market, which the results have shown is very likely the case, then these results support our hypothesis.

The primary motivation for our analysis was to attempt to explain trading activity and investment in pollution prevention technologies. Surprisingly, the regression results indicate that the firms that purchase permits are also likely to invest in pollution prevention technologies. In both of our analyses where trading activity (TRADES) and pollution prevention (PP) were the dependent variables, the other exhibited a significant and positive effect within the regression analysis. This result means that firms are purchasing permits and simultaneously investing in pollution prevention.

By definition, a rational economic behavior is one that reveals efficiency and consistency of action in the attainment of a goal, be it cost minimization, profit maximization, or some other economic target (Pearce 1990). Although the behavior exhibited in out survey may not seem to be rational with regards to firms choosing the option that offers the lowest marginal cost of abatement, it may prove to be the most rational choice in the long run. In most cases, the firms that are purchasing permits are polluting more than their original allocation would allow. Rational behavior would dictate that the firms' lowest cost of meeting their pollution allocation would be selected, which in the past has been through purchasing permits. However, if the firms are making decisions using present and future cost estimates, then the concurrent expenditure on permits and abatement technologies may be rational. If the pollution prevention technologies take several years to install, or are needed by the firm in their effort to meet other air quality regulations, then this behavior would be normal and rational.

The results of our analyses may have been influenced by the market conditions for permits over the last six years. The rational actor in the SCAQMD is going to utilize the least-cost method of obtaining the RTCs that they need for their given production level. In the SCAQMD, this least-cost solution has been via the trading market, as opposed to production modifications through pollution prevention or end of pipe technologies. The glut of RTCs on the market could be due to two compounding effects: the exit of polluting activities by firms that still operate in the SCAQMD, and the original over-allocation of RTCs at the start of the program.

The over-allocation of RTCs is a phenomenon that will be remedied as the total quantity is ratcheted back to more acceptable levels. As pollution levels fall, and RTCs become scarcer, the polluting firms will begin to utilize the least-cost methods of meeting the air quality regulations. When the final RTC allocation levels are achieved in 2003, firms will continue to modify their production processes as the permits increase in value. By over-allocating permits, this least-cost, rational activity was merely put on hold until the ratcheting of RTCs we able to take effect.

The exodus of polluting activities from the SCAQMD was not a goal of the program, because with those activities are their corresponding jobs. Analysis of the RECLAIM program indicated that it would not reduce employment levels in the SCAQMD, but that it might even increase employment through a demand for new environmental professionals (Berman, 1997). If in fact firms are acting to divert the polluting capacities of their business activities to plants outside of the AQMD, then the goals of the program are not being met. Past analyses have indicated that plant closures have negligibly affected the overall employment levels in the SCAQMD, but these studies have only focused on firms that no longer operate in the area. Additional studies on existing firms in the RECLAIM Universe, to see if they have modified their employment patterns because of RECLAIM, might lend more insight on this issue.

In conclusion, our analysis provided results that indicate that firms are simultaneously investing in RTCs and in pollution prevention technologies. Our original hypothesis that the RECLAIM program is discouraging technological innovation is not supported by the results of the analysis. The answer to our research question in this section of the paper is that firms are not limited to a single strategy in meeting their pollution allocations, but rather, they have made use of trading as well as pollution abatement technologies. These attainment strategies may have been influenced by the general economic conditions in the basin over the previous seven years, which will be discussed in more detail in the following section.

5.3 Economic Results after 7 years of RECLAIM

As previously noted, RECLAIM was designed to provide facilities with an added flexibility to meet emissions reductions requirements while simultaneously lowering the cost of compliance. The RECLAIM regulations were designed to meet all state and federal clean air requirements as well as a variety of public health performance criteria. Under the RECLAIM program, the total number of emissions allowed in the SCAQMD are reduced each year from 1994 through 2003, with the ultimate goal of achieving equivalent emissions as were outlined in the 1991 AQMP control measures. After the year 2003 there will be no incremental reductions in emission allowances, thus all RECLAIM allocations will remain constant (Luong, et al., 2000).

5.3.1 Analysis of Costs

Facilities within the RECLAIM Universe are required to maintain daily, monthly, and quarterly emissions records, as well as to reconcile their emissions with their allocations on a quarterly basis. The AQMD refers to these costs as MRR: monitoring, reporting and record keeping (Luong, et al., 2000). This procedure constitutes one of the main costs of complying with RECLAIM regulations. The other costs include equipment costs, installation costs, and administrative costs. The SCAQMD indicated in their Review of RECLAIM Findings that these cost factors have continued to stay below those projected at the time RECLAIM was adopted (Luong, et al., 2000).

RECLAIM facilities can approach the task of complying with their annual allocations either by purchasing RTCs from other RECLAIM Universe companies, by decreasing emissions through pollution prevention solutions, by installing end-of-pipe control technologies, or by reducing production. Over the first seven years of the program (as seen in the tables below,) low cost RTCs have been readily available because former RECLAIM Universe companies have decided to suspend their polluting activities in addition to closing some polluting facilities (Luong, et al., 2000). In these two cases, the RTCs that were originally allocated based upon historical activity have become available to other sources because the original equipment is no longer in operation or use. According to the AQMD, 624 tons of year 2000 NOx RTCs, 457 tons of year 2003 NOx RTCs, 247 tons of year 2000 SOx RTCs, and 186 tons of year 2003 SOx RTCs are now available due to facility or operation shutdowns (Luong, et al., 2000). This availability of low cost RTCs in the initial years of the program has allowed companies to avoid the costly installation of control equipment. The AQMD has indicated (through communications with facilities in the RECLAIM Universe,) that several facilities have reduced their emissions without making physical modifications to their equipment, or by modifying production techniques (Luong, et al., 2000).

The AQMD has noted that some RECLAIM facilities have reduced their emissions through control technologies, but when compared to other strategies, this remains a less significant approach (Luong, et al., 2000). Within their Review of RECLAIM Findings, they state that permitting records support this claim, but that the results of the analysis are consistent with the original design of the program: to allow firms to use the least expensive means of achieving required emission reductions. The administrative costs of the RECLAIM program are more poorly defined, but include employment modifications, and the costs of staff time to comply with RECLAIM's requirements. The AQMD has kept track of the job losses and gains attributed to the RECLAIM program, and indicate that the modifications do not have a significant impact on the overall employment figures of the region (Luong, et al., 2000).

5.3.2 RTC Supply and Demand

As seen in tables (5.16 and 5.17), the 1994-1999 compliance years demonstrated levels of demand for NOx and SOx RTCs (actual emissions,) that are below the total number supplied. However, in late 1999 and early 2000 the demand for NOx RTCs began to increase dramatically. The AQMD points out several factors that they believe led to the higher demand for NOx RTCs during this compliance period. These factors are outlined below (Luong, et al., 2000):

- RECLAIM's RTC supply has now reached the point where it is equal to the demand.
- There was unanticipated demand for electricity in Southern California during the summer of 2000, and a simultaneous shortage of imported electrical power during this period of peak demand.
- Southern California Edison has divested ten of its power plants as a result of the deregulation of electric utility industries in California; these power plants continue to operate, but are done so by companies that are new to the SCAQMD and its regulations.
- Electric utility power producers within the SCAQMD are generating power to be sold and used outside the South Coast areas.
- NOx RTCs were purchased en masse by the power producing facilities in the SCAQMD, which limited the supply available for other facilities.

Table 5.16: RECLAIM NOx Emissions and RTC Supply by Compliance Year (tons/year) (Lieu, 1998)

Compliance Year	Actual Emissions	RTC Supply
1994	25,314	41,428
1995	25,764	37,296
1996	24,796	33,215
1997	21,789	29,052
1998	20,982	24,989
1999	20,545	21,015

Table 5.17: RECLAIM SOx Emissions and RTC Supply by Compliance Year (tons/year) (Lieu, 1998)

Compliance Year	Actual Emissions	RTC Supply
1994	7,232	10,491
1995	8,064	9,738
1996	6,484	9,020
1997	6,464	8,295
1998	6,793	7,577
1999	6,525	6,911

Prior to the 1999-2000 compliance year, the annual average price for NOx RTCs was on the order of a few hundred dollars to two thousand per ton. Because of the aforementioned demand and supply issues, the annual average price for NOx RTC trades that occurred in the calendar year 2000 (and would count towards compliance year 1999,) was $15,369 per ton (Luong, et al., 2000). This dollar value was well above the $15,000 threshold value that was outlined in rule 2015(b). Rule 2015(b) requires that if the average trading price is above the said threshold value, that the AQMD staff must initiate an assessment of the compliance and enforcement aspects of the RECLAIM program, and establish a backstop price, if necessary (Luong, et al., 2000).

This process of establishing a backstop price also may include the implementation of technology-specific emission reductions, increased penalties, restricted trading rules, the pre-approval of trades, and enhanced monitoring. As of October of 2000, the AQMD staff was in the process of evaluating the options under rule 2015(b). Although not originally thought necessary, the option of bifurcating the market to differentiate between larger facilities or specific industries is an additional option. Any of these program modifications will have competitive implications to the individual firms, as well as efficiency costs to the marketable permit system itself.

Although the rapid rise in prices and scarcity of available RTCs has triggered an evaluative response by the AQMD, they are quick to note that several significant facility-level modifications will soon come on-line. Of the major electrical power generation facilities in the SCAQMD, eight permit applications have been submitted, calling for the installation of NOx control technologies, with efficiencies in the 80 to 95 % range (Luong, et al., 2000). If the AQMD's estimates hold, the installation of these technologies will result in the annual reduction of over 1,800 tons of NOx.

The AQMD's Review of RECLAIM Findings notes that there have been additional recent applications for permits that will allow for the installation of pollution abatement and prevention in various other industries, which will decrease the demand for NOx RTCs. The AQMD also anticipates that other RECLAIM facilities which can modify their production and waste management in the near term will do so in light of the recent NOx RTC prices; these modifications may result in a reduced demand for NOx RTCs, and may ultimately help to stabilize its price. A final potential addition to the available NOx budget is the use of Area Source Credits (ASCs), which are generated through emission reductions by non-mobile, unpermitted sources, such as agriculture equipment and residential appliances. Much like mobile sources, the ASC program has yet to be approved by the EPA, but the SCAQMD anticipates that it will receive approval for the program in the near future. This proviso will allow for the addition of approximately 68 tons of NOx per year, through June 2003.

Regardless of the means of achieving attainment, the results of the AQMD study anticipate that for a least-cost solution, 120 RECLAIM Universe sources will need to implement pollution control modifications over the next ten years (Luong, et al., 2000). The annualized cost of this equipment is approximately $14.9 million dollars, and when divided by the required NOx reductions of 4,563 tons annually, yields an overall cost of $3,300 per ton.

