Community Action for a Renewed Environmental (CARE)
Level II Grantee Final Report

Sonora Environmental Research Institute, Inc.
3202 E. Grant Rd., Tucson, AZ 85716, 520-321-9488
Grant #: RE-96989901

Grantee: Sonora Environmental Research Institute, Inc. (SERI)
Project location: Tucson, Arizona
Project title: Community Assist of Southern Arizona (CASA)
Grant period: 11/7/06-10/30/09
Project Manager: Ann Marie Wolf
EPA Project Officer: Periann Wood

TABLE OF CONTENTS

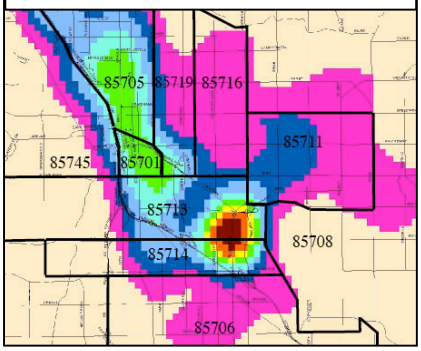
Appendices

I. THE PARTNERSHIP

a. The environmental problems our community faces

The project targeted portions of six ZIP codes in metropolitan Tucson, Arizona: 85701, 85705, 85706, 85713, 85714 and 85719. This area was chosen because it had been identified as a potential air toxics hot spot by the team's previous research (Figure 1), most of the industries and waste management facilities in Tucson are located in the area as are the main traffic corridors, and the childhood asthma rates at 13-25% are higher than the national average of 8%. Approximately 15% of the metropolitan population (85705, 85706 and 85713) receives 47% of the potential air toxics emissions. The hazard risk analysis based on chemical usage at industrial facilities demonstrated that the neighborhoods with the least resources have the highest potential risk from chemical hazards. The most frequent chemicals found in the hotspot based on usage at the facilities, potential emissions, permit data and/or actual emissions were toluene, VOCs, methyl ethyl ketone, xylenes, and methyl isobutyl ketone. The most frequent industry sectors were auto maintenance and repair, printing, plating, surface coating, woodworking and plastic materials and resins.

Figure 1: Hazard risk analysis (Red = greatest risk.)



The largest superfund site in Arizona is located within the target area along with WQARF sites (Arizona's "superfund" program.) For years the community unknowingly consumed drinking water from an aquifer contaminated with perchloroethylene and trichloroethylene and was devastated physically and emotionally by the experience. Other recent environmental issues involve illnesses such as childhood leukemia, lead poisonings, asthma and lupus. The community continued to feel disenfranchised by having little say in the groundwater remediation efforts underway.

b. The individuals and organization that were involved

The CARE partnership represented an established broad-based stakeholder group. The stakeholder groups and individuals in the partnership are given in Table 1. Partnership meetings often included citizens, business owners and other agency personnel that were interested in the program and wanted to help.

Table 1: Members of Partnership

Organization Name	Type of Organization
Alcoa Fastening Systems	Business
Arizona Department of Environmental Quality	Local Government
Arizona Department of Health Services (ADHS)	State Government
C.E. Rose Elementary School	Academic Institution
City of Tucson, Community Development Department	Local Government

City of Tucson/Pima County Household Hazardous Waste Program (HHWP)	Local Government
Community Food Bank	Non-profit
Dean of Science, University of Arizona (UA)	Individual from Academic Institution
Mark Homan	Individual
Department of Atmospheric Sciences, UA	Academic Institution
Pima Community College	Academic Institution
Pima County Department of Environmental Quality	Local Government
SEAHEC	Academic Institution
St. Elizabeth's Health Center	Non-profit/Medical Institution
Staff from Congressman Raúl Grijalva's Office	Federal Government
Staff from Supervisor Richard Elías's Office	Local Government
The University of Arizona Superfund Basic Research Program and U.S./Mexico Binational Center	Academic Institution
Trees for Tucson (Tucson Clean and Beautiful)	Non-profit
Staff from City Councilman Steve Leal's Office	Individual from local government
Tucson Fire Department	Local Government
Tucson Water	Local Government
TUSD Title I Neighborhood Coordinator/ Promotora del Barrio Program	Academic Institution
United Way	Non-profit
University of Arizona Center of Excellence in Women's Health	Academic/Medical Institution

c. New partners brought into the work

1. The University of Arizona Superfund Basic Research Program and U.S./Mexico Binational Center joined the partnership during the first year of the grant period. Their staff provided training and outreach materials especially regarding the Superfund site and associated remediation activities in southern metropolitan Tucson and translation at meetings as needed. We also partnered with them on new grant submittals.

2. Staff from Amphitheater School District also participated in the project after the first year. They provided a link to schools and consequently families in the portion of the district in our target area. Prior to their participation many of our programs were focused solely in the Tucson Unified School District (TUSD). A Family Advocate from Holaway Elementary School worked with us for two summers as a promotora.

d. Our role in the partnership and most important implementation skills

We organized the partnership, coordinated the partnership meetings, and completed all administrative functions for the partnership. Our most important skills to implement the

project were: 1) our staff have excellent organization skills, 2) we made all members of the partnership feel valuable, and 3) we effectively reached the intended audience. We are able to do this because: 1) We are a community-based organization that has been successfully conducting community outreach in the target area for over 10 years; 2) We had a community outreach structure in place that easily incorporated the CARE objectives; 3) We had meaningful involvement from the targeted community in all stages of our projects from planning to implementation; 4) We employed community residents and enlisted community residents as volunteers; 5) We had an active community advisory board already in place that contained most of the key stakeholders in the target area; 6) We had a proven track record in reaching the intended audience; and 7) We were/are trusted by the community.

e. Our most active partners

Most of our partners were active and very supportive of the program. Our most active partners and their resources and strengths are given below in Table 2.

Table 2: Most Active Partners in the CARE Partnership

Organization Name	Resources/Strengths
City of Tucson, Community Development Department – Lead Hazard Control Program (LHCP)	Provided training and outreach materials. Accepted referrals for the LHCP.
HHWP and Small Business Waste Assistance Program (SBWAP)	Provided training and outreach materials on household hazardous materials for the promotoras. Participated in new grant submittals.
Mark Homan	Provided training on leaderships skills for the promotoras and participated in developing mentoring opportunities for staff and volunteers.
Department of Atmospheric Sciences, UA	Provided technical expertise on air quality issues. Provided a graduate student to work on the air quality monitoring portion of the program. Participated in new grant submittals.
Pima County Department of Environmental Quality (PDEQ)	Provided technical expertise on a wide range of environmental issues. Operated and supported the air quality monitoring network. Coordinated the analysis of the filters for additional metals.
St. Elizabeth's Health Center (St. Elizabeth's)	Provided medical expertise and accepted referrals for blood lead testing and asthma care. Participated in new grant submittals
The University of Arizona Superfund Basic Research Program and U.S./Mexico Binational Center	Provided training and outreach materials. Provided translation at meetings when needed. Participated in new grant submittals. Participated in business visits.
Tucson Water	Provided technical expertise, a 40-hour training course and outreach materials on water quality.

Trees for Tucson (Tucson Clean and Beautiful)	Provided training and outreach materials. Provided residential shade trees at low cost to the program. Delivered trees to families.
Tucson Fire Department	Provided technical expertise, training and outreach materials on a wide range of environmental and safety issues. Provided smoke detectors for families. Was a key participant in the business visit program. Participated in new grant submittals.
Anna H. Spitz, MBA, Ph.D.	Reviewed accounting procedures and practices. Provided technical expertise and training on water conservation.

f. Our efforts to ensure that the most vulnerable community members were included in the partnership

Because so many of the families in the target area are Spanish speaking and have a distrust of government agencies, many outreach programs have had limited success with the intended audience. The SERI promotora program is successful because trained neighbors are visiting neighbors. Our staff is from the target area and is primarily monolingual in Spanish (they are all taking English classes). The community trusts SERI because we have a proven track record; we work one-on-one with families and businesses on environmental health issues, we provide all materials and presentations in Spanish, we support community efforts, we provide educational and employment opportunities, and we supply trees, lead free articles, food and smoke detectors to families. We are part of the community, not a separate entity coming into a community to conduct a project. We currently have a large cadre of volunteers and a waiting list for training and home visits which attests to the effectiveness of our programs and our ability to reach the most vulnerable community members. All of these items ensured that the most vulnerable community members were included and actively participated in the partnership.

g. Our EPA project officer role in the partnership

Our project officer played an essential role in the partnership. She guided SERI through the CARE process. She kept the partnership informed of EPA and other resources. She provided insight and expertise on other similar projects. She attended meetings when available, and she participated in training classes and workshops.

h. Barriers that our partnership experienced

Our partnership as a whole did not experience any barriers; however, members of our partnership faced and continue to face budget shortfalls. The childhood lead poisoning prevention position at ADHS was eliminated and the staff member moved to a new position. ADHS offered all of its outreach materials to the partnership, but unfortunately could no longer actively participate. St. Elizabeth's had it's funding for its specialized respiratory program swept into the State's general fund budget. Unfortunately, they could no longer accept referrals for that program because of staff reductions. Community members could still receive medical care at St. Elizabeth's. TUSD had significant budget shortfalls that resulted in the closure of the Rose Family Center and

most of its associated programs shortly after the CARE program ended. Tucson Fire Department is currently facing a budget shortfall that may result in the closure of its Business Assistance Program.

i. How has this partnership improved relationships among those involved?
Most members of the partnership had good working relationships prior to the grant program. The team had worked together before on other projects. We didn't really have any adversarial relationships to overcome.

j. Our role in similar processes to CARE program
SERI has been engaged in a similar process to CARE since 2000 when it was a member of a team that completed an EPA funded Child Health Champion Campaign focused on asthma in Nogales, Arizona. The success of that effort spurred that team to expand to other communities. Under the new program, the team through a promotora program conducted over 2,500 home visits in southern Arizona and helped families provide a healthier environment for their children. Under a grant from National Institutes of Heath, the team expanded and conducted 800 home visits and blood lead testing for children along the U.S./Mexico border. In 2004 the team expanded the program throughout southern metropolitan Tucson with outreach on multiple environmental and health issues, and began a community research program to identify air toxics hot spots.

II. THE PROJECT

a. Our CARE project

The specific aims of this project were: (1) to conduct a neighborhood participatory action plan that engaged the community in all aspects of the project and resulted in reduced exposure to toxics for families; (2) to establish a pollution prevention plan for specific industry sectors; (3) to strengthen the community's ability to make informed environmental health improvement choices and to participate in long-term solutions; and (4) to modify zoning codes to reduce community risk to environmental stresses. A listing of materials that we produced or modified during the project is attached in Table A1 in Appendix A.

b. The toxic risks that our project addressed

The partnership came to the consensus that air quality was the foremost environmental concern for the targeted community, in particular air toxics. The partnership was especially concerned over the many industrial sites surrounding the targeted community. The second priority for the team was childhood lead poisoning and proper lead abatement in homes. The third environmental concern was the quality of the drinking water in the targeted area. The fourth issue of importance was safe and environmentally sound waste management: including recycling, household hazardous waste and illegal dumping. The partnership also felt that families should receive information regarding Valley Fever, allergies and asthma. As a result of the high occurrence of asthma in the children of the target area, the team was also concerned with the chemicals used to clean the schools and their effects on children. Families received information on all of these topics during home visits.

c. The toxic reduction strategies that we pursued

The partnership chose the promotora method as the risk reduction strategy, which included home and business visits, lead screening and neighborhood meetings and presentations. Our promotoras are women from the community who have received extensive training on environmental and health issues and now wish to spread their knowledge throughout the community. They visit homes, schools and businesses, teach others skills and provide information and training that result in true differences in their own neighborhoods. They identify community concerns regarding environmental health issues and coordinate with the team to identify responses to those concerns. This enables the team to better meet community needs by responding to actual concerns in a one-on-one manner yet also in a community-wide manner. The strategy was expanded to include community mapping, air sampling and an expanded business assistance program.

d. Project questions

1. How we reached agreement on implementation decisions? The partnership made most of the implementation decisions prior to the start of the project when designing the program. During the CARE project, the partnership made decisions informally. No votes were taken at the quarterly meetings.

2. Did you reshape your partnership in any way to address strategy implementation? No, we had no need to.

3. What outside resources were most important to your project? Besides those provided by the partnership, the most important outside resources were the outreach materials provided by EPA and the Department of Housing and Urban Development (HUD) and the grant funds from HUD.
4. Was there any environmental issue that EPA seemed to lack the tools or means to address? No, although more tools need to be provided in Spanish especially materials for businesses.
5. How did you build momentum over the course of your project? Did you secure any "early wins" to help build momentum? We did not need to build momentum or have any "early wins". We had and continue to have a long waiting list for our services as do our community services partners.

e. Additional funding that was acquired
The partnership began to look for additional resources early in the project and successfully obtained several grants. Monetary resources obtained are listed in Table 3. In-kind and other resources obtained are listed in Table 4. The partnership continues to look for additional funding.

Table 3: Monetary Resources Obtained During the CARE Project

Organization Name	Funding amount ($)	Funding period
Tucson Firefighters Association	750	11/1/07-10/31/08
City of Tucson (HUD)	100,000	11/1/07-10/31/10
Walmart Foundation	200	6/1/08-12/31/08
University of Arizona (EPA)	72,000	10/1/08-9/30/11
City of Tucson	3,540	10/20/08-10/31/10
HUD	264,356	12/15/08-12/15/10
EPA	18,000	2/16/09-1/31/11
Total funding acquired	***458,846***	

Table 4: Other Resources Obtained During the Project

Organization Name	Type of support received
University of Arizona - Space Grant	The UA NASA Space Grant Graduate Fellowship from 2008-2010 had a value of $56,000. The graduate student analyzed the results of the air monitoring program and provided technical training to the promotoras.
ESRI	Received a grant for ESRI software ArcView 9.2, and ArcPad, two books *GIS Spatial Analysis and Modeling* and *Designing Geodatabases*, and a space available seat for Advanced Analysis with GIS at a value of $3,520.

University of Arizona - Dept. of Atmospheric Sciences	1. Technical advice on environmental issues. 2. Training and brochures 3. Formed partnership with the Superfund Basic Research Program and the U.S./Mexico Binational Center for advanced technical training for promotoras 4. Translation 5. Partner on EPA P2 grant
University of Arizona - Business School	Students from the business school, business writing class completed a semester long client-consultant partnership. They produced two brochures and designed a display for community events.
Tucson Water	Brochures, training and chair community advisory board
Tucson Fire Department	Smoke detectors, brochures, training and tracked statistics
Trees for Tucson	Trees for distribution
St. Elizabeth Health Center	1. Blood lead testing for families 2. Asthma care for families 3. Tracked statistics 4. Promotora training 5. Subgrantee on HUD Lead Outreach grant
Promotoras	Volunteers for all activities
President, SERI	In-kind grant administration and technical support
Pima County Department of Environmental Quality	1. Brochures and training on air quality regulations and monitoring 2. Incorporated metals testing into beryllium air quality monitoring network
Pima Community College	Interns
HHWP and SBWAP	Training, brochures and tracked statistics
Community Food Bank	Food and supplies for events
City of Tucson, Community Services Department	1. Partners on the HUD Lead Outreach grant 2. Provided a promotora training on the Rio Nuevo Tax Assistance program 3. Provided brochures and packets
Arizona Department of Environmental Health Services	1. Blood lead testing for children less than 6 years of age 2. Brochures for home visits and community events

f. Significant Project Outputs

Significant project outputs are given in Table 5. Details for community, promotora training, and media events are given in Appendix B in Tables B1, B2 and B3 respectively.

Table 5: Significant Project Outputs

Event	#
Community events held	45
Community members attending	1,508
Promotoras training events held	21
Promotoras attending	306

Media events held	11
Home visits conducted	3,917
Families referred for blood lead testing	61
Families referred to LHCP	188
Families referred for asthma care	50
Business visits conducted	803
Trees distributed	811
Smoke detectors distributed	2,000
Lead containing items replaced	168

1. Home visits

We conducted 3,917 home visits during the project. Statistics by ZIP code are given in Table 6. 85756 and 85757 are new ZIP codes formed in 2007 from ZIP codes 85706 and 85746 respectively. We visited portions of 85745 and 85746 that bordered our target area. “Other” ZIP codes primarily includes 85716, another bordering ZIP code. Demographics given in the table are from the 2000 U.S. Census.