Figure 5.3: NOx RTC Monthly Average Price Trends (Luong, 2000)

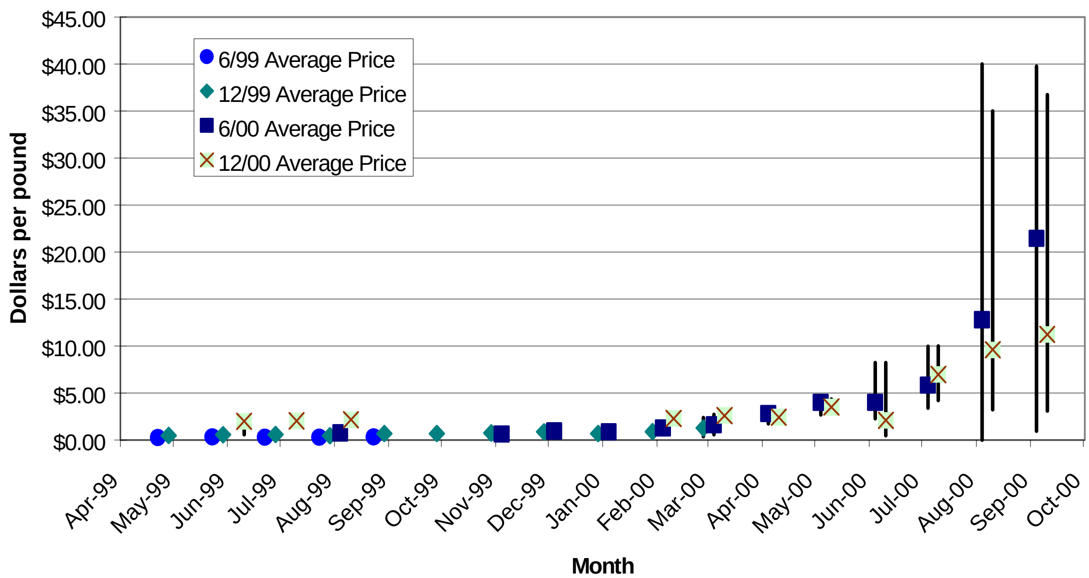


Figure 5.4: RECLAIM NOx Emissions and RTC Supply (tons/year) (Luong, 2000)

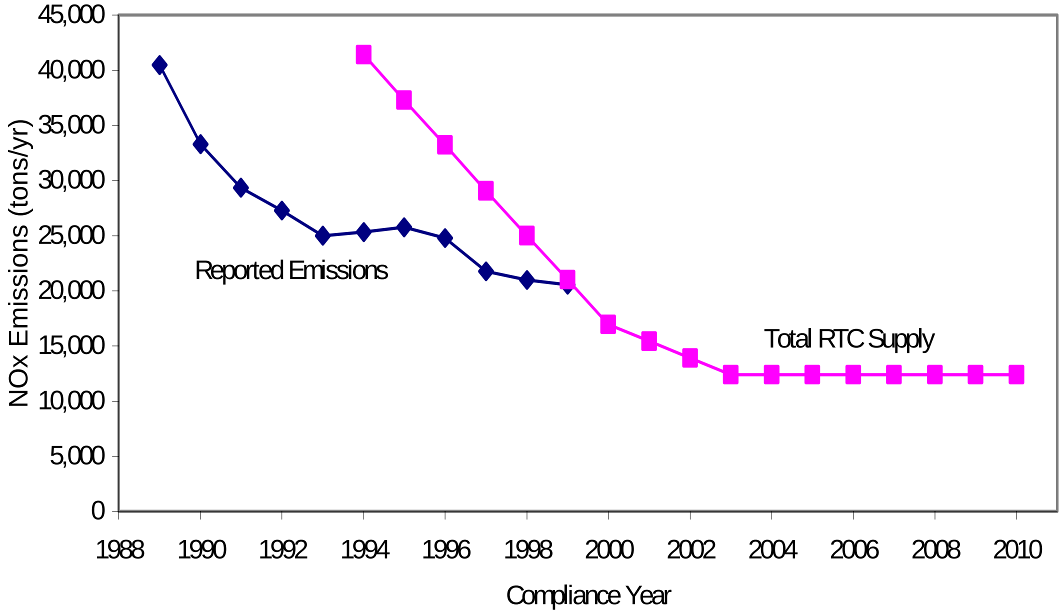
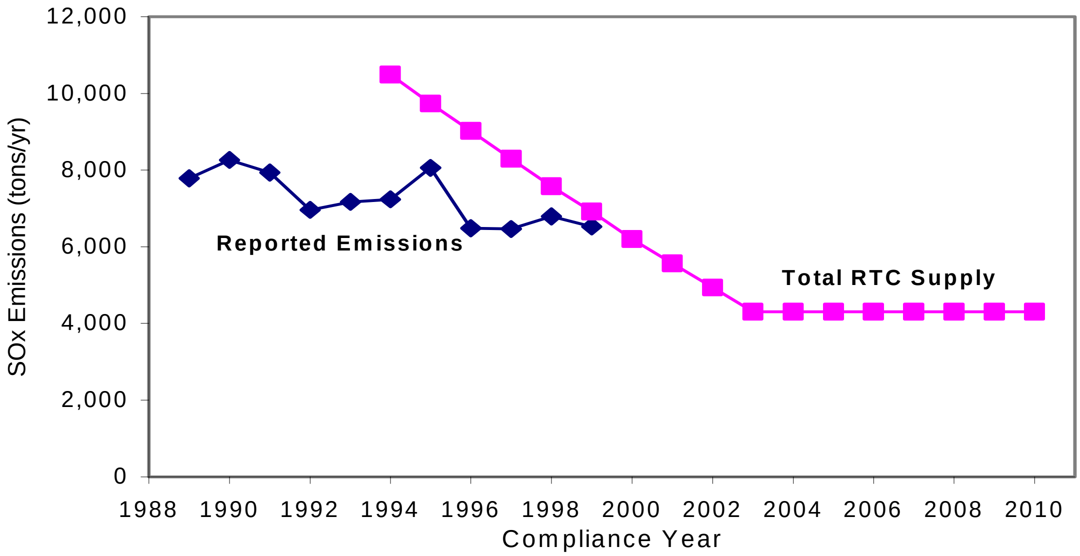


Figure 5.5: RECLAIM SOx Emissions and RTC Supply (tons/year) (Luong, 2000)



6. CONCLUSIONS

The main function of the *Industry Pollution Abatement Analysis* section (5.2) of our analysis was to explain why firms utilized the trading market, and more importantly- why they did not. We felt that a detailed analysis of trading activities could be used by the SCAQMD to better address the issue of toxic hotspots, if they were a result of trading. In an attempt to explain trading activities, our analysis hypothesized that the firms that chose not to trade do so because they have other, lower-cost methods of reducing pollution or achieving their emission targets. These lower-cost alternatives to trading include process modifications, such as the transfer of polluting activity outside of the SCAQMD, or the cessation of production in that segment of the business; more importantly, they may also include the installation of pollution abatement or prevention technologies. Unfortunately, information on these activities was not available from the SCAQMD.

The SCAQMD insists that the aforementioned firm closings and relocations have not been caused by the RECLAIM program (Lieu, et al., 1998). If this is in fact the case, then the alternatives to trading must have come from the cessation of certain productions, or the installation of abatement technologies. The SCAQMD provides firm-level trading data to the general public via their bulletin board system, but this data lacks additional, more qualitative information on the firms that participate in trading activities. A goal of our survey was to gather more firm-level data on the installation of abatement technologies, to gather control variables for the companies themselves, and to try and explain any reasons, other than cost-minimization, that these technologies might have been installed.

With the data that we collected from the SCAQMD and from our survey effort, we were able to predict that firms are simultaneously participating in trading markets and pollution abatement investment activities. This behavior, which could generate costs that are greater than other available options, may not seem to be rational: firms are expected to choose the option that offers the lowest marginal cost of abatement. However, it may prove to be the most rational choice in the long run. In most cases, the firms that are purchasing permits are polluting more than their original allocations would allow. Rational behavior would dictate that the firms' lowest cost of meeting their pollution allocation would be selected, which in the past has been through purchasing permits. However, if the firms are making decisions using present and future cost estimates, then the concurrent expenditure on permits and abatement technologies may be rational. If the pollution prevention technologies take several years to install, or is needed by the firm in their effort to meet other air quality regulations, then this behavior would be normal and rational.

Tradable emissions programs are not designed as economic tools to reduce pollution. Rather, they are designed to provide regulation at the lowest cost. As in a basic economic minimization or maximization only one variable can be maximized or minimized, so with tradable emissions programs costs can be minimized, but not in conjunction with the minimization of pollution and the maximization of environmental equity. Given that emissions trading programs are not constructed to maximize environmental equity, this study has sought to determine if the RECLAIM trading program creates further environmental justice impacts.

Our analysis outlines very specific conditions under which the trade of RTCs can be shown to exacerbate toxic hotspots in low-income and minority communities. First, a RECLAIM facility in question would need to be classified in one of the five industry types found to have a high correlation between NOx/SOx production and toxic-weighted risk emissions. Secondly, communities around the RECLAIM facility must have greater than average minority or impoverished populations. Finally, trade records would need to show that the facility had a net positive balance of RTCs at the end of the year.

Our analysis points to five industries, identified in section 5.1.4 that exhibit significant correlations between toxic risk-weighted emissions and NOx/SOx emissions. According to the results of our study, only facilities that accumulate credits within these industries could be reasonably labeled as causing an environmental justice issue.

The evaluation of RECLAIM's potential for environmental justice issues using GIS illustrated conclusively that, as has been shown for other industrial areas in the Los Angeles region, communities surrounding RECLAIM facilities, on average, have higher percentages of minorities and the impoverished than the rest of the city.

Our analysis of facilities' trade data with regard to the surrounding communities indicates that minority percentages are higher in neighborhoods around facilities with positive and negative RTC balances, but are lower than average surrounding facilities that do not trade or have a zero RTC balance. The analysis further shows higher than average percentages of impoverished communities around all RECLAIM facilities, no matter their trade patterns. Although the examination of trade patterns shows higher than average minority and impoverished populations surrounding RECLAIM facilities both with positive and *negative* RTC trade balances, our analysis cannot conclusively show a bias of RTC trade into or out of minority/impoverished neighborhoods. Our analysis averages the results over the RECLAIM facilities in the Los Angeles Basin and as such, some facilities will have positive RTC balances and others will have negative balances. Environmental justice advocates may claim that, as emissions trading cleans up one minority or low-income area yet pollutes another, the pollution continues to distributed in an unequal manner. Overall, however, our study cannot conclude that this does or does not occur.

Our investigations into the patterns of trade in RTCs, along with our survey results, indicate that the rationale for firms purchasing RTCs for facilities is more complex than we were able to properly examine in our study. A firm's purchase of RTCs can lead to increased emissions at their plant. Trading credits could be transferred as zero dollar trades to other facilities owned by the firm and increase emissions of a number of the firm's plants. Trading credits for emissions could even go unbought at the end of the trade cycle. Due to uncertainties in understanding the relationship between RTCs and NOx/SOx emissions, we cannot make a direct link between the purchase of RTCs and the magnitude of emissions of RECLAIM target pollutants.

The results of our analysis indicate that two of the three criteria for environmental justice impacts from trading in the RECLAIM program (neighborhood demographics, facility trade pattern, and facility type) are specific for the site of interest and cannot be generalized for the entire program. Without evidence of widespread accumulation of RTCs in minority and impoverished neighborhoods and lacking quantifiable links between RTCs and the magnitude of NOx/SOx emissions, environmental justice claims remain unsubstantiated. Without these crucial elements, the trade patterns of RECLAIM cannot be tied to the exacerbation of hot spots, and as such, cannot conclusively be linked to environmental inequities.

Appendix A. References

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Appendix B. Regressions for Risk Weighted Emissions vs. NOx & SOx

Figure 1. Non-Cancer Risk-Weighted Emissions vs. NOx Emissions for 373 RECLAIM Participating Facilities in 1998

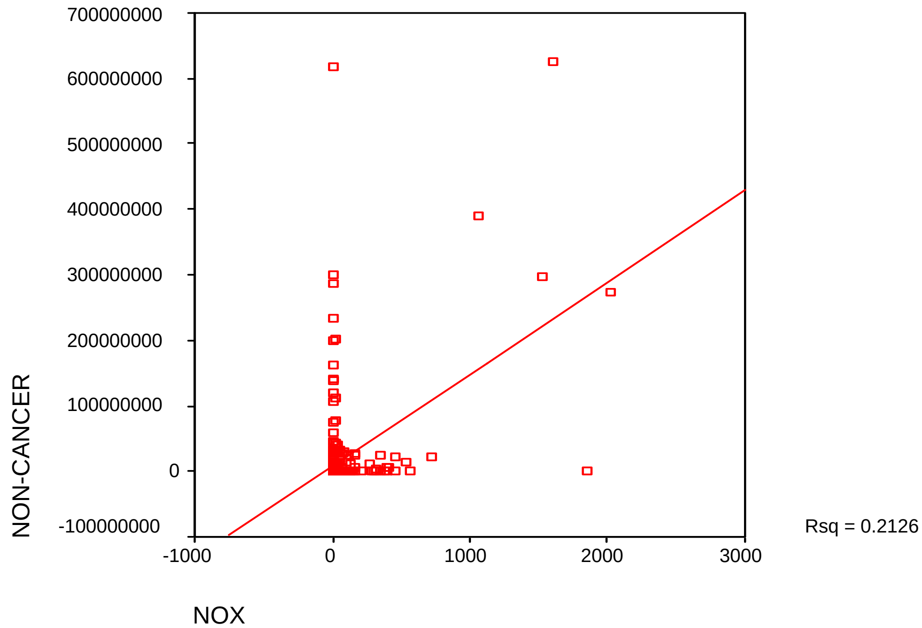


Figure 2. Cancer Risk-Weighted Emissions vs. NOx Emissions for 373 RECLAIM Participating Facilities in 1998

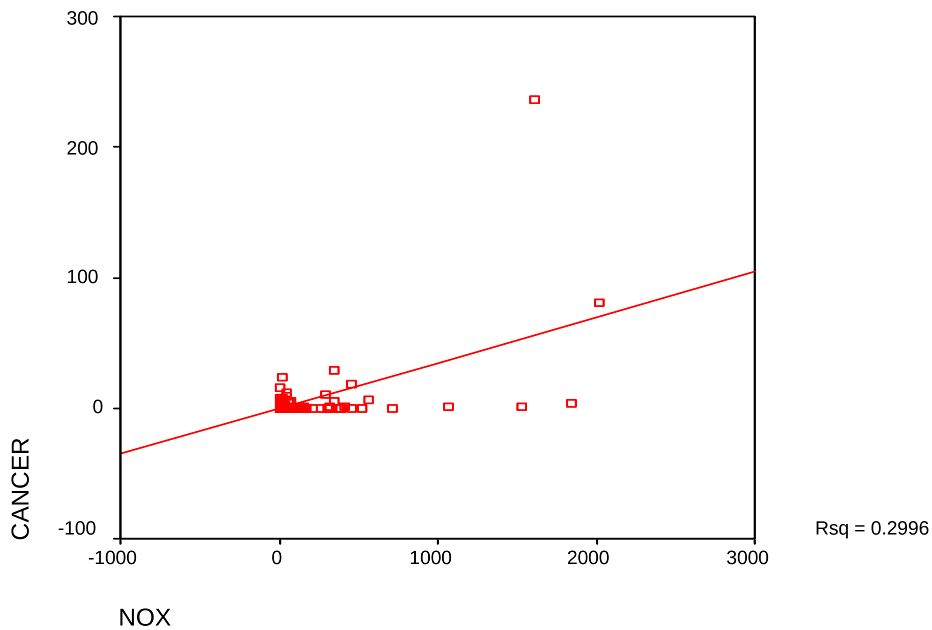


Figure 3. Non-Cancer Risk-Weighted Emissions vs. SOx Emissions for 373 RECLAIM Participating Facilities in 1998

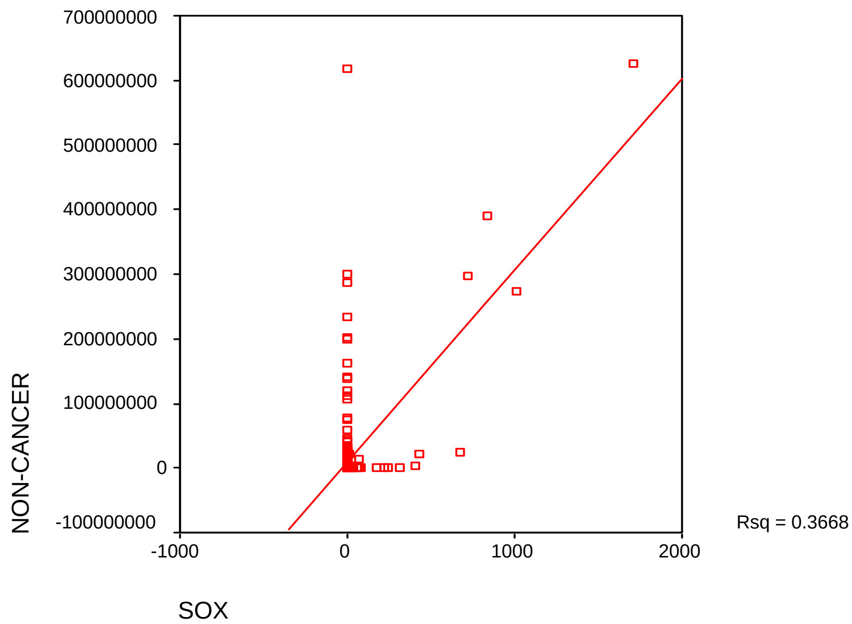


Figure 4. Cancer Risk-Weighted Emissions vs. SOx Emissions for 373 RECLAIM Participating Facilities 1998

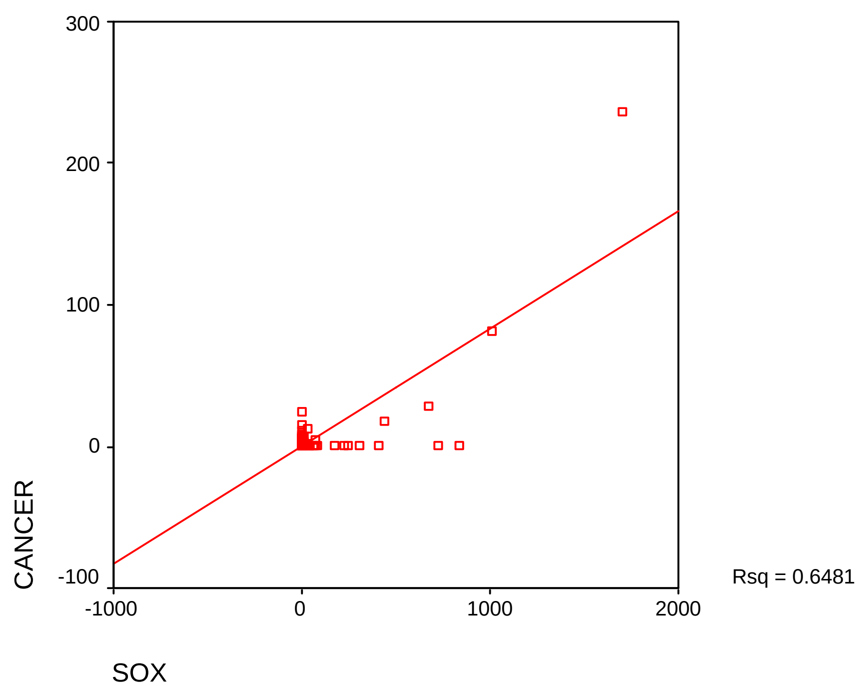


Figure 5. SIC 1311 Cancer Risk-Weighted Emissions vs. SOx Emissions by RECLAIM Participating Facilities in 1998

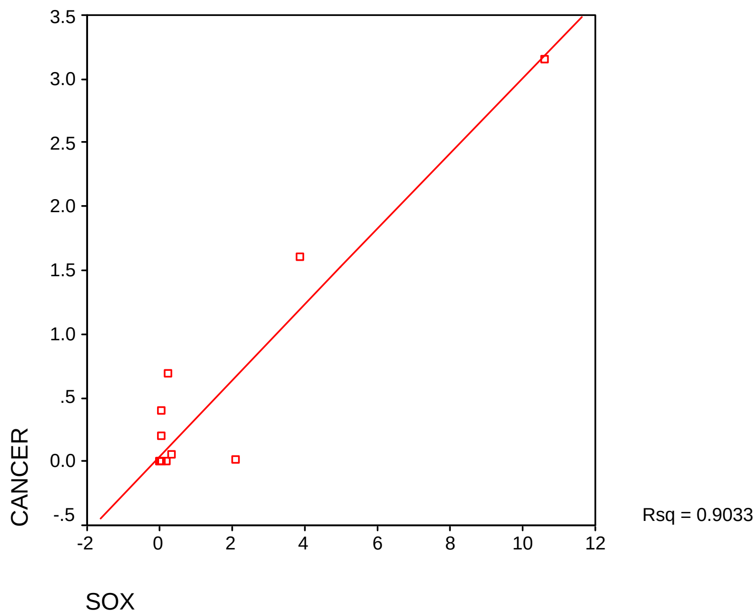


Figure 6. SIC 2611 Non-Cancer Risk-Weighted Emissions vs. NOx Emissions by RECLAIM Participating Facilities in 1998

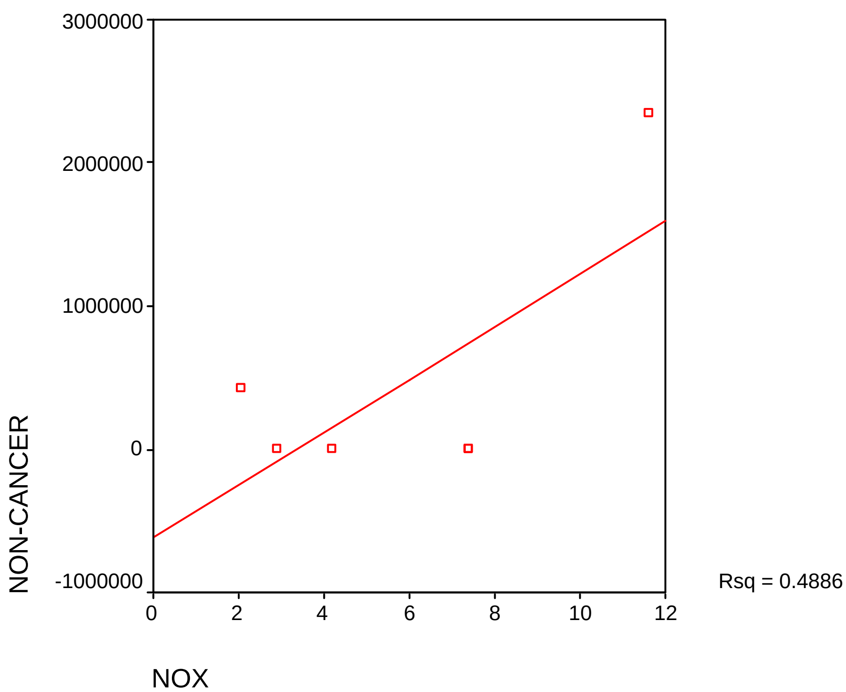


Figure 7. SIC 2611 Cancer Risk-Weighted Emissions vs. NOx Emissions by RECLAIM Participating Facilities in 1998

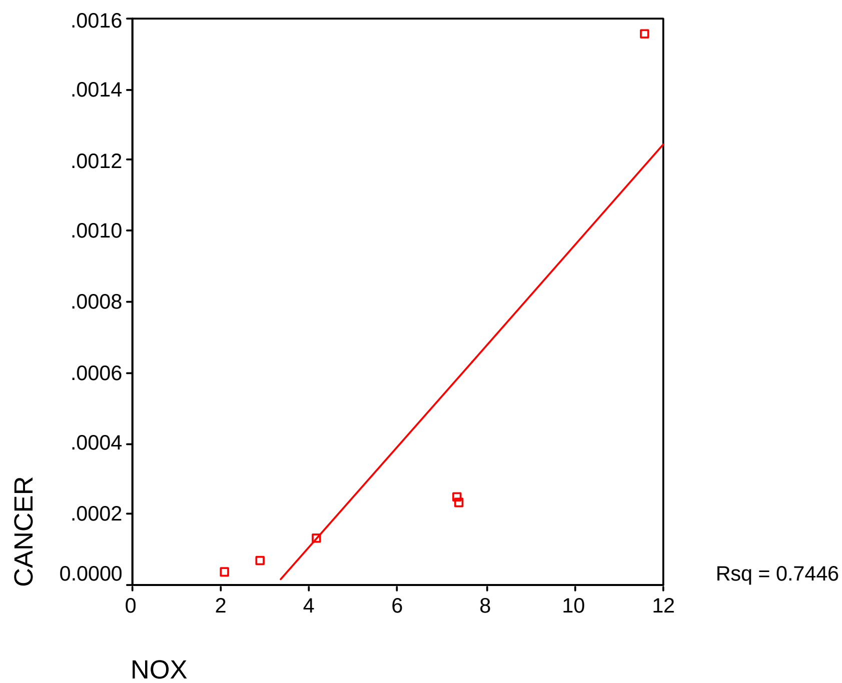


Figure 8. SIC 28 Non-Cancer Risk-Weighted Emissions vs. NOx Emissions by RECLAIM Participating Facilities in 1998