During home visits families: 1) received a packet of information on environmental health issues, 2) were prescreened for the LHCP, 3) had household items tested for lead, 4) were referred to St. Elizabeth’s for asthma care when appropriate, 5) were referred to St. Elizabeth’s for blood lead testing when appropriate, 6) were offered shade trees, 7) were referred for an asthma follow-up visit when appropriate, 8) were given smoke detectors when available, 9) had lead containing items replaced when funds were available, 10) were provided information on the City of Tucson tax assistance program when applicable, and 11) were given information on other SERI projects and activities.

Table 6: Home Visit Statistics

ZIP Code	% Below Poverty Level	% Hispanic/ Latino	% of Home Visits	% of Referrals to LHCP	% of Referrals for Blood Lead Testing	% of Referrals for Asthma Care	% of Trees
Tucson	18	36	-	-	-	-	-
85701	33	45	1	1	1	-	1
85705	26	32	9	7	7	9	6
85706 and 85756	26	70	17	20	32	26	21
85713	27	62	26	24	29	33	28
85714	31	87	20	27	13	14	22
85719	29	19	5	1	5	3	1
85745	13	49	15	11	3	4	10
84746 and 85757	16	57	5	1	1	-	4
Other	-	-	2	8	9	11	7

Results from Lead Testing

The results from the lead testing are given below. We continue to emphasize to families the potential for lead containing glaze in ceramics and widely distribute the brochure ADHS developed regarding this potential risk. During the first two years of the project we had funds to replace lead containing items. After that time we asked families wishing to keep their items to use the items only for decoration and seal them with a varnish. Reducing children's exposure to lead was one of our most significant project outcomes.

Table 7: Items Tested for Lead

Item	# Tested	# Positive	% Positive	# Replaced
Ceramics (Food Use)	1,091	131	12	82
Glassware	872	72	8	47
Other	884	50	6	17
Venetian blinds	694	23	3	15
Dust	192	3	2	0
Toys	616	6	1	0
TOTAL	4,349	285	7%	168

Effectiveness of Education about the HHWP

During home visits we discussed and provided information on the HHWP and the associated paint distribution program. These programs track participation and paint distribution by ZIP codes. We calculated the participation for our target area for the years prior to, during and after our program. Unfortunately participation from the ZIP codes in our target area fell from 23% of the total participants to 21%. Figure 2 gives the number of participants by year for the four ZIP codes that received over 580 home visits. Our program started in 2006. The increase in participation for 85745 has a strong linear correlation ($r^2 = 0.82$) with the increase in total participation for the program suggesting that the increase wasn't due to our home visits but rather the general increase in program awareness in the community. 85706, 85713, and 85714 traditionally have had low participation rates in HHWP, and our program does not appear to have had much or any impact on the rates.

We also analyzed the impact of our program on the paint distribution program. HHWP combines, repackages and distributes usable latex paint. Figures 3 gives the gallons distributed to the ZIP codes that received over 580 home visits. When we calculated the correlation between the gallons distributed in our target areas and the total gallons distributed, we found a strong linear correlation for each our ZIP codes except 87501 and 85714 (Table 8). 85701 had much lower numbers than the other ZIP codes and an usually low number for 2008. Again this suggests that the increase wasn't due to our home visits but rather the general increase in program awareness in the community.

Figure 2: Number of Participants in HHWP by Year and ZIP Code

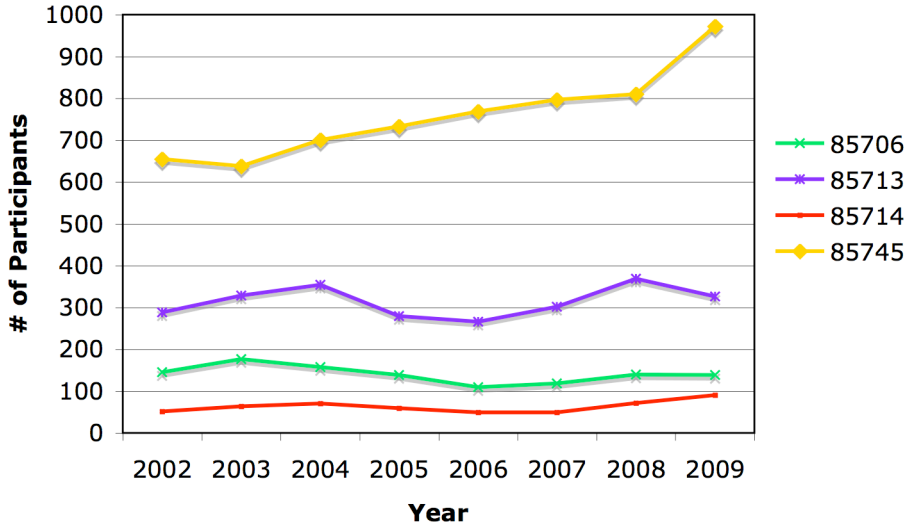


Figure 3: Paint Distributed by Year and ZIP Code

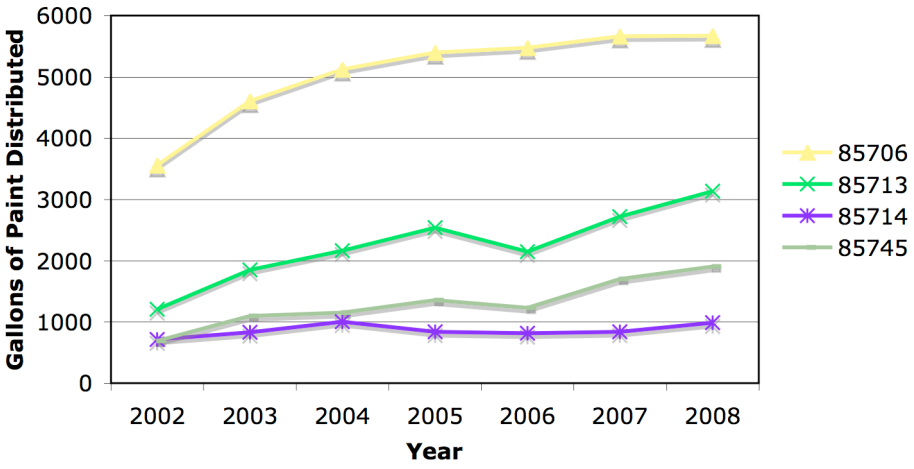


Table 8: Correlation Between Paint Distributed in Target Area and Total Paint Distributed	
ZIP Code	**Correlation Coefficient**
85701	-0.14
85705	0.99
85706	0.95
85713	0.89
85714	0.47
85719	0.93
85745	0.89
85746	0.77

2. Business visits

We completed 803 business visits as shown Table 9. Auto repair and autobody and paint shops were the most numerous business sectors in our target area, and consequently were the focus of our business visit program. We also focused on nail salons, because of the amount of pollution prevention educational material available in Spanish and because of the concern about the chemicals used at the salons and the potential exposure.

Table 9: Business Visits by Industry Sector	
Industry Sector	**# of visits**
Auto repair shops	280
Autobody and paint shops	240
Nail salons	194
Print shops	46
Tire repair shops	17
Hair salons	13
Other	13

Figure 4 gives the results of a survey we conducted to determine what incentives would help businesses choose to implement pollution prevention measures. Many owners stated that they did not have the funds to purchase new equipment even though the equipment may save money over time. Not surprisingly the number one incentive owners preferred was grants for equipment. Green certification ranked high along with reducing insurance premiums and saving money. The new City of Tucson green business certification program may be the incentive some businesses need to implement additional pollution prevention measures. Unfortunately, the right thing to do was given by about only 30% of the businesses.

Effectiveness of Business Visit Program on SBWAP

Figures 5 gives the number of new registrants in the SBWAP versus year. Our program started in 2006. 2006 through 2009 show a statistical significant increase in new registrants, but we cannot say for sure that this increase is because of our program. SBWAP does not track how business found out about their program, and we do not have records of every business that we gave a SBWAP brochure. We distributed more brochures at meetings, workshops and conferences than we did during business visits. In any case each year more businesses are registering for the SBWAP and properly disposing of their hazardous waste.

Figure 4: Results of Survey of Preferred Incentives for Implementing Pollution Prevention Measures (Print, Automotive Repair and Auto Body Shops, N=535)

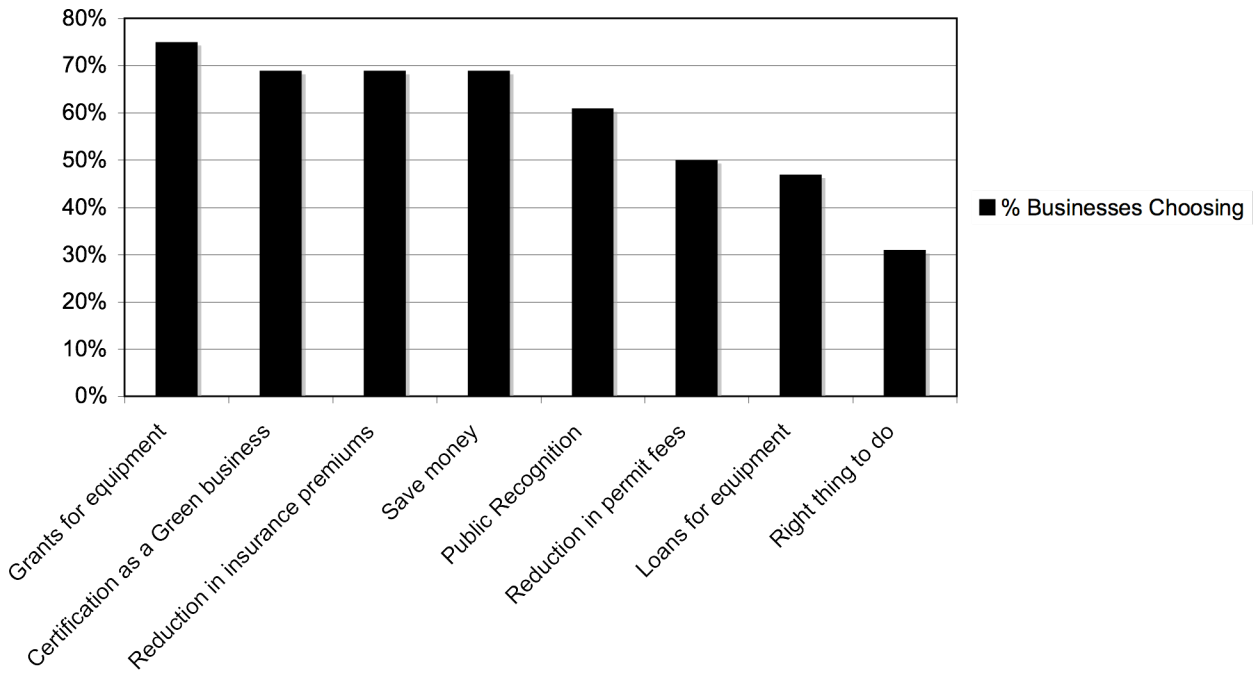
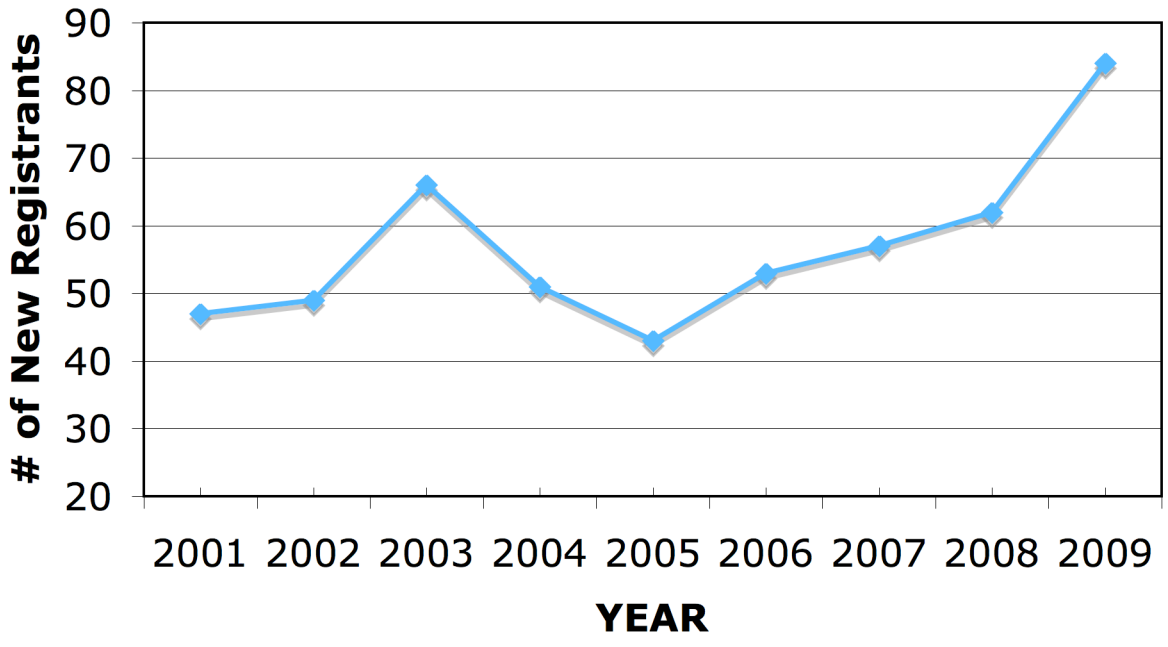


Figure 5: New Registrants by Year for SBWAP



The specific outcomes for the business visits are given in Section II.g. These business visits helped businesses save money and resources and reduced the community's, the owners' and employees' exposure to hazardous chemicals. All significant outcomes, but perhaps the most important outcome of our business visit program is our new partnership with the City of Tucson Office of Conservation and Sustainable Development and their new green business certification program. It has five focus areas: water resources, energy conservation, transportation, waste reduction and recycling, and pollution prevention. Each focus area has a checklist for the businesses to complete; we are developing industry sector specific checklists for the pollution prevention area. The City defined pollution prevention as reducing the use of hazardous chemicals. This program provides two significant benefits to our business visit program: 1) it institutionalizes pollution prevention and resource conservation as part of an ongoing City program; and 2) it provides an incentive for businesses to participate in voluntary pollution prevention and resource conservation activities.

3. Community Mapping

The goal of the community mapping project was to identify high risk areas in our target area based on environmental hazards. We walked or drove every street in our target area and collected 2,373 Universal Transverse Mercator (UTM) coordinates using Global Positioning System (GPS) units. We collected points for items such as business utilizing chemicals, storage tanks, tire piles, wells, substations, schools, daycares, clinics, and community centers. Each point was coded with a three letter description code that described the type of place and with one or more two letter activity codes that described the activities that take place at the point. Examples are shown in Table 10. A cab company received BUS or business-service as its description code and FS or fuel storage as its activity. An alignment and body shop also received BUS, but for activities it received AR – auto repair, AB – auto body and FS. A municipal park using chlorine at the community pool received PAR for park and CH for chlorine and PU for pesticides. A discarded pile of tires received the general hazard code of HAZ and the activity code for a tire pile – TP. A plating shop with a machine shop received a description code of BUM – business manufacturing and activity codes for electroplating – chromium, electroplating – general and machine shop.

Table 10: Examples of Coded Points

Type of Point	Description Code	Activity Codes
Cab Company	BUS	FS
Alignment and body shop	BUS	AR, AB, FS
Municipal park with a pool	PAR	CH, PU
Tire Pile	HAZ	TP
Plating Operation	BUM	EC, EL, MA

A hazard score (HS) was calculated for each point based on the type of activities. The HS was summation of the hazard rankings of each chemical being used at or released from a facility and was used for the analysis to determine the potentially high risks areas. The ranking system rates chemicals based on toxicity, health effects and ecologically effects, and is explained in Appendix C which contains *Section C.*

Development of SERI Rating System of the final report for EPA Assistance ID #: X-96904801-0, "Community Air Toxics Team - A Strategy for Reducing Air Toxics in Pima County". The potential types of emissions were determined from actual emissions or chemical usage data. If we did not have actual data available, we estimated the potential emissions based on the source category.

Using Geographic Information System (GIS) software we completed a kernel density spatial analysis to identify potentially hazardous areas using the HS values. Layers for zoning, schools, wells, hospitals, sewer lines, water lines and vulnerable populations were added to the map for analysis. We created general hazard maps versus census data, and using our codes described above, we created maps based on industry sectors and/or activities. These maps helped us focus our business visit efforts as well as highlight areas of concern. Sample maps are attached in Appendix D. These maps include the potential hazard analysis by: 1) ZIP Code, 2) Population Density, 3) Percent of Population Below Poverty Level, 4) City of Tucson Zoning for ZIP Codes 85705 and 85719, 5) City of Tucson Zoning for ZIP Codes 85714, 6) City of Tucson Zoning for ZIP Codes 85719, 7) City of Tucson Zoning for ZIP Codes 85713 and 85714, 8) Location of Hair Salons, 9) Location of Soldering, Welding and Sheet Metal Facilities, 10) Location of Surface Coating Facilities, and 11) Location of Woodworking Facilities.