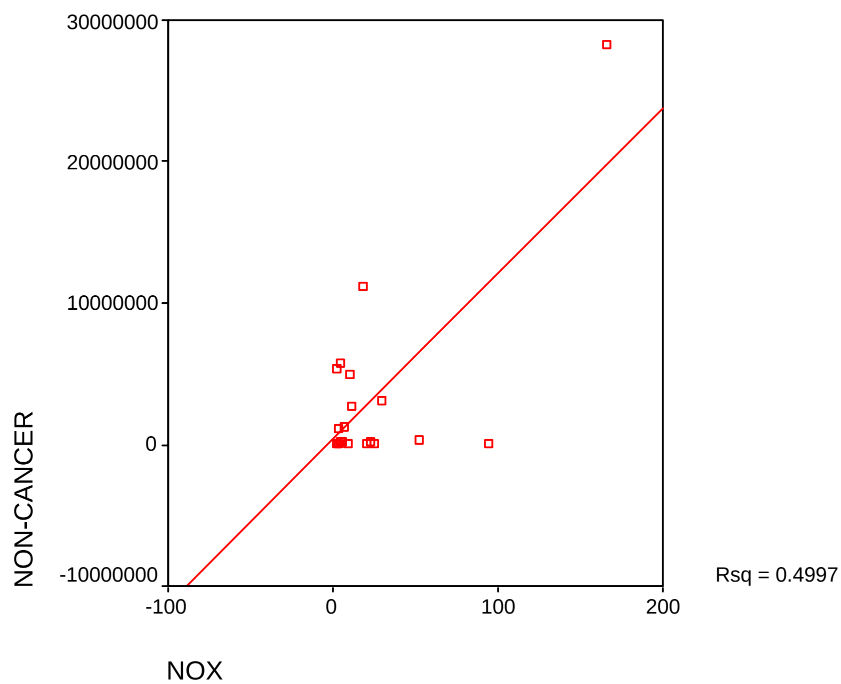


Figure 9. SIC 2911 Non-Cancer Risk- Weighted Emissions vs. NOx Emissions by RECLAIM Participating Facilities in 1998

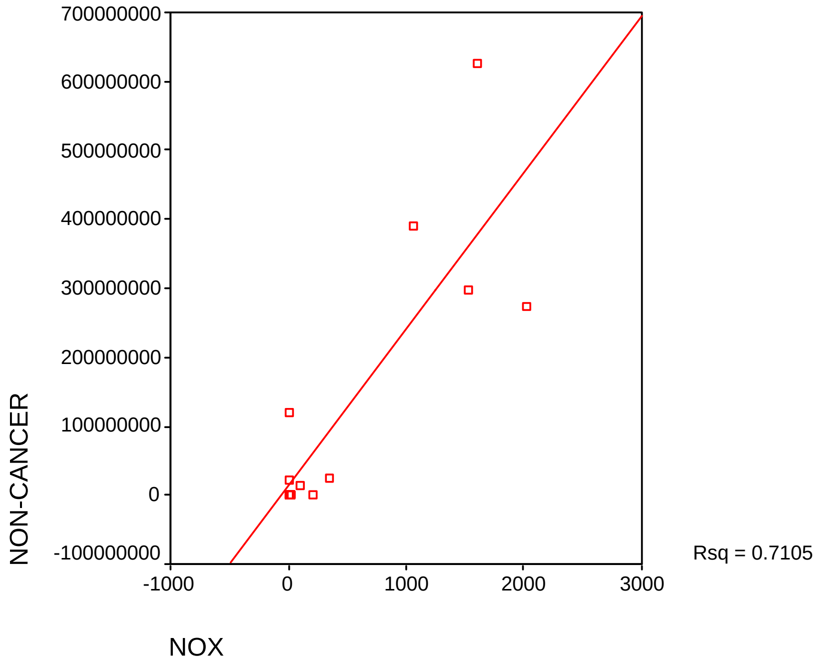


Figure 10. SIC 2911 Cancer Risk- Weighted Emissions vs. NOx Emissions by RECLAIM Participating Facilities in 1998

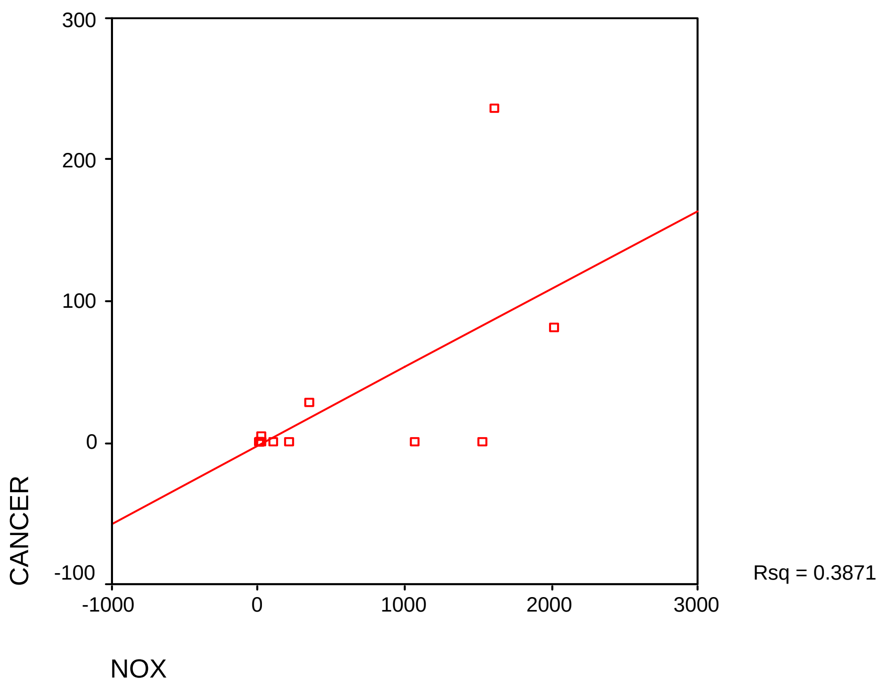


Figure 11. SIC 2911 Cancer Risk-Weighted Emissions vs. SOx Emissions by RECLAIM Participating Facilities in 1998

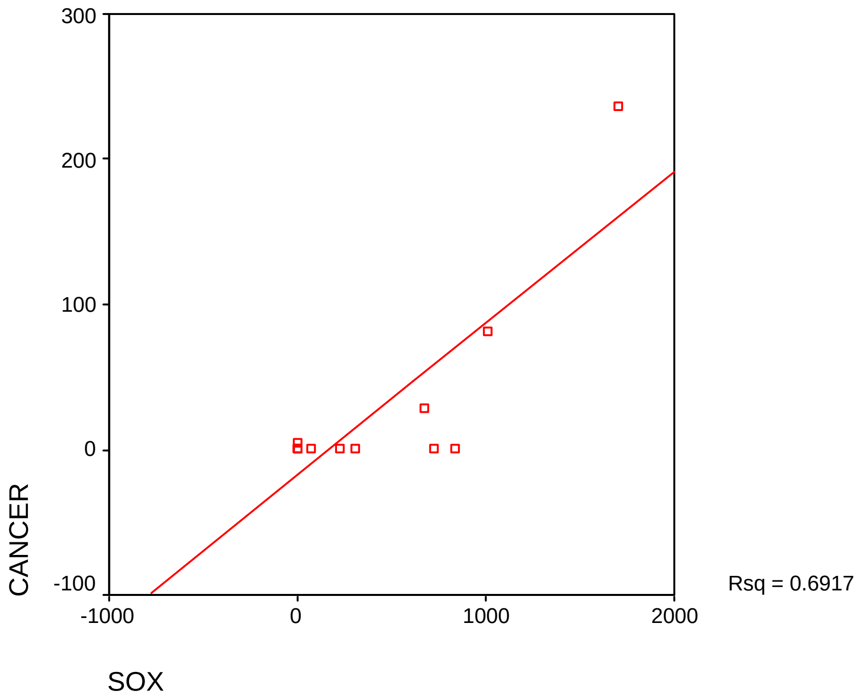


Figure 12. SIC 2911 Non-Cancer Risk-Weighted Emissions vs. SOx Emissions for RECLAIM Participating Facilities in 1998

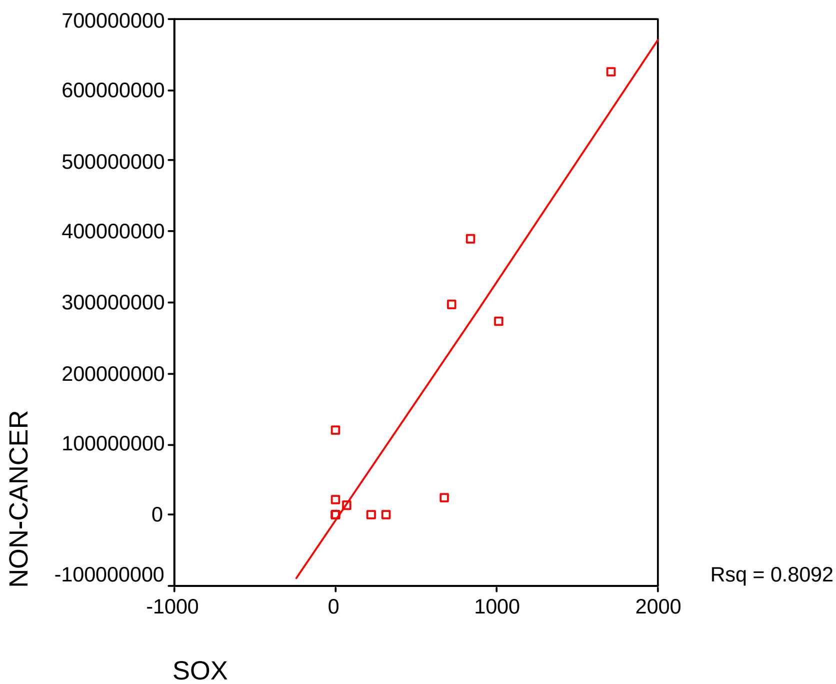


Figure 13. SIC 72 Non-Cancer Risk-Weighted Emissions vs. NOx for RECLAIM Participating Facilities in 1998

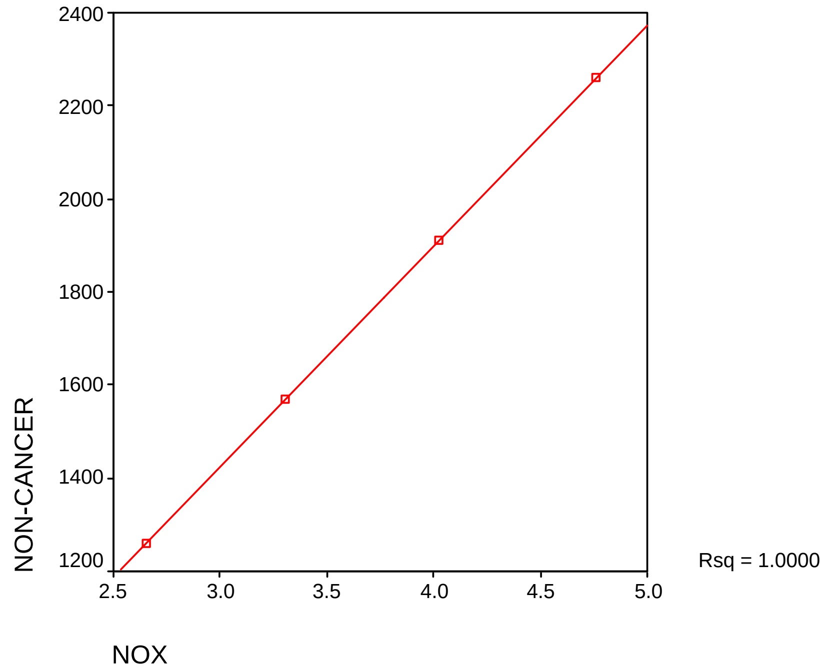


Figure 14. SIC 72 Cancer Risk-Weighted Emissions vs. NOx for RECLAIM Participating Facilities in 1998