As expected our target area for this grant (the low-income, minority portion of Tucson) contains the areas of highest concern with hotspots in portions of 85705, 85713 and 85714. The hotspot in 85713 and 85714 contains a residential zoning and a hospital surrounded by light and heavy industry zoning. The maps show a high concentration of schools and daycares in and near the hotspot in 85705. The remaining maps in Appendix D demonstrate how we can use the data to demonstrate location and/or risk by industry sector. We can also develop similar maps based on chemical usage. The community mapping project provided us with data that we continue to use for our community projects.

4. Air Monitoring Project

We partnered with PDEQ and the UA to conduct air monitoring in the Sunnyside Unified School District (SUSD) for arsenic, cadmium, chromium, cobalt, lead, nickel, and manganese. The results are contained in a draft paper entitled "PM10 and Metal Concentrations in the Sunnyside Unified (SUSD) School District of Tucson, Arizona" to be submitted to the peer-reviewed journal *Journal of the Arizona-Nevada Academy of Science*.

To address community concerns PDEQ established a monitoring network for beryllium and PM_{10} on the rooftops of six schools and buildings in SUSD. Through our partnership resources we were able to analyze the filters for additional metals. In general, the measured PM_{10} and metal concentrations are in compliance with EPA and World Health Organization standards. The most abundant metals found were lead and manganese. Chromium and nickel were detected in about half of the PM_{10} filters. Cadmium, arsenic, and cobalt were not detected in most of the samples and had average concentrations lower than the detection limits. Beryllium was detected once at a concentration of 0.35 ng/m^3, which is close to the detection limit of 0.265 ng/m^3. The beryllium may have been of natural origin, as beryllium is commonly found in the soil and the sample was

collected on a very windy day. The detailed results are discussed in the draft paper which has been given to our project officer for review.

This air monitoring project represented a significant outcome of the project because it represented a partnership between PDEQ, SERI and the UA where resources were pooled to conduct an air monitoring project that may not have been completed otherwise.

g. Our project's most significant outcomes and reductions in environmental risks

1. Reductions and savings from tree program

The Desert Southwest Community Tree Guide[1] gives detailed calculations for energy savings and reduction in pollution. The results for our tree planting program are given below in Table 11:

Table 11: Energy Savings and Reduction in Pollution from Tree Program

Savings or Reductions	Amount per tree	Total for 811 trees	Units
Electricity savings	167	135,437	kWh
Natural gas savings	2	1,622	kBtu
Carbon dioxide	198	160,578	lb
Ozone	0.17	138	lb
NO_2	0.31	251	lb
SO_2	0.2	162	lb
PM10	0.36	292	lb
VOCs	0.03	24	lb
BVOCs - biogenic volatile organic compounds	-1	-811	lb
	Total lbs saved	*160,635*	

2. Reductions from business visit program

Nail salons - Reduction in use of acetone

We distributed 50 free samples of an acetone free nail polish remover and 100 of a solvent free nail polish. The nail polish was not well received, because the users felt that it chipped more easily than standard polish. The remover was well liked and approximately 50% of the users said that they would continue to purchase an acetone free remover. From the our visits to nails salons, we estimated that the average nail salon in Tucson has 4 stations and that each station uses 8 fl. oz of acetone nail polish remover a day. Most salons are currently not using any pollution prevention measures, which means that each shop uses 1.6 lb of acetone a day or 428 lb a year when operating 5 days a week. Thirty shops (25 who received a sample and 5 who did not) said that they would switch to removers without acetone, reducing acetone use by 12,840 lb/year. We are completing follow-up visits to verify these results.

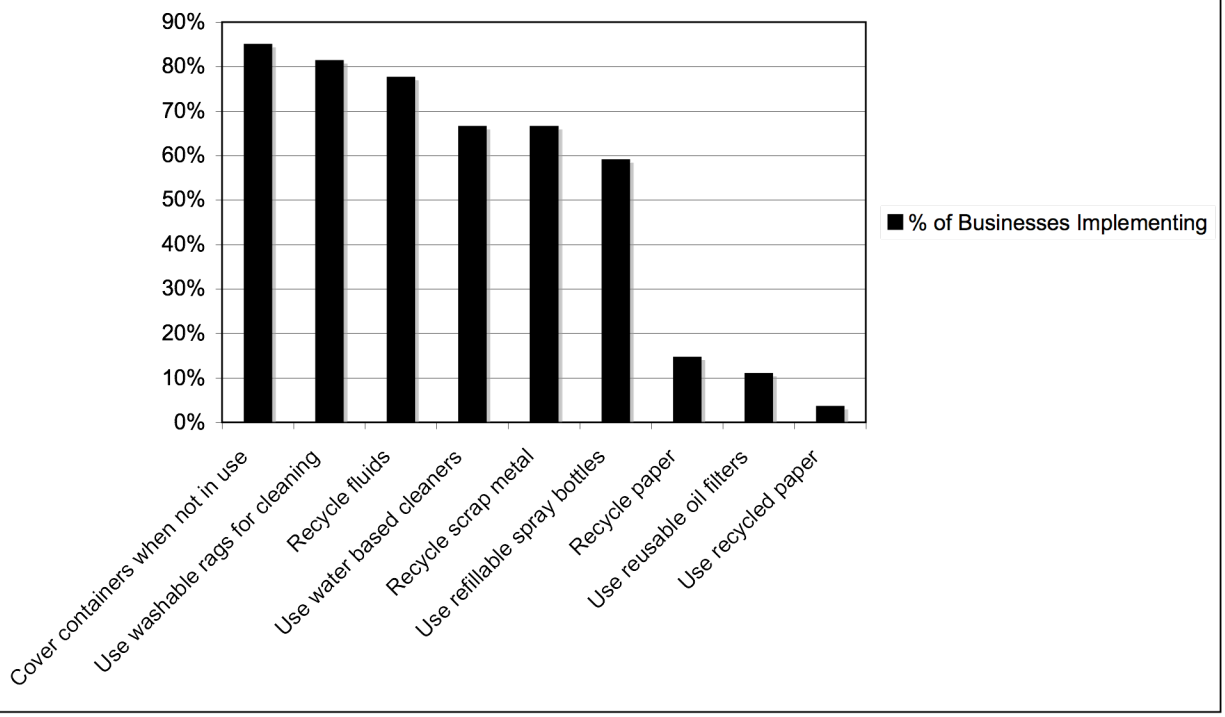
Automotive repair shops

Figure 6 gives the summary of pollution prevention measures that the owners or managers of the auto repair shops stated they would implement or had implemented. Eighty-five percent said that they would keep containers closed when not in use. This is

a difficult outcome to measure especially for small containers and drums. We've asked these businesses to track their chemical usage and purchasing over time go see if there is a measurable difference. The effect of covering solvent degreasers has been measured. Covering a cold solvent degreaser and associated drainage facility reduces emissions between 13 and 38%[2,3] Using a conservative estimate of 13%, emissions are reduced by 99 lb/year. For our 238 (85%) businesses covering their solvent degreasers will reduce emissions of volatile organic compounds by at 23,562 lb/year. We are completing follow-up visits to verify these results, and we continue to distribute samples of water-based degreasers for use in tank washers in hopes that more businesses will switch to them.

Most businesses were already using washable rags and recycling most of their fluids. The other new measure that many businesses (>60%) agreed to implement was to use water-based cleaners. Unfortunately, recycling paper and using recycled paper were not popular choices, and most businesses were not familiar with or interested in reusable oil filters. We only found one business that was using them before our visit.

Figure 6: Pollution Prevention Measures Used by Automotive Repair Shops (N=280)



Water Conservation

We distributed the Facility Manager's Guide to Water Management (Volume 26, February 2008) prepared by the Arizona Municipal Water Users Association Regional Water Conservation Committee with assistance from Black and Veatch. With over 130 pages, this guide helps businesses conduct a water use inventory and develop a water plan. Unfortunately, this guide is not available in Spanish, and we did not have the resources to translate it. Ten businesses stated that they would review the guide and

follow the process. We are completing follow-up visits to see if the guide was useful and what the businesses completed.

h. Did we achieve our objectives?

The progress toward our project objectives is given below in Table 12.

Table 12: Progress Toward Project Objectives

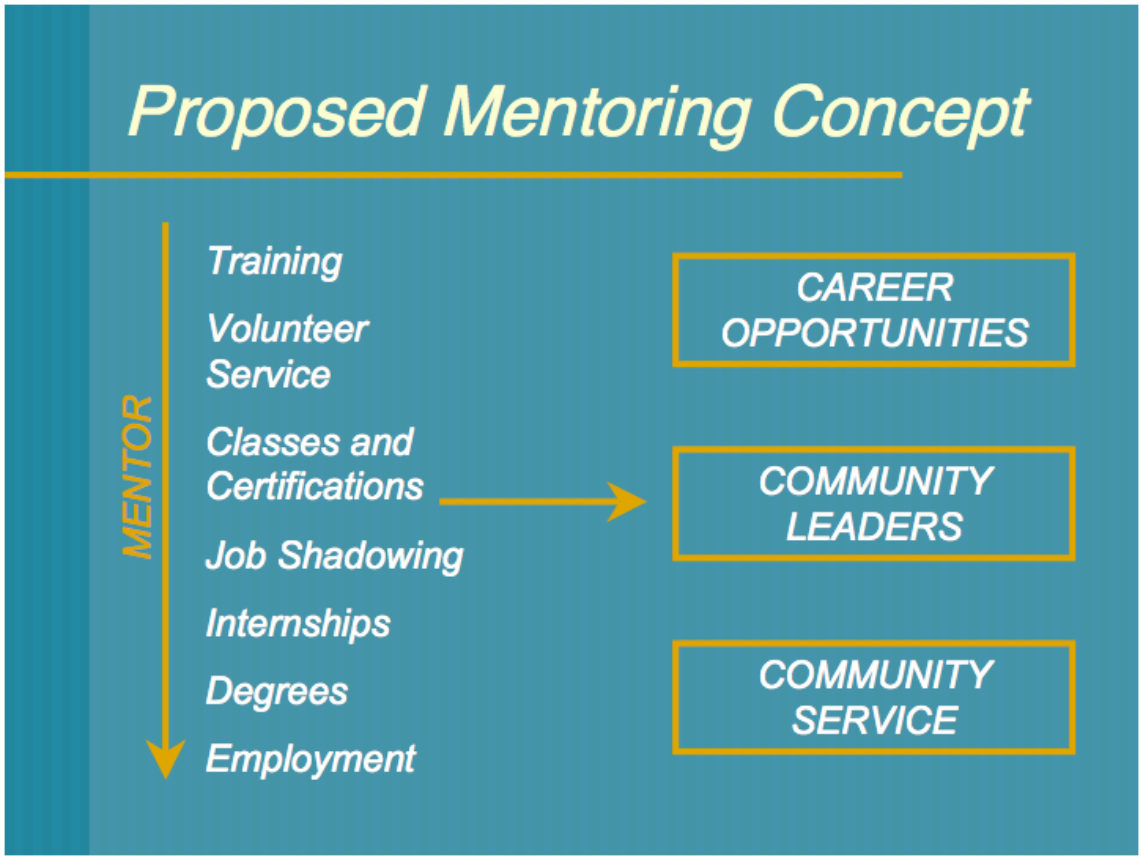
Objective	Result
Implementation of a voluntary pollution prevention program for all industry sectors of concern with a goal of 50% participation where participation is defined as successful referral to business assistance organization, attendance at a pollution prevention workshop, and/or implementation of best environmental management practices.	**OBJECTIVE MET** – 54% of the businesses participated; 238 of the auto repair, 101 autobody, 25 hair salons, 10 other, 10 for water conservation, and 61 businesses signed up for assistance programs. Over 75% want to obtain green business certification.
Participation of 75% of the families found to have lead containing items in their homes in a voluntary childhood lead poisoning prevention strategy.	**OBJECTIVE MET** - 100% of the families agreed to participate in voluntary childhood lead poisoning prevention strategy.
Development of a draft zoning ordinance based on the environmental zoning concepts.	**OBJECTIVE PARTIALLY MET** - Through the community mapping project we are looking at zoning issues in both the county and city. However our discussions with the county indicate that developing a new zoning ordinance is a long-term project that will not be completed quickly.
Participation of 25% of the families receiving home visits in other project activities (not including kick-off event).	**OBJECTIVE MET** - 77% of the families participated in one or more additional project activity.
Retention of promotoras in the program during the grant period with a goal of 95%.	**OBJECTIVE MET** - We retained 100% of the promotoras who remained in Tucson during the project.

III. REFLECTION

a. Our project's greatest achievement

Our project's greatest achievement is the substantial development of the environmental health social infrastructure in the target area and the associated workforce development. Both of these are important steps in developing an environmentally sustainable community that is based on the principles of social justice. The project began the development of an effective and viable network of community groups and individuals that can facilitate community participation and decision-making. The community mapping project in particular assisted in the development of a sense of place and an understanding of the community environment. The workforce development concept followed by the project is best outlined in a slide from a presentation on our mentoring program. The goal is to provide career opportunities, develop community leaders and conduct community service. The mentoring process provides many different opportunities for community members, but the ultimate goal is employment. Overall, the project began an integrated approach to address environmental, health, economic and social needs and reduced the community's potential to suffer harm to their health or the quality of their environment.

Figure 7: Community Workforce Development Concept Developed During Project



b. Our greatest challenges and how did we dealt with them

Our challenges and solutions are given in Table 13.

Table 13: Challenges and Solutions	
Challenge	**SOLUTION**
Businesses did not want to participate in workshops and/or conferences because of a perceived lack of time and value.	We personally visited the business and invited them to events. We scheduled the events at different times throughout the day and we offered refreshments. We tied some events to new requirements the businesses had to complete.
The workshop "Best Practices for the Collision Repair Industry" did not have the same material available in Spanish as in English. Spanish speaking attendees were insulted by the lack of materials available to them.	We prepared a Spanish packet and delivered it to the businesses. We apologized for not having a completed Spanish packet available on the day of the training.
The SUSD Governing Board at first was distrustful of Pima County completing the analyses of the air monitoring filters for metals.	Dr. Eric Betterton and Ann Marie Wolf presented at the Governing Board meetings and met with officials. Ann Marie Wolf met with concerned citizens. PDEQ arranged tours of the monitoring sites and laboratory. The complete process was transparent.
We could not accurately estimate all potential emission reductions.	We could not find in the literature any method to estimate the effect of closing containers on reducing emissions. We do not have solvent usage logs from the facilities, so we could not complete a simple mass balance. We ended up leaving the effect of closing containers out of our calculations.
Data for potential air emissions were not available for most facilities in Pima County.	Since we did not have actual emission data for all facilities, we primarily used three methods to estimate the types of emissions from facilities. We used chemical usage data when available, we studied the processes at the facility and determined the types of chemicals used and/or produced, and we developed generic profiles for specific industry sectors based on a literature search.
Some nail salon owners and staff only spoke Vietnamese.	We distributed the pollution prevention literature available in Vietnamese. We are partnering with a UA student who speaks and writes Vietnamese to translate additional materials and with a Vietnamese church to advertise and hold a workshop.
The community mapping project was very labor intensive. The task took far longer than we anticipated with the maps only being completed about six months before the end of the grant.	Even though the project took a very long time to complete, we were still able to use the data to focus our business visit efforts. Many volunteers and staff said that the community mapping project was their favorite part of the project and that they learned a lot about their community. We had substantial volunteer participation on the project, so even though it took a long time it helped mobilize the community.

Because of economic conditions we lost partners and resources.	In most cases, we or our other partners we able to take on additional tasks or responsibilities. However the closing of the Rose Family Center is a significant loss to the community that has yet to be replaced.
Our extensive outreach efforts in the target area did not increase the participation rate in the HHWP.	The ZIP codes in target area continue to have low participation rates in the HHWP. Until we conduct more research in this area we can only hypothesize that perhaps the community members are not purchasing hazardous materials, they may be using them all up and therefore have none to dispose of, or barriers to participation exists that we have not yet identified. Since they have cars, they are producing waste automotive fluids, which can be disposed of at the facility. We are now revising our strategy as part of our healthy homes project in the target area which may include special community events and/or a pick up program for the elderly.

c. How the project increased local capacity

This was discussed under section III.a. However, an untended consequence of the project was that it decreased SERI's capacity within the community to function as a community advocate on environment justice issues and it decreased SERI's technical expertise on environmental issues. SERI is now viewed more as a social services organization rather than an environmental advocacy organization working on environmental justice issues in southern metropolitan Tucson.

d. How the project produced new community leaders

Many of the women participating in the promotora program had never been involved in community activities primarily because of a lack of knowledge of the system, fear of the unknown and/or lack of English skills. Through the project the women moved from students, to interns, to volunteer promotoras, to staff, and to community leaders. For many participants and their families, this is a life changing experience. The significance of this result should not be underestimated. Without this type of community infrastructure development, community members often do not have the ability to participate in the decision-making process.

e. Reflection Questions

1. How likely is it that the progress achieved could have been made without your CARE partnership? Simply put – without the CARE funding much of the progress would not have been achieved. Our method of working is very labor intense, and we believe in paying as many of our staff as possible. Asking volunteers to complete labor intensive projects can become exploitive, and we believe at times contrary to our goal of community social infrastructure and workforce development. Our projects are sustainable in the fact that the community social infrastructure has been developed and is in place, but we always need some funding for staff and resources. Another benefit was that the CARE project gave us substantial experience and expertise to prepare our partners and us for HUD and other agency funding.

2. What would you do differently next time in terms of organizing and structuring your partnership to achieve your project objectives? I'm not sure that we would have done anything differently in terms of our partnership. We may have brought in additional business partners to assist with the business visit program.
3. How might you have been more strategic in designing or implementing your project? In hindsight we would have made sure that we were emphasizing and retaining SERI's reputation for advocacy and technical expertise. This was a SERI resource allocation problem and an issue we are now addressing. We believe that communities, especially those who have been disproportionately affected by pollution, must have strong community advocates. The CARE process with its emphasis on consensus-based solutions and community partnerships is often very successful, but at times consensus is controlled by the powerful or loudest voice and without a strong advocate in the consensus process the community's views may not be considered. Consensus building techniques are an important strategy but not the only strategy that communities may need when working toward environmental justice.
4. If you chose to create one, did you find using a logic model or other goal-driven model helpful? We did not create one. We have created them for our other projects and have found them useful at times.
5. To what extend did your CARE community communicate or engage with other CARE communities and how was that interaction helpful? We were contacted by other CARE communities that were starting their Phase II projects for advice. One CARE community visited us to observe our business assistance program.
6. Did media coverage play a role in your project? Media coverage was not very important to our project, and we did not seek out any except the *Tucson Matters* cable television program.
7. In what ways did you rely on EPA for assistance (assessing risks in your community, conflict resolution, partnership support, voluntary programs, such as Tools for Schools or Pollution Prevention)? As explained in Section I.g., we had substantial assistance from our project manager. We also relied heavily on the outreach material available from EPA.

IV. WHAT'S NEXT

1. We have been and are continuing to work on these issues with an emphasis on healthy homes and a healthy environment rather than single issue based.
2. The members of the partnership continue to meet and submit grants for additional funding and have received additional supplies and funding for fire safety.
3. We plan to increase the technical knowledge of our staff and volunteers to increase their opportunities at SERI and in the workforce.
4. We plan to strengthen SERI's reputation for technical expertise on environmental issues and as a community advocate for communities in southern Arizona.
5. We would like to formalize the promotora mentoring project in partnership with Pima Community College, the UA or SEAHEC.
6. And probably most importantly – we will develop alternative sources of funding rather than government grants - in particular, commercialize the two patents that SERI has to obtain a steady funding source.

V. FINAL BUDGET REPORT

Table 14: Final CARE Project Expenditures

Category	Actual	Revised EPA Budget	SOURCE OF FUNDS	
			Grant	Donation
PERSONNEL	$178,343.85	$181,708.11	$178,343.85	$0.00
PROMOTORA COSTS	$13,170.00	$13,170.00	$13,170.00	$0.00
BENEFITS	$32,838.38	$29,788.40	$31,826.87	$1,011.51
SUPPLIES	$21,319.30	$20,770.72	$21,319.30	$0.00
OTHER	$15,400.58	$13,727.94	$15,100.73	$299.85
CONTRACTUAL	$10,451.53	$11,026.65	$10,451.53	$0.00
TRAVEL	$9,531.54	$9,526.86	$9,531.54	$0.00
FOOD	$1,203.78	$0.00	$0.00	$1,203.78
TOTAL Direct	$282,258.96	$279,718.68	$279,743.82	$2,515.14
INDIRECT	$24,739.12	$17,973.32	$17,948.18	$6,790.94
TOTAL	$306,998.08	$297,692.00	$297,692.00	$9,306.08

All categories are within ±10% of the approved revised EPA funded budget. No food costs were paid with EPA funds. The indirect cost rate for the EPA funds of 8% was significantly lower than SERI's approved indirect cost rate, which was 12.43% in 2006, 9.66% in 2007 and 12.19% in 2008 and 2009. This resulted in SERI having over $6,700 of indirect costs not covered by the grant funds.

VI. REFERENCES

1. Desert Southwest Community Tree Guide: "Benefits, Costs and Strategic Planning", McPherson, Simpson, Peper, Maco, Xiao and Mulrean, July 2004.
2. Section 3.3 Degreasing-Commercial (Updated February 1990: reissued October 1997) http://arb.ca.gov/ei/areasrc/fullpdf/full3_3erev.pdf.
3. AP-42 Volume I, Chapter 4.6: Solvent Degreasing (Reformatted 1/95).

APPENDIX A

Table A1: List of Outreach Materials Produced or Modified During the CARE Project

Number	Revision Date	Title
CASA-001E	2-Sep-08	Air Quality and Your Child
CASA-001	8-Sep-08	¿Qué hay en el aire que respiramos?
CASA-002	27-Aug-08	Los Productos Químicos y Sus Alternativas Seguras
CASA-002E	29-Aug-08	Chemical Products and their safer alternatives
CASA-003	28-Aug-08	La Calidad del Aire Interior en las Escuales
CASA-003E	28-Aug-08	Indoor Air Quality - Is it a problem at your child's school?
CASA-004	2-Sep-08	Polvo en su hogar y la salud
CASA-004E	2-Sep-08	Dust in your home and your health
CASA-005E	12-Feb-09	Can the Chemicals in Our Homes Harm Us?
CASA-005	12-Feb-09	¿Pueden dañarnos los químicos que usamos en nuestro hogar?
CASA-006E	2-Sep-08	Cleaning the Air of Asthma Triggers
CASA-006	2-Sep-08	Pasos para hacer su casa acogedora para asmáticos
CASA-007	28-Aug-08	Alternativas para pesticidas
CASA-007E	28-Aug-08	Some Natural Pesticide Alternatives
CASA-008E	11-Apr-07	ATSDR-Beryllium
CASA-008	11-Apr-07	ATSDR-Beriio
CASA-009	29-Aug-08	EL Envenenamiento con Plomo y su niño
CASA-009E	28-Aug-08	Lead Poisoning and Your Child
CASA-010E	2-Sep-08	What are air toxics?
CASA-010	2-Sep-08	¿Cuales son tóxicos en el aire?
CASA-011	29-Aug-08	Fiebre del Valle
CASA-011E	29-Aug-08	Valley Fever
CASA-012	29-Aug-08	Virus del Oeste del Nilo-Preguntas y Respuestas
CASA-012E	29-Aug-08	West Nile Virus
CASA-013	28-Aug-08	Cómo puede controlar el crecimiento de moho en su hogar
CASA-013E	28-Aug-08	How to Reduce Asthma Triggers in Your Home
CASA-014	3-Sep-08	¿Qué es un pesticioda?
CASA-014E	3-Sep-08	What is a pesticide?
CASA-015	27-Aug-08	Resultados de Plomo – only in Spanish
CASA-016	1-Apr-07	Lead follow-up request
CASA-016E	1-Apr-07	Forma de solicitud para seguimiento del plomo
CASA-017	2-Sep-08	Formulario - programs "Arboles para Tucsón"
CASA-017E	2-Sep-08	Trees for Tucson Application
CASA-018	27-Aug-08	Arboles para Tucsón
CASA-018E	17-Aug-08	Trees for Tucson
CASA-019	29-Aug-08	Alimentos Que Ayudan a Proteger a Su Niño Del Envenenamiento Con Plomo
CASA-019E	29-Aug-08	Foods Can Help Protect Your Child From Lead Poisoning
CASA-020	29-Aug-08	Sencillas medidas para proteger a sus niños del plomo
CASA-020E	29-Aug-08	Simple steps to protect your child from lead
CASA-021	2-Feb-09	Visitas a Casa Checklist
CASA-021E	2-Feb-09	Home Visits Checklist
CASA-022E	26-Aug-08	CONSENT FORM FOR PARTICIPATION IN THE COMMUNITY ASSIST OF SOUTHERN ARIZONA PROGRAM

CASA-022	26-Aug-08	CONSENTIMIENTO PARA PARTICIPAR EN EL PROGRAMA DE ASISTENCIA COMUNITARIA DEL SUR DE ARIZONA
CASA-023	24-Oct-08	Referencia al Centro de Salud Saint Elizabeth para el Cuidado de Asma
CASA-023E	3-Sep-08	Referral to St. Elizabeth's Health Center for Asthma Care
CASA-024	6-Oct-08	Referencia al Centro de Salud Saint Elizabeth para Prueba de Sangre para el Plomo
CASA-024E	6-Oct-08	Referral to St. Elizabeth's for blood lead testing
CASA-025	17-Sep-08	Recomendaciones
CASA-025E	12-Oct-08	Recommendations for lead containing items
CASA-026	12-Oct-08	Seguimiento del Programa de la Ciudad de Tucson
CASA-026E	13-Oct-08	Follow-up for Lead Hazard Control Program
CASA-027	12-Oct-08	Cómo puede controlar el crecimiento de moho en su hogar
CASA-027E		Not in English
CASA-028	11-Feb-09	PROGRAMA (CASA) DE ASISTENCIAS COMUNITARIA PARA EL SUR DE ARIZONA
CASA-028E	22-Oct-08	COMMUNITY ASSIST OF SOUTHERN ARIZONA (CASA) PROGRAM
CASA-029	30-Oct-08	Referencia al programa de la Ciudad de Tucson para prueba del plomo en pintura de casas
CASA-029E	27-Oct-08	Referral to the City of Tucson Lead Hazard Control Program
CASA-030	30-May-08	Ciudad de Tucson Programa de Control de Peligro de Plomo
CASA-030E	30-May-08	City of Tucson Lead Hazard Control Program
CASA-031E	27-April-09	To Report Septic Odors
CASA-031	27-April-09	Reporte los malos olores
CASA-032	01-May-09	Forma de sequimiento del programa de asma – only in Spanish
CASA-035	01-May-09	Asma checklist – only in Spanish
CASA-036B	01-Sep-09	Door Knob Hanger

APPENDIX B

Table B1: Community Presentations				
#	DATE	LOCATION	TOPIC	ATTENDEES
1	2/07-4/07	House Meetings in the Target Area	CASA Program	9 meetings with 20 attendees each - 180
2	3/31/07	César Chávez Coalition	CASA Program	100+
3	6/5/07 6/12/07 6/19/07 6/26/07	Rose Family Center	"The Family Institute" Sessions 1 and 2: water quality, air quality, household hazardous waste and lead poisoning. Session 3: environmental health and students painted a mural about the environment and their community. Session 3: organic gardening and the student planted a garden at the center.	93 children from 45 families ages 8-14
4	10/26/07	Santa Rosa Center	Lead, household hazardous chemicals and asthma	16
5	11/8/07	Mission View Elementary School	Lead, household hazardous chemicals and asthma	5
6	11/26/07	Lynn Urquidez Elementary School	Lead, household hazardous chemicals and asthma	11
7	12/10/07	Sierra Middle School	Lead, household hazardous chemicals and asthma	15
8	1/14/08	Head Start	Lead, household hazardous chemicals and asthma	5
9	1/22/08	Head Start – Prince Elementary School	Lead, household hazardous chemicals and asthma	13
10	2/26/08	Rivera Elementary School	Lead, household hazardous chemicals and asthma	14
11	2/28/08	Los Niños Elementary School	Lead, household hazardous chemicals and asthma	13
12	3/8/08	El Rio Neighborhood Center	Lead, household hazardous chemicals and asthma	43
13	3/26/08	Summit View Elementary School	Lead, household hazardous chemicals and asthma	50
14	4/28/08	Southside Head Start	Lead, household hazardous chemicals and asthma	27
15	8/20/08	District Advisory Council Tucson Unified School District	CASA Program	50
16	8/27/08	Mission Park Apartments	Childhood Lead Poisoning	7
17	8/27/08	Pueblo High School	Open house - CASA Program	70
18	8/28/08	Wakefield Elementary School	Open house - CASA Program	40
19	8/28/08	Holaway Elementary School	Open house - CASA Program	50
20	10/16/08	Maxwell Middle School	Childhood Lead Poisoning	4

21	10/23/08	Amphi School District - Family Advocates	CASA Program	17
22	10/28/08	Sunnyside Unified School District Governing Board	Air Monitoring Project	20
23	8/08	Sam Lena Library	"Best Practices for the Collision Repair Industry"	86
24	11/13/08	El Rio Neighborhood Center	Childhood Lead Poisoning	20
25	12/22/08	Pima Community College	CASA Program	22
26	1/27/08	Sunnyside Unified School District Governing Board	Air Quality Monitoring Project	40
27	1/13/09	Tully Elementary School	Childhood Lead Poisoning and Household Hazardous Chemicals	20
28	3/9/09	Holaway Elementary School	Childhood Lead Poisoning, Air Pollution, Household Hazardous Material (HHM) and Safer Alternatives to HHM	24
29	3/13/09	Oury Recreation Center	Childhood Lead Poisoning and Household Hazardous Material	11
30	3/14/09	El Rio Neighborhood Center	CASA Program	60
31	3/20/09	Mission Manor Head Start	Childhood Lead Poisoning and Household Hazardous Material	40
32	4/16/09	House of Neighborly Service	Childhood Lead Poisoning and Household Hazardous Material	33
33	5/9/09	Pima Community College	Home and business visits and SERI vision	13
34	5/14/09	City Council Member Steve Leal's Office	Air Quality Monitoring Project	7
35	5/20/09	City of Tucson/Pima County Household Hazardous Waste Steering Committee	Business visit program	10
36	6/23/09	Sunnyside Unified School District, Governing Board Meeting	Air Quality Monitoring Project	13
37	6/24/09	National Federation of Grandmothers Club of America	Lead and household hazardous chemicals	4
38	7/29/09	Math, Inf. Systems & Science Camp for Middle School Girls	Lead, air quality, household hazardous chemicals and alternatives	39
39	8/4/09	Sunnyside Neighborhood Association Fair	CASA program	4 (a thunderstorm disrupted the event)
40	8/5/09	My Little Angels Day Care	Lead and household hazardous chemicals	100
41	9/3/09	Wakefield Elementary School	Open house – CASA program	20
42	9/9/09	District Advisory Council TUSD	Lead and asthma program	60
43	9/25/09	Oury Recretaion Center	CASA Program	18

44	10/21/09	Menlo Park Elementary School	Lead and household hazardous chemicals and asthma	14
45	10/23/09	Tully Elementary School	CASA Program	7

Table B2: Promotora Training Courses

Date	Training Course	Instructors/Institutions	Attendees
1/23/07 – 1/29/07	Environmental Health Training - 18 C.E.U, air toxics, indoor-outdoor air quality issues, asthma, lead poisoning, hazardous materials and nutrition	SERI, SEAHEC, PDEQ, HHWP, Luz Social Services, Tucson Water and St. Elizabeth's Health Center	26
9/24/07 – 9/28/07	Environmental Health Training - 20 C.E.U, air toxics, indoor-outdoor air quality issues, asthma, lead poisoning, hazardous materials and nutrition	SERI, SEAHEC, PDEQ, HHWP, Luz Social Services, Tucson Water, University of Arizona and St. Elizabeth's Health Center	39
1/12/08	Toxicology Basics	University of Arizona and Instituto Tecnológico de Sonora	21
1/12/08	Educational Activities at Flandrau Planetarium (for children of promotoras that were attending Toxicology Basics)	University of Arizona	18
3/26/07 – 3/30/07	Water Quality and Resources	Tucson Water	21
9/4/07	Community Mapping Project - General	SERI	16
9/29/07	Community Mapping Project - How to Use A GPS	SERI	17
10/1/07	Community Mapping Project - Field Exercise	SERI	15
1/08 – 2/08	Lead Safe Work Practices and Train the Trainer	City of Tucson	10
1/8/08	Business visit training on auto repair, print and paint shops and nail salons.	SERI	10
8/1/08 – 6/5/09	Community Leadership Training	St. Elizabeth's Health Center	8
10/8/08	Air Quality Monitoring	University of Arizona, PDEQ	8
11/21/08	Air Quality Monitoring Laboratory Tour - PDEQ	PDEQ	6
12/10/08	Rio Nuevo Tax Assistance Program	City of Tucson	16
3/19/09	Wastewater Treatment Laboratory	Pima County Wastewater Reclamation Department	8
5/13/09	In-depth Asthma Workshop	University of Arizona	17
8/28/09	Woodworking Business Visit Training	SERI	9
6/24/09	Solid Waste and Recycling	University of Arizona	10
9/10/09	Breast Cancer Awareness	St. Elizabeth's Health Center	10
9/21/09	Lead Toxicity	St. Elizabeth's Health Center	12
10/15/09	Solvents – The Environment and Health	University of Arizona	9