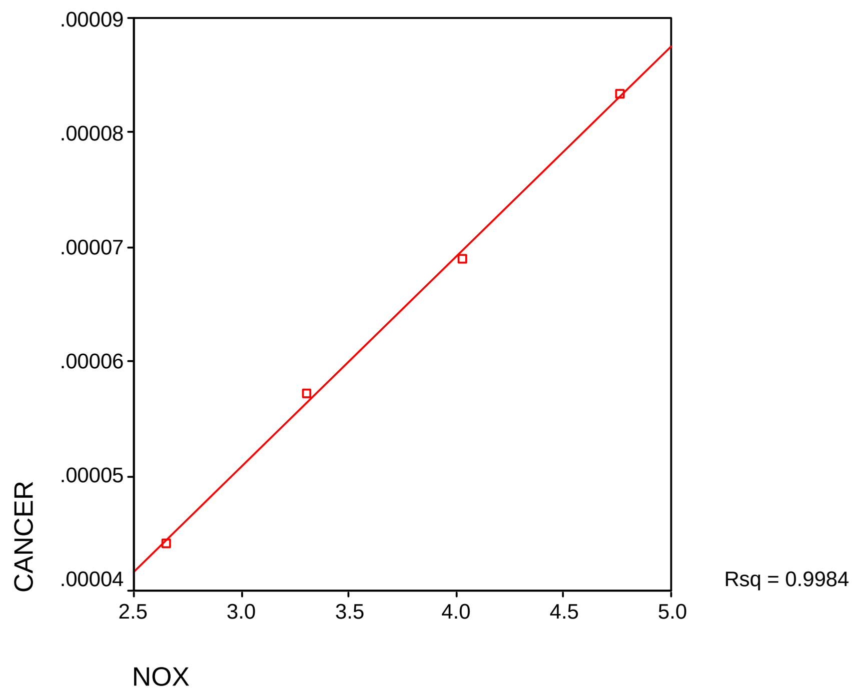


Figure 15. SIC 72 Non-Cancer Risk-Weighted Emissions vs. SOx Emissions for RECLAIM Participating Facilities in 1998

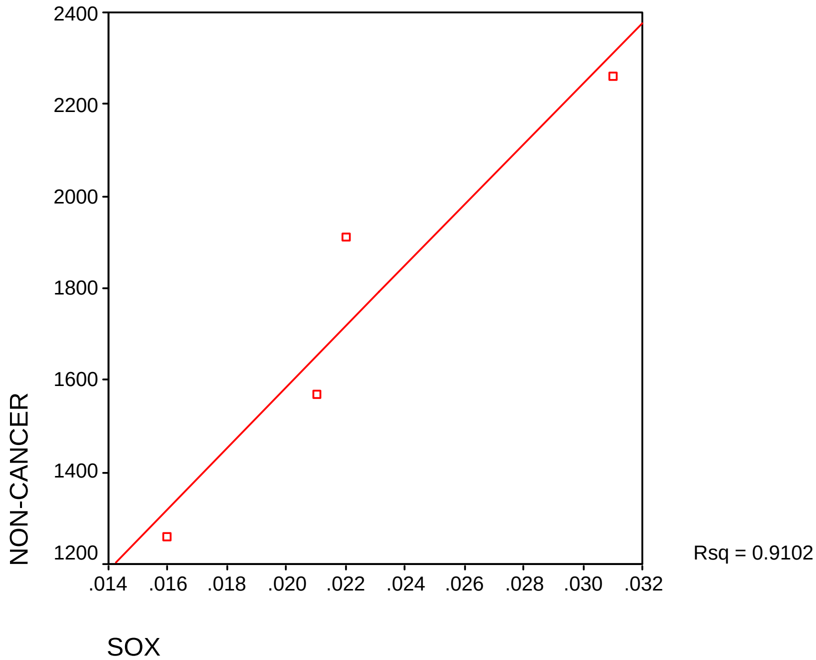
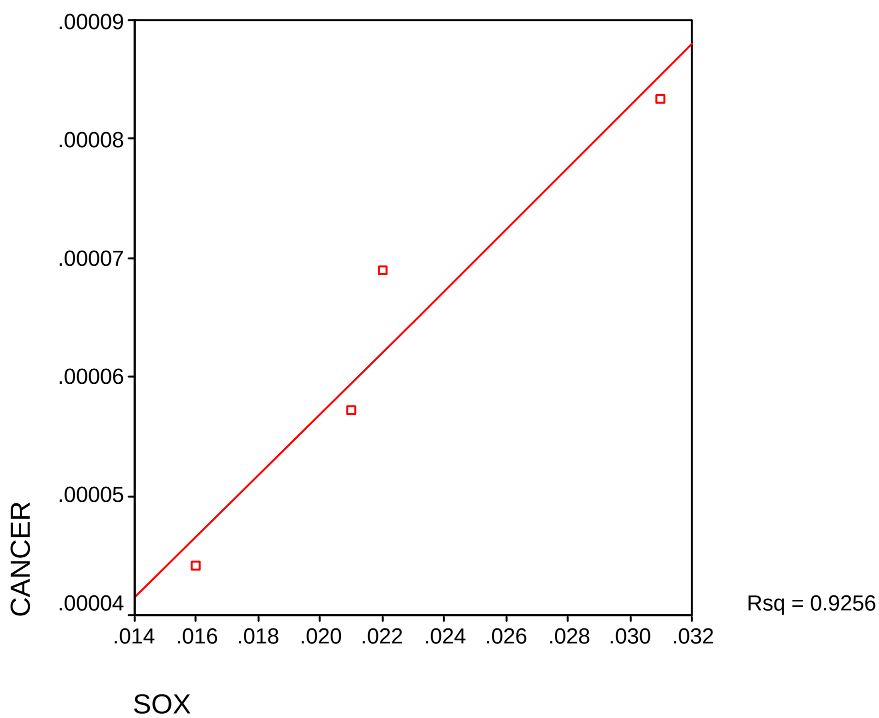


Figure 16. Cancer Risk-Weighted Emissions vs. SOx Emissions for RECLAIM Participating Facilities in 1998



Appendix C. Significance of Comparison of Proportions

Two proportions can be compared statistically using the following C-test:

$$\mathbf{C} = \frac{p_1 - p_2}{\sqrt{(p_1 q_1 / n_1) + (p_2 q_2 / n_2)}}$$

Where:

p_1 = proportion of facility 1

p_2 = proportion of facility 2

q_1 = 1 – proportion of facility 1

q_2 = 1 – proportion of facility 2

n_1 = number of samples in proportion 1

n_2 = number of samples in proportion 2

This tests the hypothesis that there is no significant difference between the two proportions. C-values greater than 1.96 indicate a difference between the proportions that falls above a 0.05 significance level.

(Williams 1995)

Appendix D. Toxic compounds used to create Risk-Weighted Emissions

Chemical	Chronic Non-Cancer Risk	Cancer Risk	Chemical	Chronic Non-Cancer Risk	Cancer Risk
1,3-Butadiene		X	Ethylene Dibromide (EDB)	X	X
Acetaldehyde	X	X	Ethylene Glycol	X	
Acrolein	X		Ethylene Oxide	X	X
Acrylic Acid	X		Fluorides & Cmpds	X	
Acrylonitrile	X	X	Fluorocarbons (CFC-113)	X	
Allyl Chloride	X	X	Formaldehyde	X	X
Ammonia	X		Gasoline Vapors	X	
Antimony & Cmpds	X		Glutaraldehyde	X	
Arsenic & Cmpds	X	X	Glycol Ethers (EGMEA)	X	
B(a)anthracene		X	Hexane	X	
B(a)P		X	Hydrazine	X	
B(b)fluoranthen		X	Hydrochloric Acid	X	
B(k)fluoranthen		X	Hydrogen Cyanide (HCN)	X	
Benzene	X	X	Hydrogen Fluoride	X	
Beryllium & Cmpds	X	X	Hydrogen Sulfide	X	
Bromine & Cmpds	X		Isopropyl Alchol	X	
Cadmium & Cmpds	X	X	Lead & Cmpds		X
Carbon Disulfide	X		Maleic Anhydride	X	
Chlorobenzene	X		Manganese & Cmpds	X	
Chloroform	X	X	Methyl Bromide	X	
Chloroprene	X		Methyl t-Butyl Ether	X	X
Chrysene		X	Methyl Chloride		
Cr(VI)	X	X	Methyl Chloroform (1,1,1-TCA)	X	
ChromiumTrioxide	X	X	Methylene Chloride	X	X
Copper & Cmpds	X		4,4'-Methylene Dianiline	X	X
Cresols	X		Mineral Fibers	X	
Cyanide Cmpds	X		Napthalene	X	
Dibenz(a,h)anthracene		X	Nickel & Cmpds	X	X
1,2-DiCLBenzine	X	X	Nitric Acid		
1,4-Dioxane	X	X	Nitrogen Dioxide	X	
EDC (1,1,-Dichloroethane)		X	Particulate Matter	X	X
EGBE	X		PCBs	X	X
EGEE	X		Perchloroethylene	X	X
EGEEA	X		PGME	X	
EGME	X		Phenol	X	
Epichlorohydrin	X	X	Phosphine	X	
1,2-Epoxybutane	X		Phosphoric Acid	X	
Ethyl Benzene	X		Phosphorus	X	

Chemical	Chronic Non-Cancer Risk	Cancer Risk
Phthalic Anhydride	X	
Propylene	X	
Propylene Oxide	X	X
Selenium	X	
Sodium Hydroxide	X	
Styrene	X	
Sulfates	X	
Sulfur Dioxide	X	
Trichloroethylene (TCE)	X	X
Toluene	X	
T-2,4-diisocyanate (Toluene)	X	X
Vinyl Acetate	X	
Vinyl Chloride	X	X
Xylenes	X	
Zinc & Cmpds	X	
Zinc Oxide	X	
p-DiClBenzene	X	X
1-4,7,8HxCDD	X	X
2,3,7,8-TCDD	X	X
1,2-DiCLBenzine	X	X

Appendix E. Focus on the Petroleum Industry (SIC 2911s)

To evaluate SIC 2911, the emissions data from section 5.1 were used. These consist of 1998 data and serve only as a snapshot in time. Because NOx, SOx and their associated risk-weighted emissions are analyzed for 1998 only, conclusions concerning emission distributions are relevant solely to 1998. Trade flow data for SIC 2911 was accumulated from the SCAQMD BBS. These data represent net trades (net = bought-sold) per industry and facility from 1994 to 1999. Utilizing trade data from a 6 year span helps to identify important trends both at the industry and firm level.

Much of the concern over air pollution in the LA basin must be attributed to the high emissions levels of the Petroleum and Coal Products Industry (SIC 29). Our analysis finds that in 1998, RECLAIM participating facilities within SIC 29 accounted for approximately 7047 tons of annual NOx emissions and 5565 tons of annual SOx emissions. Moreover, in the analysis of section 5.1.3, SIC 29 demonstrated a significant correlation between NOx and SOx emissions and toxic risk-weighted emissions, accounting for high overall significance (Refer to Table 5.3 in section 5.1.4). According to our findings, the 14 members of SIC 2911 demonstrated the most considerable correlation of all SIC 29 industries. Of the 7047 annual tons of NOx emissions and 5565 tons of annual SOx emissions for SIC 29 in 1998, 6953 annual tons of NOx and 5543 annual tons of SOx were generated by SIC 2911 facilities alone (Refer to table 1). This accounts for the vast majority of SIC 29 emissions. Because of their high RECLAIM and toxic pollutant emissions, a closer analysis of SIC 2911 facilities is warranted.