Table B3: Media Events			
#	**Date**	**Media**	**Event**
1	2/4/07	*The Arizona Daily Star* - newspaper	Article about the program
2	3/6/07	*Tucson Citizen - newspaper*	A reporter shadowed the promotoras for a day and wrote a lengthy article
3	3/15/07	*El Imparcial - newspaper*	Picked up and printed the *Tucson Citizen* article
4	3/07	102.7 FM – radio station Television – Noticias 33 (Univision) and KVOA	Picked up and printed or reported on the *Tucson Citizen* article
5	3/07	*The Roadrunner* - the Arizona newsletter for the Automotive Service Association of Arizona	Article about the business visit program
6	3/07	*Gatekeeper Newsletter* - the newsletter for the Arizona Emergency Response Commission	Article about the program
7	6/27/07	Tucson Access Cable TV Public Station	Two promotoras represented the program on the telelvision show “Local Matters” which was shown 10 times over two weeks.
8	7/08	“The Environmental Factor”- monthly newsletter of NIEHS, http://www.niehs.nih.gov/news/newsletter/2008/july/tucson.cfm	Article entitled “Training Community Health Advocates in South Tucson”
9	4/20/09	Radio “La Preciosa”	Two-hour talk show on the CASA Program
10	6/18/09	UANews http://uanews.org/node/26121	Article entitled “UA Provides Expertise in Promotora Training”
11	6/19/09	Noticias 33 (Univision) - television	Lead, household hazardous chemicals and business visits

C. DEVELOPMENT OF SERI RATING SYSTEM

TABLE OF CONTENTS

SUMMARY

We developed a method to rate potential emissions from facilities in Pima County to help determine potential air toxics hot spots or localized areas of concern. We initiated this study because no rating system could be found that covered all substances of concern. The rating system evaluates a substance by whether it: (A) is a carcinogen, (B) causes reproductive/developmental problems, (C) persists in the environment, D) bioaccumulates, and by (E) a general health rating, (F) a general hazard rating and (G) a chronic health rating.

The system compares favorably with other systems that rate chemicals released to the environment; it does not compare well with those based on occupational exposure. The system does not have criteria for effects to flora and fauna, as our purpose was to look at potential effects on human health. Hence, one of the limitations of the system is this lack of a thorough evaluation of ecological effects. Another limitation is the fact that the system does not predict potential exposure as some models do. It does not predict whether an effect will occur, rather it compares substances in terms of their potential to be hazardous.

DEFINITIONS

BCF or bioconcentration factor is the chemical's propensity to bioaccumulate in the environment. The bioconcentration factor (BCF) is a measure of the ability for a water-borne chemical substance to concentrate in fatty tissue of fish and aquatic organisms relative to its surroundings.

BOD is the biological oxygen demand. **BOD half-life** is the number of days required to reduce the biological oxygen demand from a chemical in water by half due to biodegradation by microbes.

EC_{50} is the median effect concentration; the concentration at which 50% of the test population exhibit a specified response during a specified time period.

K_{ow} is the octanol-water partition coefficient.

LC_{50} is the concentration that kills 50% of organisms via inhalation.

LD_{50} is the dose that kills 50% of organisms via ingestion.

A **pyrophoric** substance is one the ignites spontaneously in air.

Reference concentration or **RfC** is defined as an estimate of continuous inhalation exposure to the human population that is unlikely to cause an appreciable risk of deleterious effects over a lifetime.

Reference dose or **RfD** is defined as an estimate of a dally exposure to the human population unlikely to cause appreciable risk of deleterious effects over a lifetime. It represents an assessment of noncancer health hazards resulting from ingestion exposure to chemical or physical agents.

I. REVIEW OF OTHER SYSTEMS

Chemical ranking and scoring systems are typically used as screening tools for a rapid assessment of relative chemical hazards. Most consider the toxic effects of chemicals and some measure of exposure but are not intended to serve the same purpose as a quantitative risk assessment. Davis, et. al. (1994) completed an evaluation of 51 chemical ranking and scoring systems and developed a list of the most commonly used criteria (1).

The most common health criteria listed in order of frequency included:

- *carcinogenicity, mutagenicity, genotoxicity*, most often characterized by the weight, type, or amount of evidence that a chemical would elicit that effect;
- *systemic (non-carcinogenic) or general health effects*, most commonly characterized by chronic or subchronic RfD or RfC values;
- *aquatic toxicity*, most often quantified by acute LC_{50} and EC_{50} data;
- *mammalian toxicity*, most often quantified by acute LD_{50} and LC_{50} data;
- *developmental/reproductive toxicity*, again most often measured by the weight, type, or amount of evidence;
- *physical hazard*, most often characterized by ignitability, boiling point, and reactivity;
- *plant toxicity*, most commonly measured by EC_{50} data;
- *terrestrial non-mammalian toxicity*, most often characterized by acute LD_{50}; and
- *general ecological effects*, with no specific endpoint used by more than one system (1).

The most common exposure criteria in order of frequency included:

- *degradation or transformation potential*: most commonly measured by half-life in the environment and some type of BOD data;
- *mobility and partitioning*, most often characterized by K_{ow} and the BCF;
- *estimated dose, environmental occurrence, concentration, or amount released*, most commonly measured by annual releases to environment and production volume; and
- *exposure frequency or intensity*, relates to potential receptors and usually is measured by population size or number potentially exposed (1).

They evaluated the general strengths and weaknesses of systems by reviewing ease of use or complexity, flexibility, access of data, number of chemicals the existing system has been demonstrated on, applicability to various classes of chemicals, reproducibility or subjectiveness of scoring methods and completeness where completeness includes:

- the purpose and application of the ranking and scoring system;
- the human health criteria and endpoints included;
- the criteria and endpoints included for environmental effects;
- whether measures of exposure are included;
- the data selection approach and handling of missing data;
- the use of aggregation and weighing of different health and environmental impacts;
- methods of accounting for chemical potency and severity of effects; and
- inclusion of other impacts or issues (1).

Some ranking systems are based only on a measure of chemical toxicity and do not take into account differences between chemicals that affect their persistence in the environment or the likelihood that humans or other organisms will be exposed to that substance.

Chemicals of similar toxicity are scored the same, even if one is rapidly degraded in the environment and has little likelihood of human exposure, while another persists and bioconcentrates in the food chain with a high likelihood of human exposure. Six systems are briefly discussed below and evaluated in reference to Davis, et. al. (1994) in Table C-1. Three of the systems were compared to the SERI systems in Section III.

A. Minnesota Toxicity Index (MTI)
The Minnesota Pollution Control Agency developed an indexing system for toxic air pollutants that takes both toxicity and exposure potential into account. It defines the hazard potential as the ratio of potential exposure over toxicity. This system highlights the fact that interpretation of toxic emissions inventory data requires additional information beyond the mass of emissions.

A fugacity model calculates the potential exposure by using environmental fate and transport processes to estimate chemical concentrations in different environmental media. The model requires the following properties for each substance: molecular weight, solubility, vapor pressure, octanol-water partitioning coefficient, food chain multipliers (if available), degradation half-lives in air, water, soil, and sediment and melting point. It estimates the cumulative dose of a chemical that humans receive after a standardized amount of the chemical is released to air.

Human and ecological toxicity indicators represent the toxicity. The system's human health component uses two indicators: RfCs and RfDs. Ecological toxicity indicators include aquatic and wildlife indicators. If there are no human or ecological data available, the threshold limit value (TLV) divided by 100 is used as a toxicity indicator in the Indexing System. (2, 3, 4).

Strengths: The system is thought to be more rigorous than those that arbitrarily assign scores as it processes data in a meaningful way by actually calculating concentrations in environmental compartments, identifying exposure routes and determining potential hazard. The model predicts where in the environment a substance is most likely to cause effects.

Limitations: The approach is limited for metals and many inorganic substances, since these substances do not have known air-water partition coefficients or vapor pressures. TLVs may not be appropriate for evaluating continuous exposure or community air pollution problems.

B. University of Tennessee Total Hazard Score (UTN)
The University of Tennessee Total Hazard Score indicates how a chemical compares with others in terms of its capacity to harm human health, ecosystems and/or environmental health. The scores combine ecological and human health impacts ensuring that chemicals that pose low human health hazards remain priorities if they pose high ecological hazards. The system assigns hazard scores based on the following algorithm where HV equals hazard value:

Total Hazard Value = (Human Health Effects + Environmental Effects) x Exposure Potential where:

Human Health Effects = HVoral LD_{50} + HVinhalationLC_{50} + HVcarcinogenicity + HVother

Environmental effects = HVoral LD_{50} + HVfishLC_{50} + HVfishNOEL

Exposure Factor = HVBOD + HVhydrolysis + HVBCF

Human Health Effects include two measures of acute toxicity to mammals and two measures of chronic toxicity (a carcinogenicity score and a multiple endpoint score based on whether a chemical possesses evidence of mutagenicity, developmental effects, reproductive effects, neurotoxicity and/or other chronic effects.

Environmental Effects include one measure of acute toxicity to mammals and two measures of toxicity to aquatic organisms. NOEL is the no observed effect level in a chronic test.

Exposure Factors include indicators of environmental persistence and bioaccumulation in an aquatic environment. Hydrolysis half-life is the time required to reduce the amount of a chemical in water by half through reaction with water. (5)

Strengths: Ranking systems that take into account toxicity and persistence as the UTN system does provide a better indicator of the potential environmental hazards of a chemical than toxicity alone.

Limitations: Exposure Factors in the UTN system are based on indicators of environmental persistence and bioaccumulation in an aquatic environment.

C. Environmental Defense Fund (EDF) CALTOX Values

The EDF system calculates a risk score, or toxic equivalency potential (TEP), for a chemical by conducting a screening level risk assessment of an environmental release using the CalTOX model. CalTOX utilizes data on a pollutant's physical-chemical properties and the landscape characteristics of the environment receiving a release to model how that chemical will be distributed among seven connected environmental compartments. CalTOX predicts the chemical concentrations in these compartments taking into account transport and transformation processes that affect the pollutant. (6)

TEPs indicate the relative human health risk associated with a release of one pound of a chemical, compared to the risk posed by release of a reference chemical. Information about the toxicity of a chemical (how much of it is required to cause harm) and its exposure potential (how much of it people are exposed to) are used to make this comparison. TEPs are based on a screening-level risk assessment that estimates the cancer and/or noncancer health risks associated with the total dose of a chemical that people will receive if one pound of that chemical is released to air or water in a model environment. In this risk scoring system, all releases of carcinogens are converted to pounds of benzene-equivalents; all releases of chemicals that cause noncancer health effects are converted to pounds of toluene-equivalents.

Strengths: EDF's cancer and noncancer risk scores are generated by a method that considers variations in both a chemical's inherent toxicity and human exposure potential. This offers a advantage over scoring systems that either do not consider exposure at all or rely on surrogate measures of exposure potential. These other methods do not attempt to quantify the dose of a chemical that people receive as a result of releases to air.

Disadvantages: Its application to ecological risk assessment is somewhat limited. The model was not designed for assessing environmental transport during periods of a few weeks to a few days when transport processes are dynamic. Terrestrial fauna are not included.

D. Indiana Relative Chemical Hazard Ranking System (IRCHS)

The Indiana Clean Manufacturing Technology and Safe Materials Institute at Purdue University developed a hazard evaluation system for chemicals that produces separate rankings for ecological effects and occupational health effects, as well as a total hazard score that integrates both types of hazards. The system combines information about a chemical's toxicity to humans and ecosystems with information about chemical characteristics that influence the likelihood of exposure to a substance. The system expands upon the chemical ranking system developed by the University of Tennessee (Subsection B) by including hazardous impacts on air quality, potential soil and groundwater contamination and stratospheric ozone depletion (7). The IRCHS assigns hazard scores between 0 and 200 based on the following formula:

Total Hazard Value = [(1.15 x Worker Exposure Hazard Value) + (Environmental Hazard Value/3.5)]/2

where the Environmental Hazard = Hvwater+ Hvair + Hvland + Hvglobal

*Hvwate*r = UTN total hazard value score
Hvair = sum of hazard values assigned if a chemical is a criteria pollutant, a hazardous air pollutant, a high risk pollutant, or an extremely hazardous substance
Hvland= hazard value assigned according to its hazardous waste classification and characteristics
Hvglobal = hazard value assigned if a chemical is a Class I or Class II ozone depleting substance

The Worker Exposure Hazard Value has three components: health effects, routes of exposure and safety. The health effects component is based on the TLVs, carcinogenicity, and the Short Term Exposure Limit. The routes of exposure component is base on the vapor pressure, if the chemical can be absorbed through the skin or mouth and if the chemical can produce dusts or mists. The safety component is based on the NFPA values for flammability and reactivity and the corrosivity of the chemical.

Strengths: IRCHS considers ecological impacts in water, air, and land versus the UTN system that only consider aquatic ecosystem effects. IRCHS It also considers many components not found in other systems.

Limitations: One important limitation of the IRCHS is that exposure potential is estimated based on the values of certain physical and chemical properties of the chemical, not on

estimates of the actual dose received as in EDF's TEPs. Another important limitation is that the IRCHS health scores are designed for occupational exposures to chemicals, which are generally much higher than environmental exposures experienced by the general public.

E. ICI Environmental Burden (EB) Methodology

ICI, one of the largest multinational chemical manufacturers, has developed a method for evaluating its environmental performance based on the estimated "Environmental Burden" created by company activities. ICI uses its EB methodology to rank the potential environmental impact of its different emissions and to improve its environmental management and reporting.

The EB methodology accounts for acidity, global warming, human health effects, ozone depletion, photochemical ozone creation, aquatic oxygen demand and ecotoxicity to aquatic life. Factors are assigned to each individual emission which reflects the potency of its possible impact. The environmental burden for each category is calculated by multiplying the weight of each substance emitted by its potency factor and summing across all substances capable of adversely affecting that category. The EB method uses benzene as a reference chemical for measuring human health effects. All chemical releases are converted into benzene-equivalents using a potency factor based on the occupational exposure standard for this chemical in the United Kingdom.

Strengths: The method includes criteria not included in many systems: acidity, global warming, ozone depletion and photochemical ozone creation.

Limitations: The method only addresses the potential human health impacts of carcinogens released to air: it does not address noncancer health effects or the human health impacts of chemical releases to water. It does not consider potential exposure or compare the toxicity of other chemicals to benzene using cancer potency factors. Instead it uses less reliable occupational standards.

F. Australian National Pollutant Inventory System (ANPI)

In ANPI each substance is evaluated on a 0-3 scale for human health effects, environmental effects and exposure. The health and environmental effects are summed to give a 0-6 hazard score which is multiplied by the exposure score to give total score of 0-18. The human health effects are evaluated by acute toxicity, chronic toxicity, carcinogenicity and reproductive toxicity. Environmental effects are evaluated acute toxicity, chronic toxicity, persistence and bioaccumulation. Exposure is evaluated by the potential release in Australia, bioavailability, environmental fate and volume of production. Criteria are based on European Community Risk Phrases and include aquatic, mammalian, plant, avian and flora and fauna toxicity. (9)

Strengths: ANPI is one of the few systems that looks at plant and avian toxicity. It includes persistence and bioaccumulation in its chronic toxicity component. It is an easy to use, straightforward system that doesn't require complex modeling.

Limitations: The exposure component is based on amount of substances handled not amounts released.

II. SERI RATING SYSTEM

The hazard score was determined by whether or not a substance (A) is a carcinogen, (B) causes reproductive/developmental problems, (C) persists in the environment, D) bioaccumulates, and by (E) a general health rating, (F) a general hazard rating and (G) a chronic health rating.

Table C-1: Comparison of Rating Systems Using Davis et al. (1994) Criteria.

CRITERIA	MTI	UTN	EDF	IRCHS	EB	ANPI	SERI
HEALTH							
carcinogenicity, mutagenicity, genotoxicity	X	X	X	X	X	X	X
systemic (non-carcinogenic) or general health effects	X	X	X	X		X	X
aquatic toxicity	X	X		X	X	X	X
mammalian toxicity	X	X		X		X	X
developmental/reproductive toxicity	X	X		X		X	X
physical hazard	X		X	X		X	X
plant toxicity						X	
terrestrial non-mammalian toxicity						X	
general ecological effects				X	X	X	
EXPOSURE							
degradation or transformation potential	X	X	X	X		X	X
mobility and partitioning	X	X	X	X		X	X
estimated dose, environmental occurrence, concentration, or amount released	X		X		X	X	
exposure frequency or intensity			X		X		

Data for the carcinogen column were primarily sourced from the Agency for Toxic Substances and Disease Registry's (ATSDR) ToxFAQs, EPA's IRIS database and California Air Resources Board's (CARB) Chemical Summaries. Each substance was rated as follows: an "8" indicates that the substance is a known carcinogen; a "6" indicates the substance is a probable carcinogen; a "4" indicates the substance is a possible carcinogen; a "2" means no classification available and "0" indicates that the substance has not been classified as a carcinogen

Data for the reproductive/developmental problem column were sourced from the CARB and the ATSDR, and were rated as follows: a "6" means that the substance is known to cause reproductive and/or developmental problems in humans and animals; a "4" means that it is known to cause problems in animals; a "2" means that no information is available and a "0" means that it is not known to cause reproductive/developmental problems.

Data for the persistence column were sourced from the PBT Profiler (http://www.pbtprofiler.net), the CARB, and the ATSDR. Each substance's persistence was graded in four media (water, soil, sediment and air). The ratings were determined as

follows: a “6” indicates that the substance is very persistent in air, water, soil and/or sediment, which means that it’s half-life is greater than 180 days in water, soil and/or sediment and greater than 30 days in air. A “4” indicates that the substances is persistent in air, water, soil and/or sediment, which means that it’s half-life is greater than or equal to 60 days in soil, water and sediment and greater than 2 days in air. A “2” indicates that no information is available, and a “0” indicates that the substance is not persistent in air, soil, water, and/or sediment, which means that its half-life is less than 60 days in soil, water and sediment and less than or equal to 2 days in air.

Data for the bioaccumulation column were sourced from the PBT Profiler and the ATSDR and were rated as follows: a “8” indicates that the substance is very bioaccumulative which means that its bioconcentration factor (BCF) is greater than or equal to 5,000. A “6” indicates that the substance is bioaccumulative which means that its BCF is greater than or equal to 1,000 but less than 5,000. A “4” indicates that its BCF is greater than or equal to 500 but less than 1,000. A “2” indicates that no information is available. A “0” indicates that the substance is not bioaccumulative, which means that its BCF is less than 500. *[Note: the PBT Profiler uses the bioconcentration in fish because “chemicals that have the potential to bioconcentrate also have the potential to bioaccumulate.”]*

The general health ranking is based on Oral LD_{50} Rat or Inhalation LC_{50} Rat values. The divisions are based on a combination of the WHO Toxicity Classifications and the EPA Toxicity Categories (10,11). The WHO Classifications and EPA Categories both stop at >2,000 mg/kg. We added two additional categories to further differentiate the chemicals. The general hazard rating is based on physical characteristics of the chemical: flammability, reactivity and corrosivity. A liquid is combustible if it has a flash point at or above 37.8°C, flammable if it has a flash point between 21°C and 37.8°C and highly flammable if it has a flash point at or below 21°C. The physical characteristics were primarily sourced from Material Safety Data Sheets published by The Physical and Theoretical Chemistry Laboratory Oxford University at http://physchem.ox.ac.uk/msds/.

The systemic (non-carcinogenic) or chronic health effects rating is based on the RfD, RfC or ATSDR Minimum Risk Levels (MRL). Data were primarily sourced from the ATSDR ToxFAQs, EPA’s IRIS database, EPA’s Health Effects Assessment Summary Tables (HEAST) and CARB’s Chemical Summaries. We arbitrarily assigned a value of 2 for those substances without data. Table C-2 outlines the rating system. The Substance Scoring Table is found in Appendix I.

Examples: *Hexachlorobenzene*, #94 in Appendix I, is a probable carcinogen and therefore receives a score of 6. It is known to cause reproductive or developmental problems in animals and humans giving it a score of 6. Its half-life in water, soil, sediment and air is 180, 360, 1,600 and 58 days respectively, giving a score of 6 for all media. Its BCF is 5,200 giving a score of 8. The Oral LD_{50} Rat is 3,500 mg/kg which gives a Health rating of 3, but the Inhalation LC_{50} Rat is 3.6 ppm which gives a Health rating of 4. We choose the more conservative value of 4. Hexachlorobenzene is a combustible solid giving it a Hazard rating of 2. The RfD for hexachlorobenzene is 0.0008 mg/kg-day giving it a Chronic Health rating of 6. Its Hazard Score is 56.

Table C-2: SERI Hazard Rating System for Substance

(A) Carcinogen
- 0 Evidence of Non-carcinogenicity
- 2 Not classifiable
- 4 Possible
- 6 Probable
- 8 Known

(B) Reproductive/Development
- 0 Not known to cause reproductive/developmental problems
- 2 No information available
- 4 Known to cause problems in animals
- 6 Known to cause problems in animals and humans

(C) Persistence (water (W), soil (SO), sediment (SE), and air (A))
- 0 Not persistent
- 2 No information available
- 4 Half-life greater than or equal to 60 days in soil, water or sediment and greater than 2 days in air
- 6 Half-life greater than or equal to 180 days in soil, water or sediment and greater than 30 days in air

(D) Bioaccumulation
- 0 Not bioaccumulative - BCF less than 500
- 2 No information available
- 4 BCF greater than or equal to 500 but less than 1,000
- 6 BCF greater than or equal to 1,000 but less than 5,000
- 8 BCF greater than or equal to 5,000

(E) General Health Rating (Oral LD_{50} Rat or Inhalation LC_{50} Rat)
- 0 No health hazard or LD_{50} >100,000 mg/kg or $LC50_{50}$ > 20,000 ppm
- 1 LD_{50} 5,001 to 100,000 mg/kg or $LC50_{50}$ 1,001 - 20,000 ppm
- 2 LD_{50} from 2,001 to 5,000 mg/kg or $LC50_{50}$ from 201 to 1,000 ppm or no information available
- 3 LD_{50} from 501 to 2,000 mg/kg or $LC50_{50}$ from 21 to 200 ppm
- 4 LD_{50} from 51 to 500 mg/kg or $LC50_{50}$ from 2 to 20 ppm
- 5 LD_{50} from 5 to 50 mg/kg or $LC50_{50}$ from 2 to 20 ppm
- 6 LD_{50} < 5 mg/kg or $LC50_{50}$ < 0.2 ppm

(F) General Hazard Rating
- 0 No general hazard
- 2 Combustible
- 4 Flammable, reactive or corrosive
- 6 Highly flammable or pyrophoric
- 8 Explosive

(G) Chronic Health Ranking (RfD, RfC or MRL)
- 0 No chronic health effects
- 1 > 5 mg/kg-day or 5 ppm
- 2 > 1 and ≤ 5 mg/kg-day or > 1 and ≤ 5 ppm or no information available
- 3 > 0.1 and ≤ 1 mg/kg-day or > 0.1 and ≤ 1 ppm
- 4 > 0.01 and ≤ 0.1 mg/kg-day or > 0.01 and ≤ 0.1 ppm
- 5 > 0.001 and ≤ 0.01 mg/kg-day or > 0.001 and ≤ 0.01 ppm
- 6 > 0.0001 and ≤ 0.001 mg/kg-day or > 0.0001 and ≤ 0.001 ppm
- 7 > 0.00001 and ≤ 0.0001 mg/kg-day or > 0.00001 and ≤ 0.0001 ppm
- 8 ≤ 0.000001 mg/kg-day or ≤ 0.000001 ppm

Toluene, #81 in Appendix I, is not classifiable as a carcinogen and therefore receives a score of 2. It is known to cause reproductive or developmental problems in animals and humans giving it a score of 6. Its half-life in water, soil, sediment and air is 15, 30, 140 and 2.7 days respectively, giving scores of 0, 0, 4 and 4 respectively. Its BCF is 25 also giving a score of 0. The LD_{50} Oral Rat is 636 mg/kg giving a Health rating of 3. With a flash point of 4°C, toluene is highly flammable which results in a Hazard rating of 6. The RfC for toluene is 5 ppm giving it a Chronic Health rating of 2. Its Hazard Score is 27.

The calculation of the scores for hexachlorobenzene and toluene is shown in Table C-3. These two chemicals are well separated by the rating system. The system places the 204 substances into 46 categories. Duplication does still occur, but primarily of the lower ranked substances. Two other substances have the same score as hexachlorobenzene, but thirteen have the same as toluene. The complete table is given in Appendix I

Table C-3: Ratings for Hexachlorobenzene and Toluene

Air Toxic	Carcinogen (NC-Not Classified, N-No, Y-Yes)	Rat.	Repro/ Develop (I-Inconclusive, A-Animal, H-Human, N-No)	Rat.	Persistence				Bio.	Haz. Rat.	Hlth. Rat.	Chronic Hlth. Rating	Score
					W	SO	SE	A					
Hexachlorobenzene	Probable	6	A, H	6	6	6	6	6	8	2	4	6	56
Toluene	NC	2	A, H	6	0	0	4	4	0	6	3	2	27

III. COMPARISON OF SERI SYSTEM TO OTHER RATING SYSTEMS

Table C-4 and C-5 compare the SERI system to three systems reviewed in Section I. In Table C-4, the highest rated ten substances in each system are given. Not all systems rate all substances. PCBs and hexachlorobenzene are not rated in ANPI. Arsine is rated as an arsenic compound in MTI. To better compare ANPI with the SERI system we divided out the exposure rating, since it is primarily based on usage in Australia. The column labeled "ANPI H+E" contains only the combined health and environmental criteria. As expected from Table 3, the SERI system compares favorably with the MTI system. Our new system utilizes all of the same criteria as MTI except for "estimated dose, environmental occurrence, concentration, or amount released." Of interest is the fact that we use a simple additive process rather than a fugacity model but have a comparable rating of substances. Of course our system does not estimate concentrations or potential exposure as the model does and has a more limited use. Our system does not compare well with the IRCHS system, probably because IRCHS is based on occupational exposure. The differences between the ANPI system and ours probably reflects the lack of terrestrial and plant toxicity and general ecological effects. Carbon tetrachloride is ranked number 26 and antimony and compounds number 30 in our system.

Table C-5 is similar to Table C-4 except that is shows the lowest ranked eleven substances. (Our system produced a tie between numbers 10 and 11.) We left out the ANPI system since ANPI H+E is more pertinent. These are not the lowest ranked substances in our system: they are the lowest ranked that have also been ranked by at least one of the other systems. Again our system compares the best with the MTI system, albeit not as well as in Table C-4. (Molybdenum trioxide was not ranked in MTI.)

These tables along with Table C-1 give us confidence that the SERI hazard rating system adequately rates the substances for our purposes. Its primary limitation is that it does not predict potential exposure as some models do. It does not predict whether an effect will occur, rather it compares substances in terms of their potential to be hazardous. We do not know the amount of potential emissions of each substance. We know if a facility has used the substance in the past, has the potential to emit the substance based on the type of facility and/or if the facility has an air permit regulating emissions of the substance. By rating the hazardous potential of these substances we are able to identify the potential hot spots for further study.

Table C-4: Comparison of Top Ten Ranked Chemicals in Four Systems

SERI Hazard Score	MTI	IRCHS	ANPI	ANPI H+E
Polychlorinated biphenyls (PCBs)	Dioxin and like Compounds	Hydrazine	Hexavalent Chromium	Hexavalent Chromium
Arsine	Mercury and Compounds	Acrolein	Dichloromethane	1,1,2,2-Tetrachloroethane
Dioxin and like Compounds	Polychlorinated biphenyls (PCBs)	Ethylene Oxide	Cadmium and compounds	Arsenic and Compounds
Hexachlorobenzene	Polycyclic Organic Matter	Hydrogen Fluoride	Sulfuric Acid	Arsine
Hexavalent Chromium	Cadmium and compounds	Vinyl Chloride	Xylenes (Mixed Isomers)	Cadmium and compounds
Mercury and Compounds	Hexavalent Chromium	Benzene	Arsenic and Compounds	1,3-Dichloropropene
Cadmium and Compounds	Hexachlorobenzene	Epichlorohydrin (EP Resin)	Lead and Compounds	Beryllium and Compounds
Lead and Compounds	Antimony and Compounds	1,3-Butadiene	Trichloroethylene	Inorganic Cyanide Compounds
Selenium and compounds	Carbon Tetrachloride	Formaldehyde	Benzene	Methyl Bromide (Bromomethane)
Polycyclic Organic Matter	Selenium and Compounds	Carbon Tetrachloride	1,3-Butadiene	Ethylene Dibromide (Dibromoethane)

Table C-5: Comparison of Lowest Ranked Eleven Substances in Fours Systems.

SERI	MTI	ANPI H+E	IRCH
Ethylbenzene	Toluene	Antimony and Compounds	Acetone
Ethanol	Naphthalene	Hydrochloric Acid	Ethylbenzene
Acetone	Phenol	Chromium (III) and Compounds	Diethylene Glycol
Methyl Methacrylate	Ethanol	Nickel and Compounds	Diesel Fuels
Molybdenum Trioxide	Isophorone	Methyl Ethyl Ketone (2-Butanone)	Antimony and Compounds
2-Methoxyethanol (methyl cellosolve)	Maleic Anhydride	Hydrochloric Acid	Ethanol
Methyl tert-Butyl Ether	Methanol	Ethylene Glycol	Bromochlorodifluoromethane (Halon 1211)
Ethylene Glycol	Ethylene Glycol	Acetone	Cupric Chloride
Phenol	Acetone	Ethylbenzene	n-Methyl-2-Pyrrolidone
Methyl Isobutyl Ketone	Sulfuric Acid	2-Methoxyethanol (methyl cellosolve)	Molybdenum Trioxide
Glycol Ethers	Methyl Methacrylate	1,1,1-Trichloroethane	1,2,4-Trimethylbenzene (pseudocumene)

REFERENCES

1. Davis, G.A., Swanson, M. and S. Jones. (1994). *Comparative Evaluation of Chemical Ranking and Scoring Methodologies.* EPA Order No. 3N-3545-NAEX (April 7, 1994).

2. Pratt, G.C., P.E. Gerbec, S.K. Livingston, R. Oliaei, G.L. Bollweg, S. Paterson and D. Mackay. (1993). **An indexing system for comparing toxic air pollutants based upon their potential environmental impacts.** *Chemosphere* 27(8): 1359-1379.

3. Minneapolis Environmental Management. (1997). *Minneapolis Air Toxics Brief and Emissions Fee Proposal for Point Source Air Emissions (Draft 5/12/97)***.** Minneapolis Air Quality Management Authority, MN.

4. Pratt, G.C. and C.Y. Wu. (2001). **Analysis of Air Toxics Emission Inventory: Inhalation Toxicity-Based Ranking.** *Journal of the Air and Waste Management Association*. 51:1129-1141.

5. Davis, G.A., L.E. Kincaid, M.B. Swanson, T. Schultz, J. Bartmess, B. Griffith and S. Jones. (1994). *Chemical Hazard Evaluation for Management Systems: A Method for Ranking and Scoring Chemicals By Potential Human Health and Environmental Impacts.* U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, Ohio.

6. *Pollution Locator: Using a Screening Level Risk Assessment to Assign Risk Scores.* www.scorecard.org/env-releases/def/tep_caltox.html.

7. *IRCH: Indiana Relative Chemical Hazard Score. Indiana Clean Manufacturing Technology and Safe Materials Institute. Purdue University.* http://www.ecn.purdue.edu/CMTI/IRCHS/.