Table 1: 1998 Total and Facility Average NOx and SOx emissions for SIC 2911

	Total 1998 NOx Emissions (Tons)	**Total 1998 SOx Emissions (Tons)**	**1998 Facility Average NOx Emissions (NOx)**	**1998 Facility Average SOx Emissions (SOx)**
SIC 2911	6953.36	5543.93	496.67	395.99

Evidence, such as that outlined in section 5.2.2, suggests that RECLAIM participating facilities are disproportionately located amidst minority and low-income communities. (Time limitations prevented further insight into whether SIC 29 facilities in particular tend to be located in this inequitable fashion.) Further research uncovered that there was a net accumulation of emissions credits by these facilities in 1998. While we cannot say for certain where these net accumulations took place, or that these accumulations likely accrued in minority or impoverished neighborhoods, we can estimate that SIC 2911 facilities obtained, through trading, the potential for higher risk-weighted emissions. (An accumulation of credits does not necessarily translate into higher NOx, SOx and associated toxic risk weighted emissions because a) "net credit trades" may account for company credits not solely facility credits and b) a facility may not use all of their credits. They might, for example, have difficulty selling unused credits.)

Despite a lack of analysis on specific SIC 2911 facility locations, but with the help of general low-income and minority location trends for RECLAIM participating facilities, initial conclusions about the effects of net credit accumulations by SIC 2911 can be made. This finding would point to an environmental justice in impoverished neighborhoods were it not for the important conclusion made in section 5.1.6 that suggests there is not a net accumulation of RECLAIM credits in these neighborhoods. Instead, the data suggests that hot spots may exist, but not necessarily in minority or low-income communities.

The data seems to indicate is that there are a few important players in the SIC 2911 trading that effect the overall credit flow. Their possible impact on any increased concentration of toxic risk-weighted emissions in local neighborhoods is supported by the strong toxic emission and NOx/SOx emission correlation demonstrated in section 5.1.3 by the SIC 2911 facilities. As these facilities trade credits and undergo any corresponding change in NOx or SOx emissions, the amount of toxic risk-weighted emissions will change as well. In turn, their impact on public health will have been altered.

Figure 1: Net Flow of RECLAIM Credits for SIC 2911

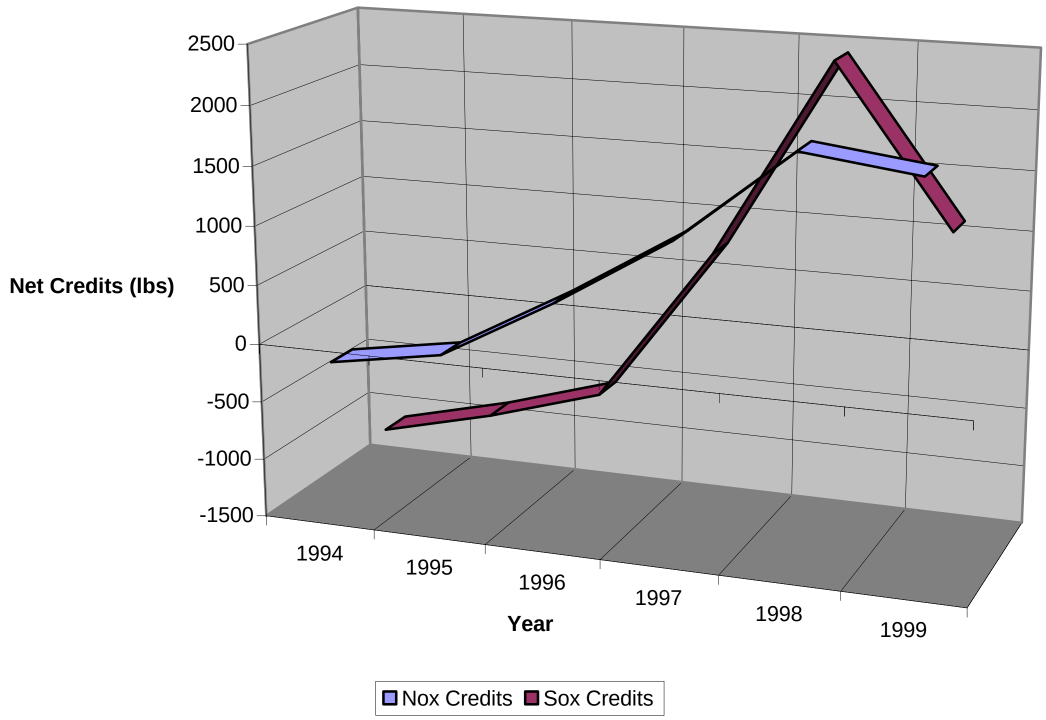


Table 2: Net Flow of Credits for SIC 2911

		1994 Net Flow of Credits	1995 Net Flow of Credits	1996 Net Flow of Credits	1997 Net Flow of Credits	1998 Net Flow of Credits	1999 Net Flow of Credits
SIC 2911	**SOx**	**-188.64**	**-25.57**	**506.99**	**1101.78**	**1890.80**	**1770.10**
	NOx	**-1085.85**	**-847.52**	**-552.95**	**759.86**	**2421.17**	**1111.43**

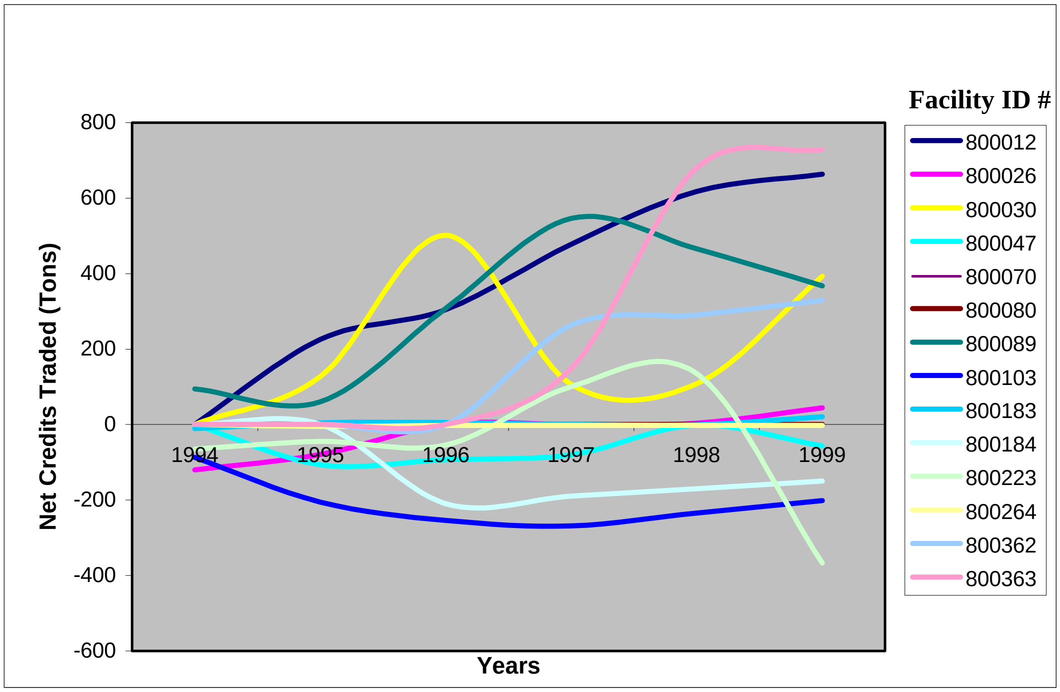
The facilities in SIC 29 accounted for approximately 33% of NOx emissions by RECLAIM facilities in 1998. The petroleum refining industry (SIC 2911) comprises 98% of these emissions. Nearly 90% of the SIC 2911 NOx emissions were generated by 4 facilities in 1998. These 4 facilities thus accounted for just under 30% of total RECLAIM NOx emissions in 1998. The 4 facilities are the Texaco Refinery and Marketing Inc in Wilmington, Mobil Oil Corporation in Torrance, Chevron Products Co in El Segundo and ARCO Products in Carson.

Similar claims can be made for SIC 2911 SOx emissions with respect to total RECLAIM emissions. Approximately 75% of the total 1998 RECLAIM SOx emissions are attributed to SIC 2911. Of these, nearly 90% are produced by five facilities putting their portion of the total RECLAIM emissions at 67%. In addition to the 4 facilities mentioned above, Ultramar Inc in Wilmington is the 5th major contributing facility.

Examining the figures in Table 2, a clear trading trend has taken place in SIC 2911 since 1994. Both SOx and NOx credit markets have seen a shift from a net selling of credits to a net purchasing of credits as time passed. The variance of SOx trading has been lower than that of NOx trading. The amplitude in NOx trading begins with a net sell off of 1085.85 credits in 1994 and peaks with net purchasing of 2421.17 credits. Trading for SOx credits has been more moderate, rising from net sales of 188.64 credits to a net inflow of 1890.80 credits. For both NOx and SOx credit flows, increased purchasing trends diminished in 1999. Net purchases of NOx credits in SIC 2911 experienced a particularly sharp drop off from 1998 to 1999 of over 1300 credits (Refer to Figure 1).

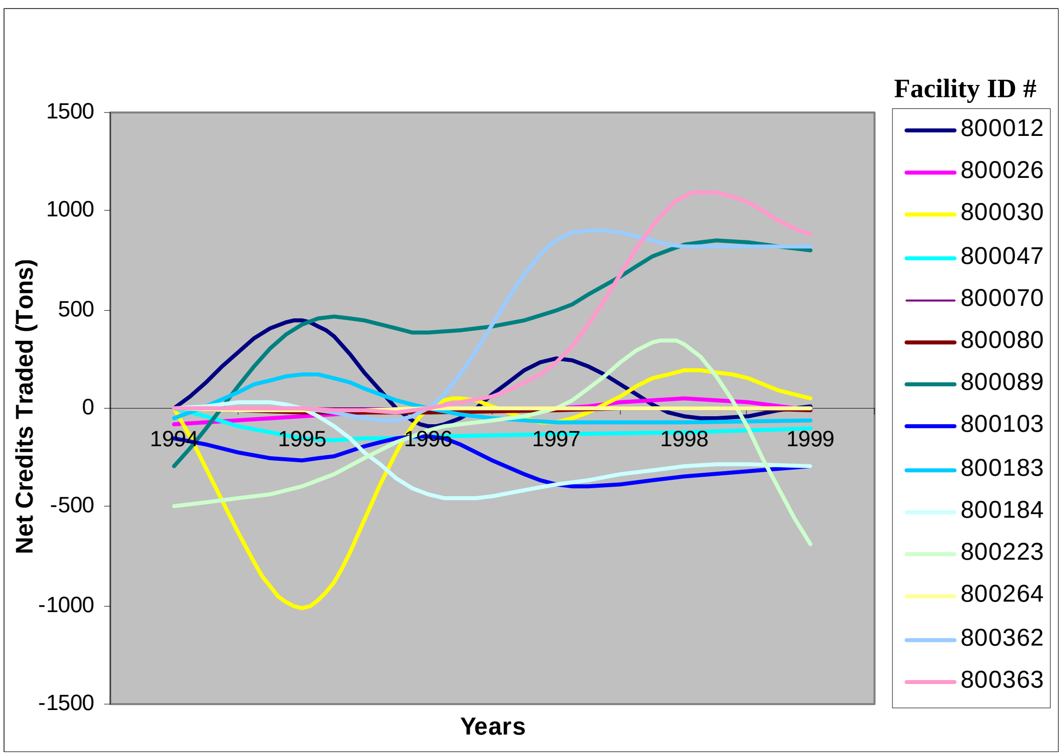
Figures 2 and 3 illustrate the RTC trading patterns for SIC 2911 facilities. Because under our analysis net trades cannot be directly correlated to changes in emissions, the impacts of trading within SIC 2911 are inconclusive. To the extent that a large accumulation of NOx credits could lead to a significant increase in toxic risk-weighted emissions (especially in light of the high statistical significance in section 5.1.3) an exact increase measurement is nearly impossible to determine. Furthermore, although hot spots may coincide with the location of RTC accumulations, they do not necessarily present environmental inequalities.