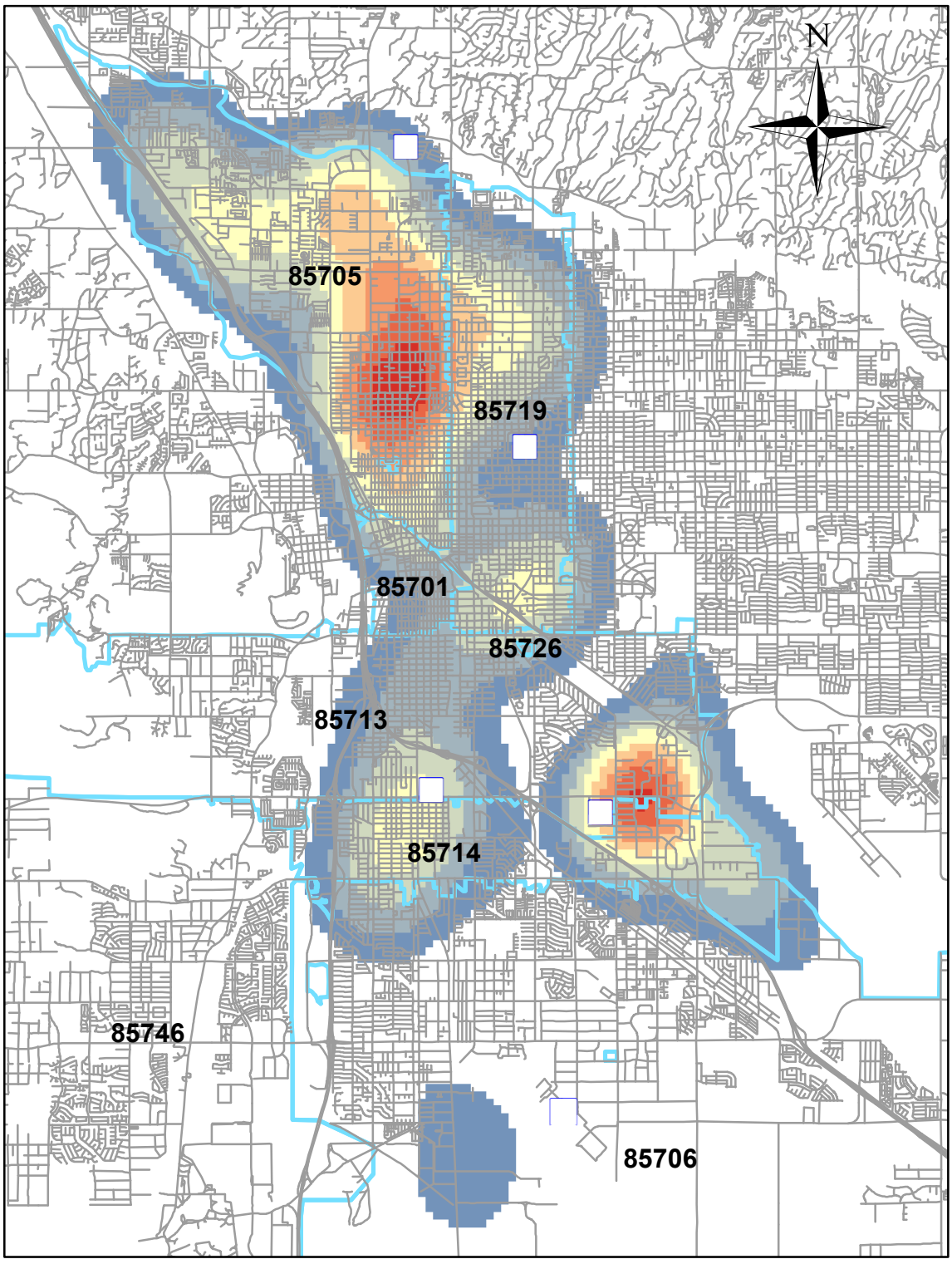
8. Michael Wright, David Allen, Roland Clift and Hein Sas. (1997). *Measuring the Corporate Environmental Performance: The ICI Environmental Burden System.* **Journal of Industrial Ecology** 1:4 (Fall 1997).

9. National Pollutant Inventory, Technical Advisory Panel. (1999) *Final Report to the National Environmental Protection Council*. (January 1999).

10. WHO International Program on Chemicals Safety. (2004). *The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification* 2004. Updated 12 April 2005 and 28 June 2006.

11. Federal Regulations on Acute Toxicity. U.S. EPA Classification and Labeling Regulations. 40 **CFR** Ch.I 156.10: General Provisions - Labeling Requirements.

Tucson Metropolitan Area : Potential Hazardous Analysis By Zip Code



Legend

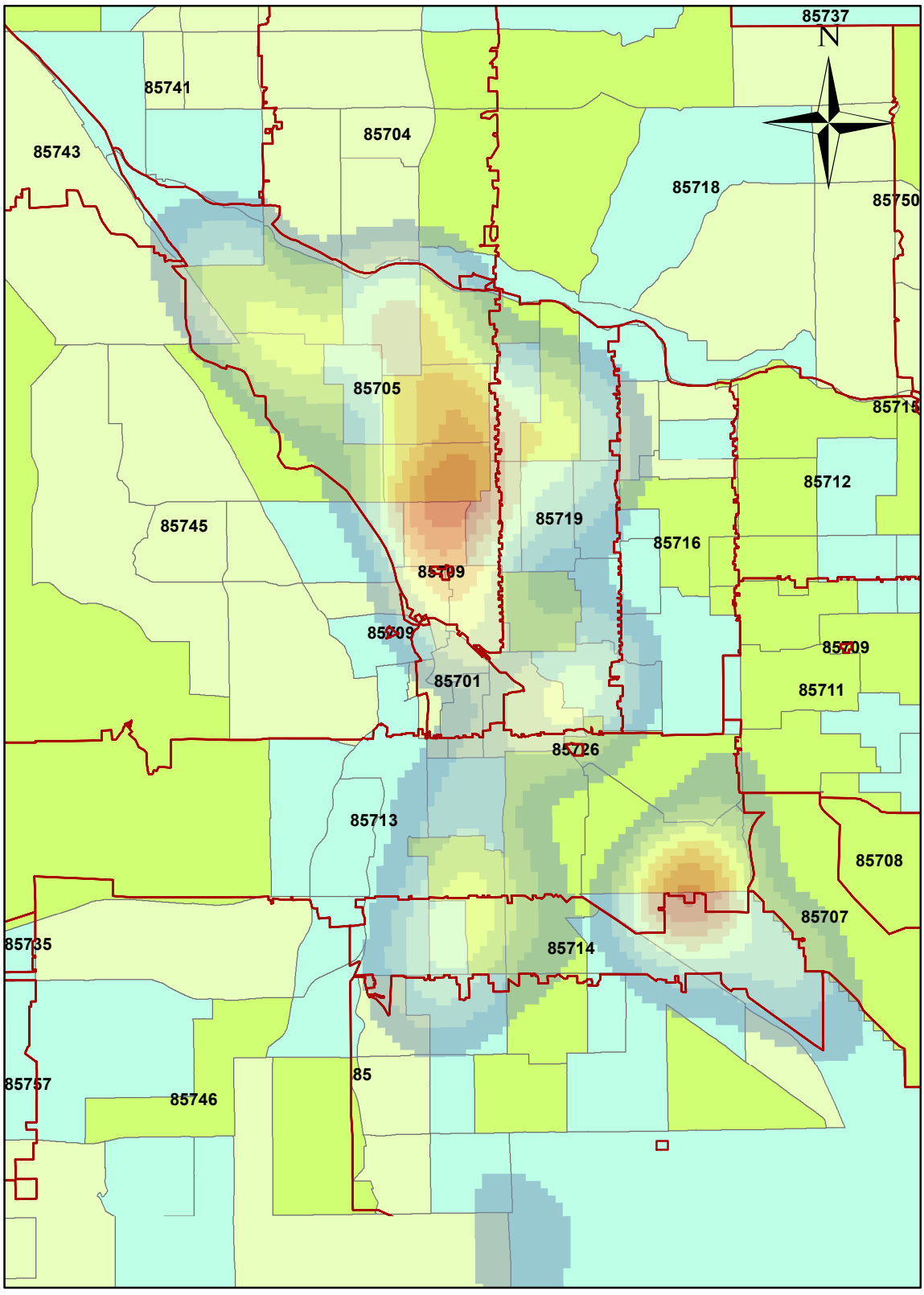
Hospital
Airport
Streets
zip

Potential Hazard Score

0 - 336
337 - 685
686 - 1,022
1,023 - 1,359
1,360- 1,707
1,708 - 2,044
2,045 - 2,381
2,382- 2,730
2,731- 3,066

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Tucson Metropolitan Area: General Population



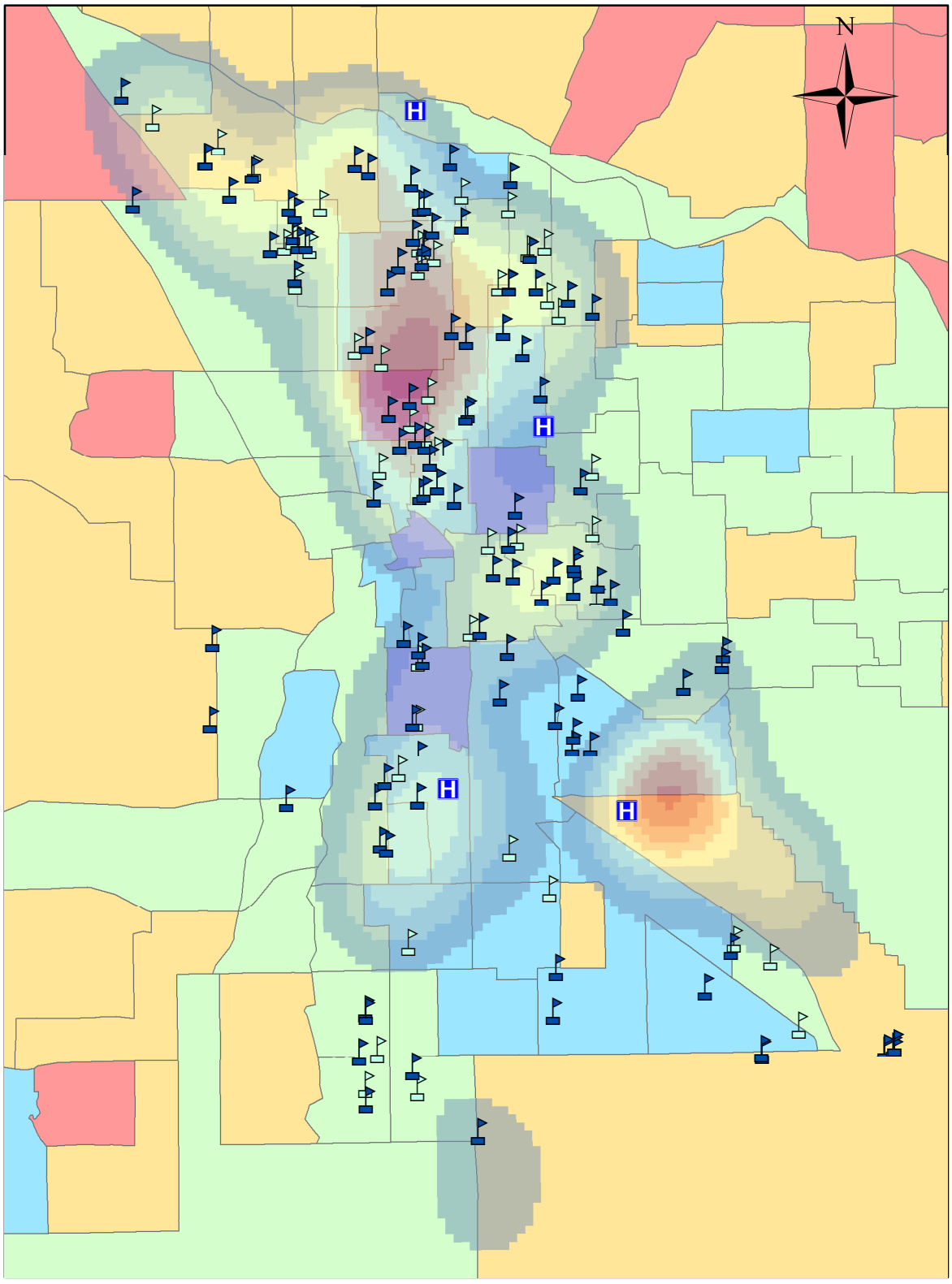
Legend

zip **Population**

- 202- 3437
- 3438 - 5743
- 5744 - 11190

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Tucson Metropolitan Area: Percent Below Poverty Area

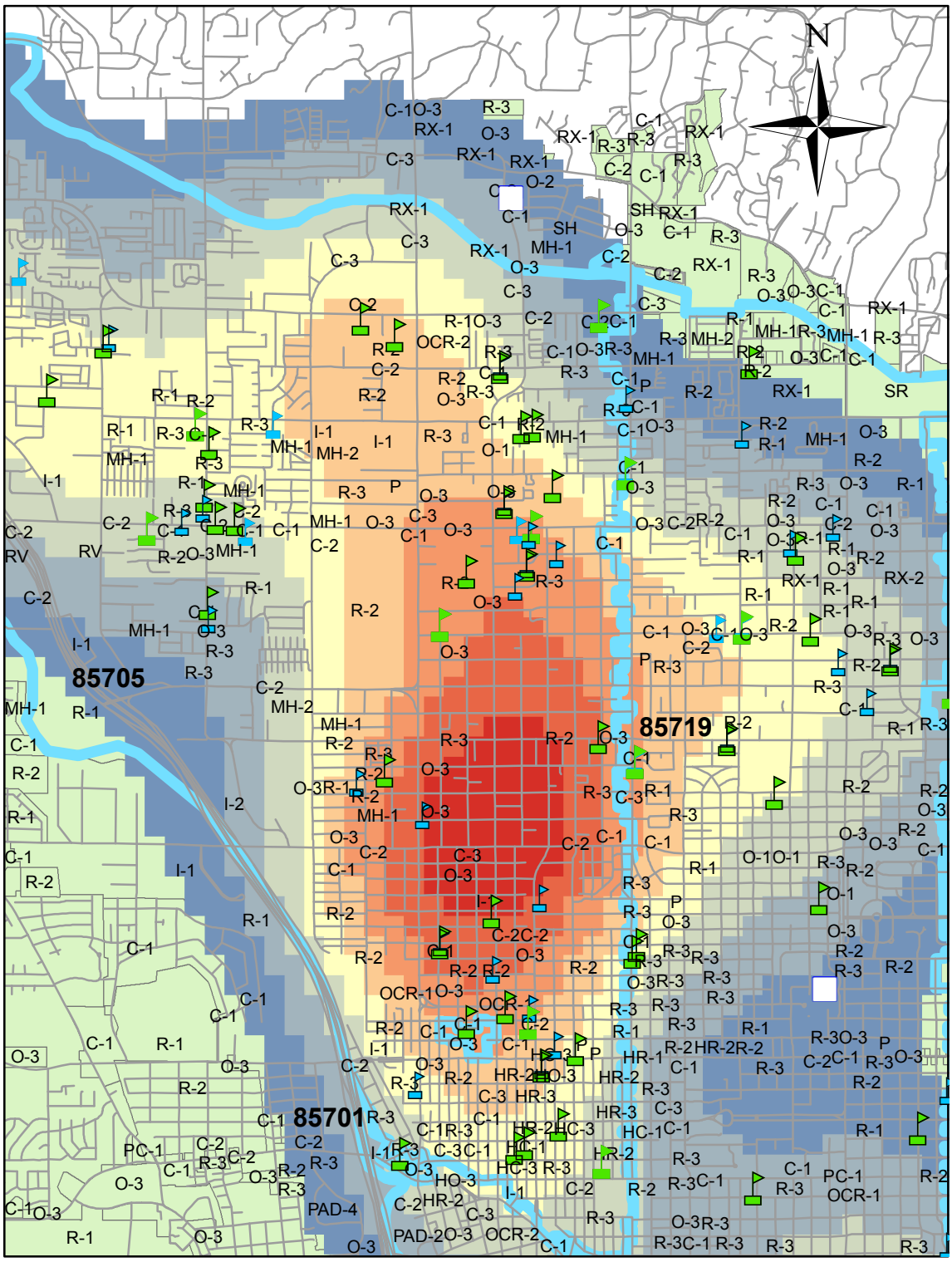


Legend

- Hospital
- Schools
- Daycare
- **% Bel Pov**
  - 0.00 - 6.00
  - 6.01- 14.00
  - 14.01 - 25.70
  - 25.71 - 39.70
  - 39.71 - 59.50

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Potential Hazardous Analysis: City of Tucson Zoning
Zip Codes 85705 and 85719