Figure 2: SIC 2911 Net Credits Traded for SOx (Listed by facility ID number*)



***Refer to Table 3 for facility names**

Figure 3: SIC 2911 Net Credit Trades for NOx (Listed by facility ID number)*



***Refer to Table 3 for facility names**

Table 3: SIC 2911 Facility ID Names and Annual Net Trades

Facility ID	Facility Name	Pollutant	1994	1995	1996	1997	1998	1999
800012	ARCO PRODUCTS CO	NOx	0.00	450.00	-92.67	250.27	-43.11	9.22
		SOx	0.00	226.02	305.25	478.25	617.57	663.91
800026	ULTRAMAR INC	NOx	-85.00	-45.00	0.00	0.00	50.00	-7.16
		SOx	-120.00	-80.00	0.00	0.00	3.75	44.00
800030	CHEVRON PRODUCTS CO.	NOx	0.00	-1017.67	0.00	-67.53	193.68	52.69
		SOx	0.00	126.92	501.86	106.03	107.62	392.94
800047	FLETCHER OIL & REF	NOx	0.00	-151.56	-145.24	-135.94	-119.65	-101.36
		SOx	0.00	-106.41	-93.48	-80.55	-2.00	-56.66
800070	HUNTWAY REFINING CO	NOx	0.00	0.00	0.00	0.00	0.00	0.11
		SOx	0.00	0.00	0.00	0.00	0.00	0.00
800080	LUNDAY-THAGARD OIL CO	NOx	0.00	-15.76	-15.25	-15.00	0.00	-7.50
		SOx	0.00	0.00	0.00	0.00	0.00	0.00
800089	MOBIL OIL CORP	NOx	-289.53	427.91	390.14	491.79	829.62	800.14
		SOx	94.18	60.04	308.62	547.00	466.50	368.03
800103	POWERINE OIL CO	NOx	-156.50	-265.00	-144.21	-389.42	-341.28	-289.70
		SOx	-87.00	-206.02	-253.97	-268.64	-234.96	-201.29
800183	PARAMOUNT PETR CORP	NOx	-54.82	175.00	0.00	-75.00	-74.16	-63.75
		SOx	-10.82	4.08	4.92	0.00	-0.51	20.00
800184	GOLDEN WEST REF CO	NOx	0.00	0.00	-438.94	-387.63	-298.82	-296.75
		SOx	0.00	0.00	-210.00	-190.20	-170.18	-150.16
800223	TEXACO REF & MARKETING INC	NOx	-500.00	-400.00	-106.79	0.00	325.00	-688.18
		SOx	-65.00	-45.00	-54.04	100.00	134.62	-367.09
800264	EDGINGTON OIL COMPANY	NOx	0.00	-5.45	0.00	0.00	0.00	0.00
		SOx	0.00	-5.20	-2.18	-2.18	-2.18	-2.18
800362	TOSCO REFINING COMPANY	NOx	0.00	0.00	0.00	853.33	825.64	823.40
		SOx	0.00	0.00	0.00	263.56	290.72	329.55
800363	TOSCO REFINING COMPANY	NOx	0.00	0.00	0.00	235.00	1074.26	880.28
		SOx	0.00	0.00	0.00	148.50	679.85	729.06

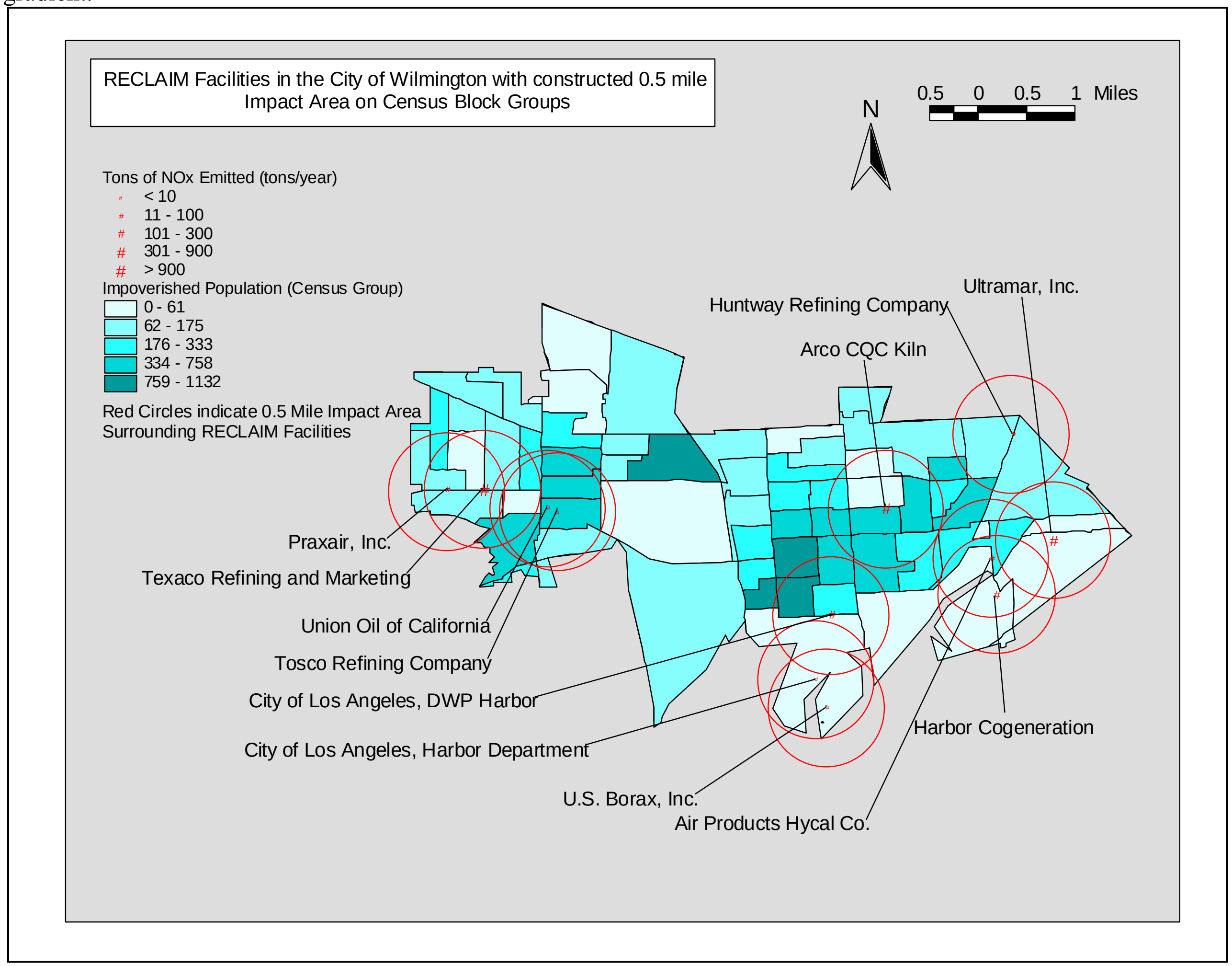
Appendix F. Case Study of the City of Wilmington

The majority of Wilmington's NOx emissions originate from the Texaco Refining and Marketing in the 2911 SIC category, which produces 1067 of Wilmington's total 2044 tons of NOx per year. Texaco Refining and Marketing purchased 65,000 NOx credits, allowing the additional production of 32.5 tons of NOx for the 1998 trade year. With the strong correlation coefficient of 113.4 for tons of non-cancer risk weighted emissions per ton of NOx and 2.76E-5 for tons of cancer risk weighted emissions per ton of NOx for the 2911 SIC category, we can multiply this by the 32.5 tons of NOx producible by Texaco, showing an increase in cancer toxic risk weighted emissions of 8.97E-4 tons (1.75 lbs) and a 3685.5 ton increase in non-cancer toxic risk weighted emissions.

Using the 1998 trade data for NOx credits, Wilmington as a whole saw a net influx of 200 tons worth of NOx credits from industries in the 2800 and 2900 series of SIC categories. Multiplying the correlation coefficient for each SIC with the NOx credits for each 2800 and 2900 series facility in Wilmington, the total tonnage of cancer risk weighted emissions attributed to NOx credits are 4.67 tons and the total tonnage of non-cancer risk weighted emissions attributed to NOx credits are 22,115 tons. With a net influx of 62.5 tons worth of SOx credits, the same set of calculations can be performed, finding the credits attributable for 5.89E-3 tons of cancer risk weighted emissions (11.776 lbs) and 10,818 tons of non-cancer risk weighted emissions. As this analysis does not examine the collinearity of NOx and SOx, the extent of risk weighted emission overlap between the NOx and SOx correlations is unknown. Unfortunately, as the toxic emission concentrations were unavailable for this analysis, this study is unable to determine how this increase in toxic risk weighted emissions would be reflected in measurements of cancer risk in terms of cases developed per million.

As figure 1 indicates, the Wilmington area between Praxair, Inc. and Texaco Refining and Marketing on one side and Union Oil of California and Tosco Refining on the other sits in an area with a high potential risk for cumulative impacts from the four facilities. Three of the four facilities are refineries in the 2911 SIC code, which has a strong correlation between NOx and SOx and for both cancer and non-cancer causing toxics. The fourth facility, Praxair, Inc. is in the 2813 SIC code, which also shows strong correlations between NOx and non-cancer causing toxics.

Figure 1: Map of the Census Block Groups comprising the City of Wilmington.
RECLAIM facilities and this study's constructed 0.5-mile impact areas have been mapped over the demographic gradient.



In the earlier analysis of impoverished and non-white populations in proximity to RECLAIM facilities, Wilmington showed disproportionately larger impoverished populations near RECLAIM facilities, but no significant differences between non-white populations inside or outside of impact areas. While the census block groups in the impact areas of Praxair, Tosco, Texaco, and Union do not have the highest impoverished populations in the city, the areas do include census block groups among the top 15 impoverished block groups in the city. It should be noted, however, that while Texaco Refining and Marketing purchased 65,000 NOx credits and nearly 27,000 SOx credits, Union Oil sold just over 27,000 NOx credits and nearly 14,000 tons of SOx, and so partially offsets any risk increases that may be caused by the purchase of credits by other facilities in the area. Regardless, the impact areas between Praxair, Inc., Texaco Refining and Marketing, Union Oil of California, and Tosco Refining see an influx of NOx and SOx credits correlated with “risky” emissions. As the impact area has a greater than average impoverished population, these credit purchases show potential to create environmental justice impacts.

Similarly the impact areas for NOx and SOx Arco CQC Kiln and the City of Los Angeles, DWP Harbor cover highly impoverished neighborhoods in the eastern part of the city. The correlations between NOx/SOx and toxics for the City of Los Angeles, DWP Harbor, however, fail significance tests and while Arco CQC Kiln purchased 19,600 NOx credits, it sold 14,900 SOx credits, canceling nearly three quarters of the risk weighted emissions attributable to the NOx credit purchase. Additionally, the impact areas for Arco CQC Kiln and City of Los Angeles, DWP Harbor indicate fewer problems with cumulative impact issues.

These results indicate that the risk to some poor and minority communities near RECLAIM facilities can increase as the facilities purchase RTCs or decrease as facilities sell RTCs. While it may be the case that the net RTCs bought by one facility must be sold from another facility, thus reducing the risk to surrounding communities at those locations, worsening one community’s conditions for improvements in another’s conditions is a trade-off that lies at the heart of environmental justice issues.

Appendix G. Survey Cover Letter

December 11th, 2000

Dear,

We are inviting you to participate in a research effort to evaluate the effectiveness of the Regional Clean Air Incentives Market (RECLAIM). We are independent researchers from the Bren School of Environmental Science and Management at the University of California, Santa Barbara.

As part of this evaluation process, we have developed the attached questionnaire to gauge the success of RECLAIM from the participants' perspectives. The survey is short, 12 questions in total, and shouldn't take more than two minutes to complete.

The survey is being conducted by researchers at the University of California, Santa Barbara, and is in no way affiliated with the South Coast AQMD, or any other regulatory agency. Your assistance in completing this brief questionnaire will provide an independent feedback loop to program coordinators. The information you share with us will remain confidential, and will be analyzed and presented in aggregate form.

We respectfully request that you return the questionnaire by January 5th, 2001, using the self-addressed return envelope that is included. Please use the fax number below, if more convenient for you.

If you would like to request a copy of the report, please check the box at the end of the survey and be sure to include your address. If you would like any additional information on the project, please don't hesitate to contact me at the phone number, fax number, or email address listed below.

Again, we appreciate your time and help with this survey.

Sincerely,

Scott E. Lowe
Research Associate
SLOWE@BREN.UCSB.EDU

PHONE: (805) 696-XXXX FAX: (775) 307-4456

Appendix H. Survey Questionnaire

RECLAIM Universe Questionnaire — Fall 2000

COMPANY NAME: ____

Please answer the following questions to the best of your ability, using the check boxes to the right:

1. When did your company enter RECLAIM? (YEAR) ____

2. How many permits was your company allocated when you entered the program? (TONS/YEAR) ____________

3. How many employees are there currently in your company? ____________________________________

4. How many employees are responsible for Air Quality Management within your company? _____________

5. How frequently do you meet with an AQMD RECLAIM representative: Daily ☐ Weekly ☐ Monthly ☐ Yearly ☐ Less than Yearly ☐

6. Have you participated in any informational meetings organized by the SCAQMD (Workshops, Roundtables, Public Hearings, etc.)? Yes ☐ No ☐

   If Yes, how often do you attend? Weekly ☐ Monthly ☐ Yearly ☐ Less than Yearly ☐

7. Are any of your facilities ISO-14001 certified? If so, how many? Yes ☐ _________ No ☐

8. Are you part of any voluntary environmental quality programs (ClimateWise, Design for the Environment, EnergyStar, etc.)? Yes ☐ No ☐

   If yes, please provide the name(s) of these programs: ____

   ____

9. The goods and/or services that your company provides are primarily consumed/used in: The Los Angeles Area <u>Only</u> ☐ Southern California ☐ California ☐ Western United States ☐ United States ☐ Globally ☐

10. As compared to your competitors, how much have you invested in:

	Significantly Less	Less	About the Same	More	Significantly More
A. End-of-Pipe Solutions (ie: Scrubbers, Bagging, etc.)	1	2	3	4	5
B. Pollution Prevention Solutions (ie: New Burner Installations, etc.)	1	2	3	4	5

If you would like a copy of the results of this survey, please check this box ☐ and provide your mailing information

Appendix I.   Correlation Table for Survey Response

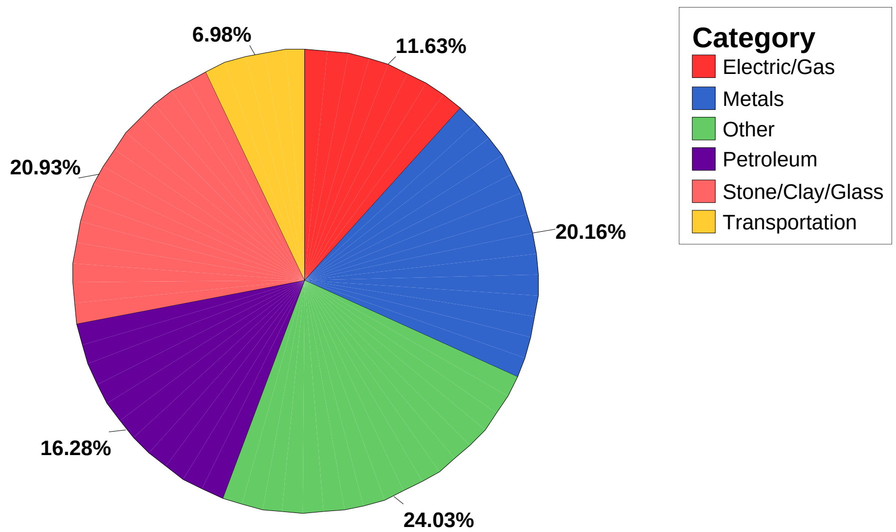
Correlations

		TRADES	PP	EOP	COASTDUM	PUBLIC	DUM_ELEC	DUM_PETR	PERM	DUM_STON	DUM_MTL	AQMS	FREQREC	INF_MTGS	ISO_4K	VOL_PRGM	SCOPE
TRADES	Pearson Correlation	1.000	.169	.147	.120	.052	.053	-.003	-.020	-.009	.050	.103	.168	.104	.021	.016	.164
	Sig. (2-tailed)	.	.068	.116	.174	.556	.551	.974	.820	.920	.573	.245	.058	.241	.811	.861	.064
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
PP	Pearson Correlation	.169	1.000	.545**	.013	-.020	-.041	.086	-.020	-.010	.005	.027	.002	.014	.081	-.098	.041
	Sig. (2-tailed)	.068	.	.000	.892	.834	.659	.355	.830	.917	.960	.775	.984	.879	.388	.291	.663
	N	117	117	115	117	117	117	117	117	117	117	117	116	117	117	117	117
EOP	Pearson Correlation	.147	.545**	1.000	.039	.006	-.013	.025	-.037	-.102	.203*	.005	.009	.043	.029	-.141	.073
	Sig. (2-tailed)	.116	.000	.	.681	.946	.891	.793	.691	.279	.030	.956	.926	.648	.760	.134	.441
	N	115	115	115	115	115	115	115	115	115	115	115	114	115	115	115	115
COASTDUM	Pearson Correlation	.120	.013	.039	1.000	.092	.004	.080	-.040	.100	-.041	-.054	-.044	-.110	-.008	.030	.072
	Sig. (2-tailed)	.174	.892	.681	.	.301	.966	.366	.652	.261	.644	.542	.624	.215	.930	.734	.419
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
PUBLIC	Pearson Correlation	.052	-.020	.006	.092	1.000	-.040	-.006	-.069	-.096	-.082	.077	.043	.033	.161	.157	.221*
	Sig. (2-tailed)	.556	.834	.946	.301	.	.649	.946	.434	.277	.353	.386	.631	.711	.069	.076	.012
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
DUM_ELEC	Pearson Correlation	.053	-.041	-.013	.004	-.040	1.000	-.160	.309**	-.187*	-.182*	.110	.002	.074	-.087	-.004	-.264**
	Sig. (2-tailed)	.551	.659	.891	.966	.649	.	.070	.000	.034	.039	.215	.981	.407	.328	.960	.003
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
DUM_PETR	Pearson Correlation	-.003	.086	.025	.080	-.006	-.160	1.000	.046	-.227**	-.222*	-.020	.259**	.079	.080	-.038	-.132
	Sig. (2-tailed)	.974	.355	.793	.366	.946	.070	.	.602	.010	.012	.823	.003	.371	.369	.666	.136
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
PERM	Pearson Correlation	-.020	-.020	-.037	-.040	-.069	.309**	.046	1.000	.110	-.122	.199*	.146	.151	-.008	.136	-.134
	Sig. (2-tailed)	.820	.830	.691	.652	.434	.000	.602	.	.214	.169	.024	.101	.087	.924	.124	.130
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
DUM_STON	Pearson Correlation	-.009	-.010	-.102	.100	-.096	-.187*	-.227**	.110	1.000	-.258**	-.096	.008	.086	-.039	.009	-.090
	Sig. (2-tailed)	.920	.917	.279	.261	.277	.034	.010	.214	.	.003	.280	.926	.333	.660	.922	.309
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
DUM_MTL	Pearson Correlation	.050	.005	.203*	-.041	-.082	-.182*	-.222*	-.122	-.258**	1.000	.029	-.070	-.157	.050	.014	.209*
	Sig. (2-tailed)	.573	.960	.030	.644	.353	.039	.012	.169	.003	.	.744	.431	.075	.572	.874	.018
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
AQMS	Pearson Correlation	.103	.027	.005	-.054	.077	.110	-.020	.199*	-.096	.029	1.000	.118	.085	-.027	.006	.082
	Sig. (2-tailed)	.245	.775	.956	.542	.386	.215	.823	.024	.280	.744	.	.185	.336	.763	.946	.358
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
FREQREC	Pearson Correlation	.168	.002	.009	-.044	.043	.002	.259**	.146	.008	-.070	.118	1.000	.254**	-.068	.060	-.040
	Sig. (2-tailed)	.058	.984	.926	.624	.631	.981	.003	.101	.926	.431	.185	.	.004	.446	.498	.653
	N	128	116	114	128	128	128	128	128	128	128	128	128	128	128	128	128
INF_MTGS	Pearson Correlation	.104	.014	.043	-.110	.033	.074	.079	.151	.086	-.157	.085	.254**	1.000	.043	.070	.011
	Sig. (2-tailed)	.241	.879	.648	.215	.711	.407	.371	.087	.333	.075	.336	.004	.	.628	.428	.902
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
ISO_4K	Pearson Correlation	.021	.081	.029	-.008	.161	-.087	.080	-.008	-.039	.050	-.027	-.068	.043	1.000	.203*	.195*
	Sig. (2-tailed)	.811	.388	.760	.930	.069	.328	.369	.924	.660	.572	.763	.446	.628	.	.021	.027
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
VOL_PRGM	Pearson Correlation	.016	-.098	-.141	.030	.157	-.004	-.038	.136	.009	.014	.006	.060	.070	.203*	1.000	.089
	Sig. (2-tailed)	.861	.291	.134	.734	.076	.960	.666	.124	.922	.874	.946	.498	.428	.021	.	.314
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129
SCOPE	Pearson Correlation	.164	.041	.073	.072	.221*	-.264**	-.132	-.134	-.090	.209*	.082	-.040	.011	.195*	.089	1.000
	Sig. (2-tailed)	.064	.663	.441	.419	.012	.003	.136	.130	.309	.018	.358	.653	.902	.027	.314	.
	N	129	117	115	129	129	129	129	129	129	129	129	128	129	129	129	129

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix J. Industry Composition



Appendix K. Survey Statistics

Table 1: Frequency Table for PUBLIC variable

Is the Company a Publicly Traded Company?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Privately Owned	79	61.2	61.2	61.2
	Public Company	50	38.8	38.8	100.0
	Total	129	100.0	100.0	

Table 2: Frequency Table for FREQ_REC variable

Frequency of AQMD Meetings

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than Yearly	24	18.6	18.8	18.8
	Yearly	77	59.7	60.2	78.9
	Monthly	23	17.8	18.0	96.9
	Weekly	3	2.3	2.3	99.2
	Daily	1	.8	.8	100.0
	Total	128	99.2	100.0	
Missing	System	1	.8		
Total		129	100.0		

Table 3: Frequency Table for SCOPE variable

Market scope

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Los Angeles Area Only	10	7.8	7.8	7.8
	Southern California	16	12.4	12.4	20.2
	California	10	7.8	7.8	27.9
	Western United States	29	22.5	22.5	50.4
	United States	24	18.6	18.6	69.0
	Global	40	31.0	31.0	100.0
	Total	129	100.0	100.0	

Table 4: Frequency Table for AQMS variable

Air Quality Managers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 or less AQMS	63	48.8	48.8	48.8
	1.5 to 3 AQMS	48	37.2	37.2	86.0
	3.5+ AQMS	18	14.0	14.0	100.0
	Total	129	100.0	100.0	

Table 5: Frequency Table for VOL_PRGM variable

Voluntary Program Participation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	120	93.0	93.0	93.0
	Yes	9	7.0	7.0	100.0
	Total	129	100.0	100.0	

Table 6: Frequency Table for ISO_4K variable

ISO-14001 Certified

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	122	94.6	94.6	94.6
	Yes	7	5.4	5.4	100.0
	Total	129	100.0	100.0	

Table 7: Frequency Table for INF_MTGS variable

Participation in Informal Meetings

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	28	21.7	21.7	21.7
	Yes	101	78.3	78.3	100.0
	Total	129	100.0	100.0	

Table 8: Frequency Table for PERM variable

Initial allocation of RTCs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-2.9 tons	21	16.3	16.3	16.3
	2.9 -5.7 tons	22	17.1	17.1	33.3
	5.8-10 tons	23	17.8	17.8	51.2
	10.1-18.2 tons	20	15.5	15.5	66.7
	18.3-45.2 tons	22	17.1	17.1	83.7
	45.3+ tons	21	16.3	16.3	100.0
	Total	129	100.0	100.0	

Table 9: Frequency Table for COASTDUM variable

Firm Location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Inland or Coastal + Inland Operations	35	27.1	27.1	27.1
	Coastal Operations Only	94	72.9	72.9	100.0
	Total	129	100.0	100.0	