Legend

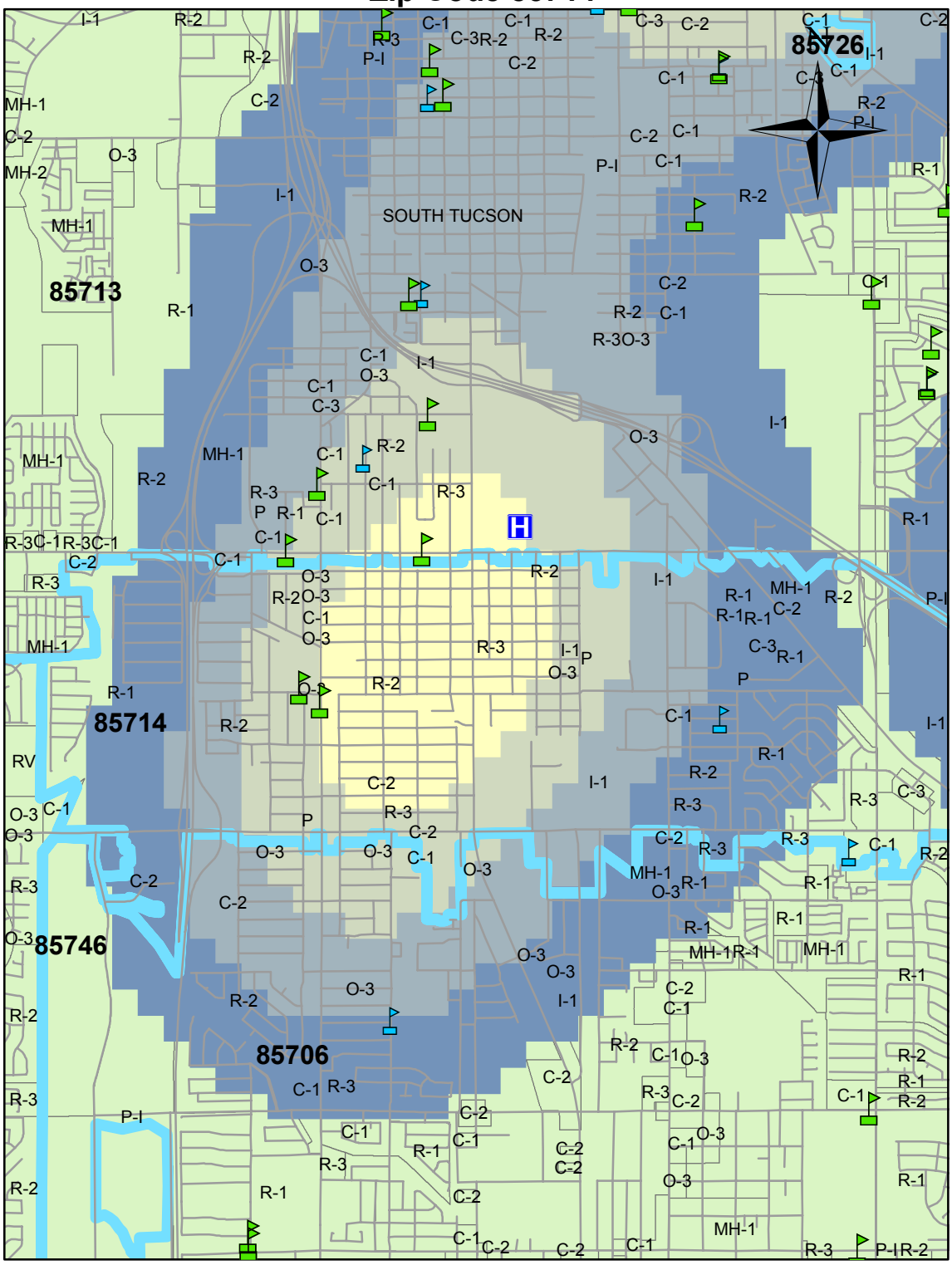
- Hospital
- Schools (SERI)
- Daycare
- Airport
- Streets
- zip
- Zoning City of Tucson

Potential Hazard Score

0 - 336	1,360- 1,707
337 - 685	1,708 - 2,044
686 - 1,022	2,045 - 2,381
1,023 - 1,359	2,382- 2,730
	2,731- 3,066

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Potential Hazardous Analysis: City of Tucson Zoning
Zip Code 85714



Legend

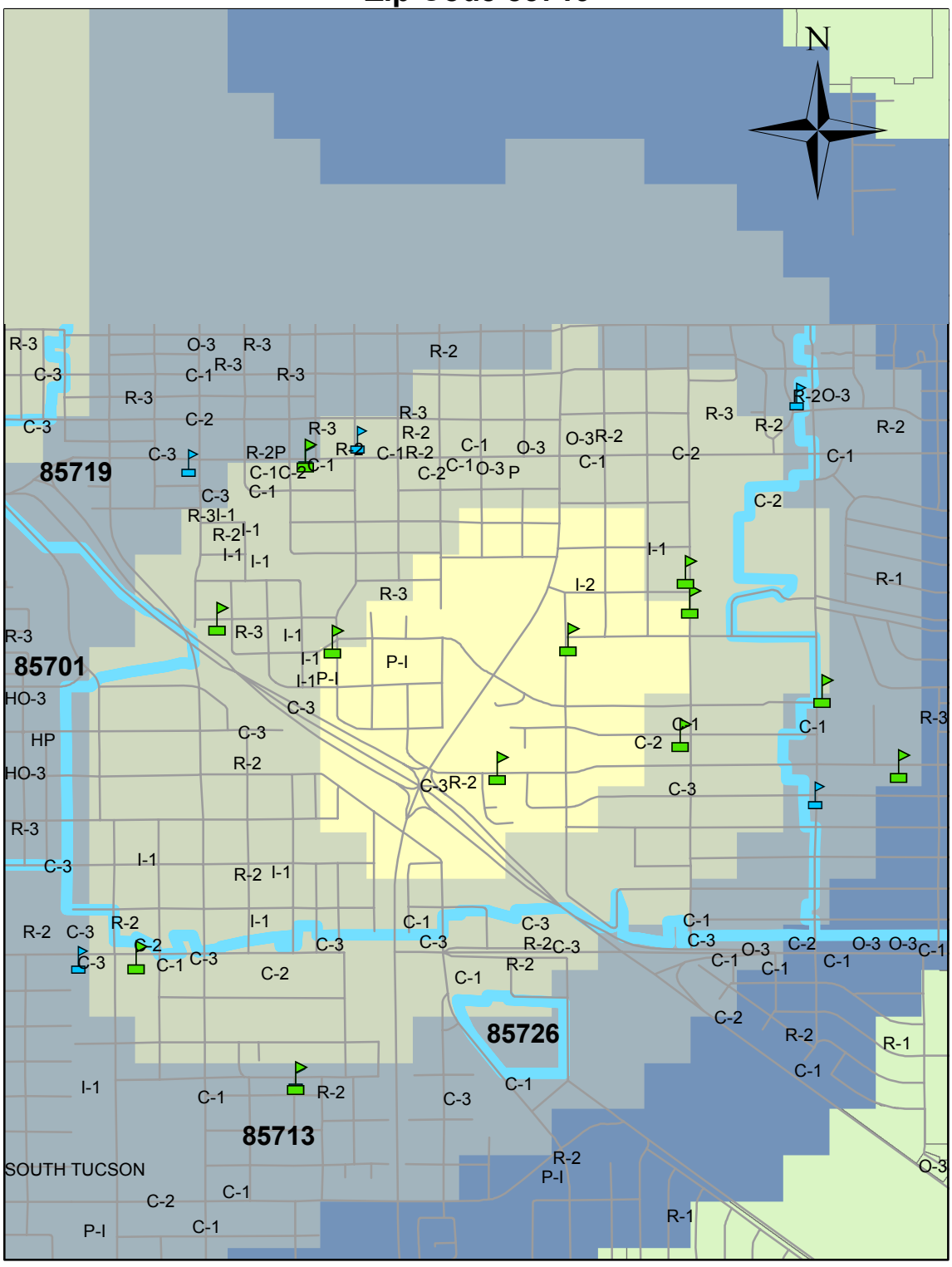
- Hospital
- Schools (SERI)
- Daycare
- Airport
- Streets
- zip
- Zoning City of Tucson

Potential Hazard Score

0 - 336	1,360- 1,707
337 - 685	1,708 - 2,044
686 - 1,022	2,045 - 2,381
1,023 - 1,359	2,382- 2,730
	2,731- 3,066

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Potential Hazardous Analysis: City of Tucson Zoning
Zip Code 85719



Legend

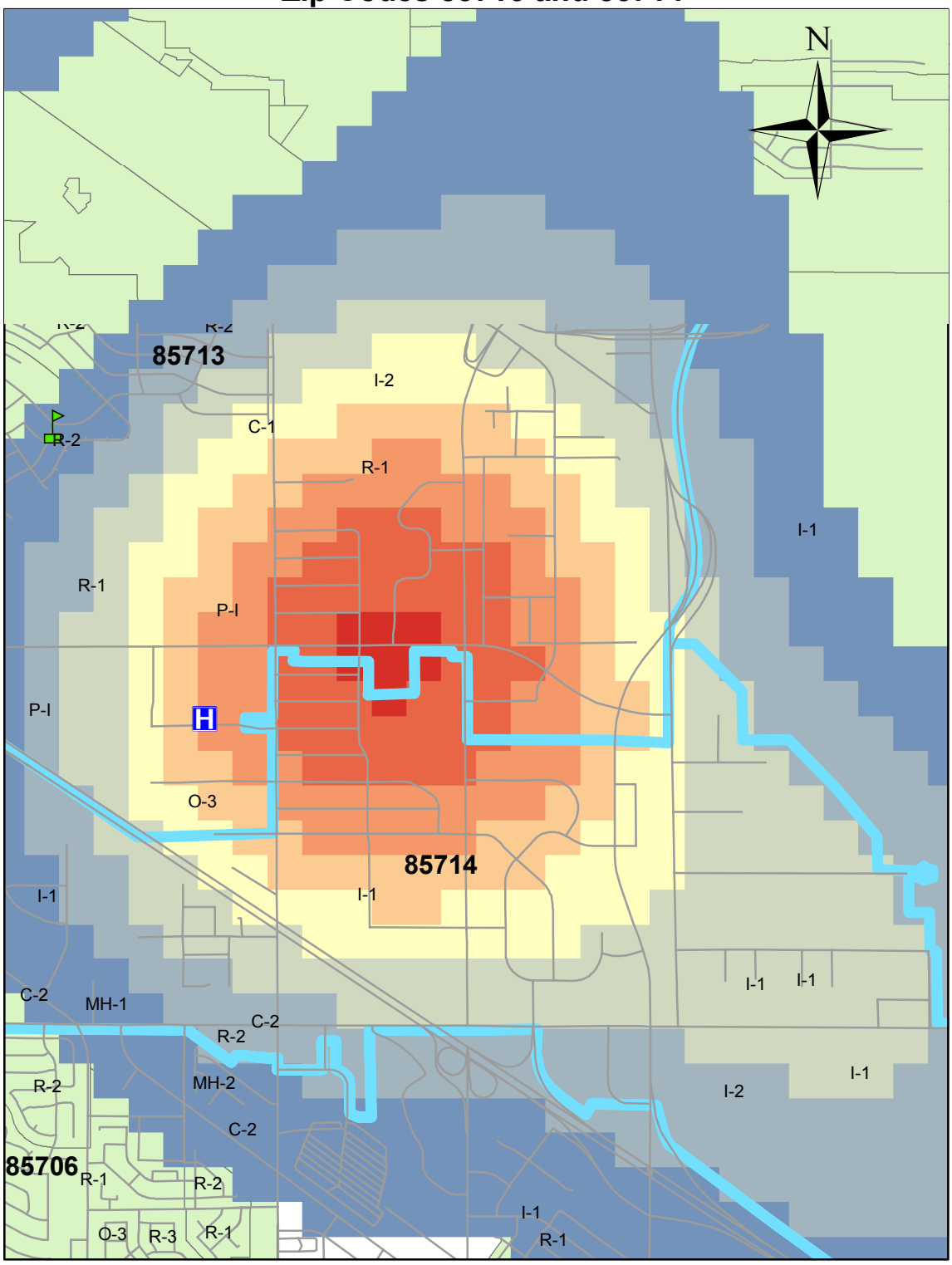
- Hospital
- Schools (SERI)
- Daycare
- Airport
- Streets
- zip
- Zoning City of Tucson

Potential Hazard Score

- 0-336
- 337-685
- 686-1,022
- 1,023-1,359
- 1,360-1,707
- 1,708-2,044
- 2,045-2,381
- 2,382-2,730
- 2,731-3,066

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Potential Hazardous Analysis : City of Tucson Zoning
Zip Codes 85713 and 85714



Legend

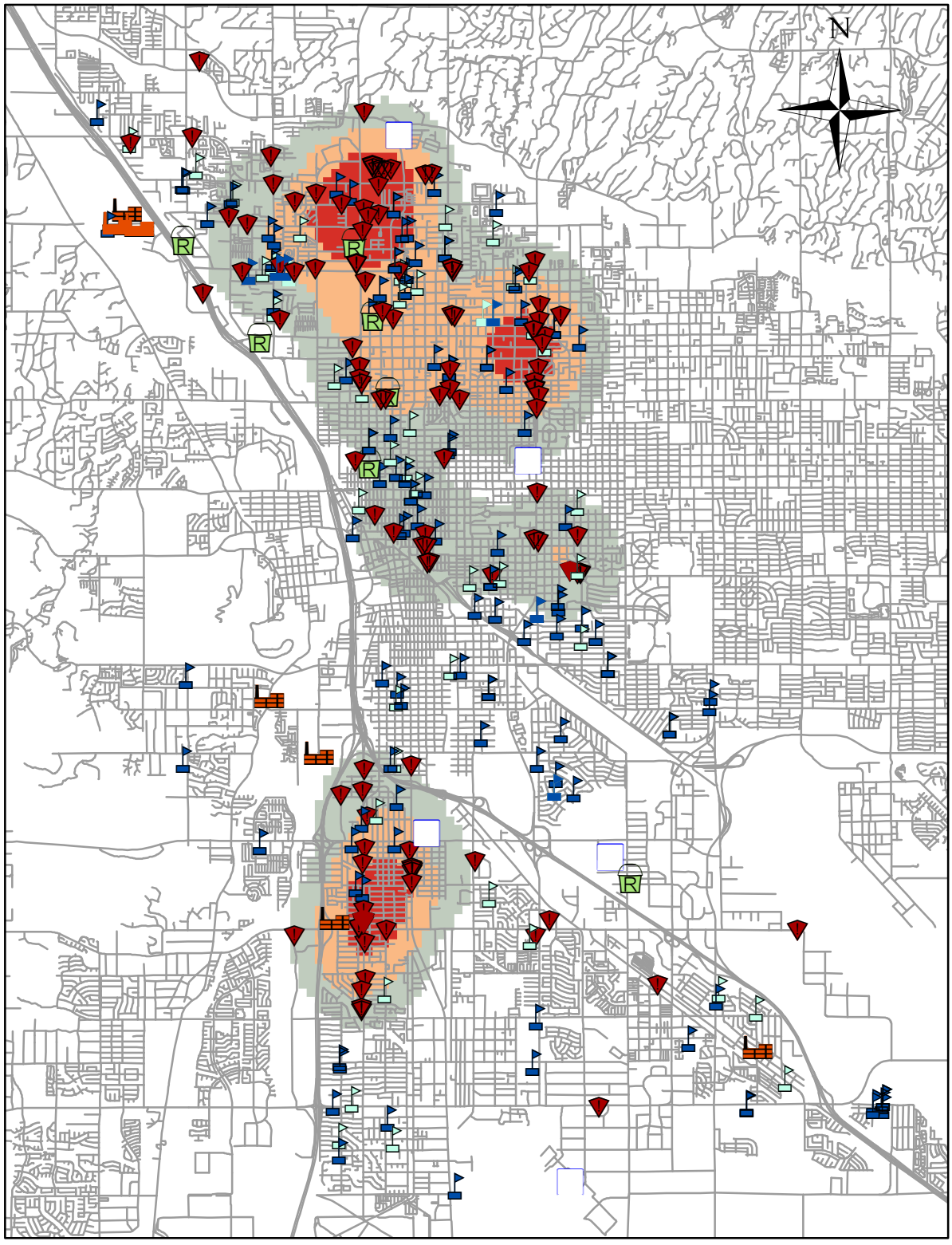
- Hospital
- Schools (SERI)
- Daycare
- Airport
- Streets
- zip
- Zoning City of Tucson

Potential Hazard Score

0 - 336	1,360- 1,707
337 - 685	1,708 - 2,044
686 - 1,022	2,045 - 2,381
1,023 - 1,359	2,382- 2,730
	2,731- 3,066

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Tucson Metropolitan Area: Hair Salon



Legend

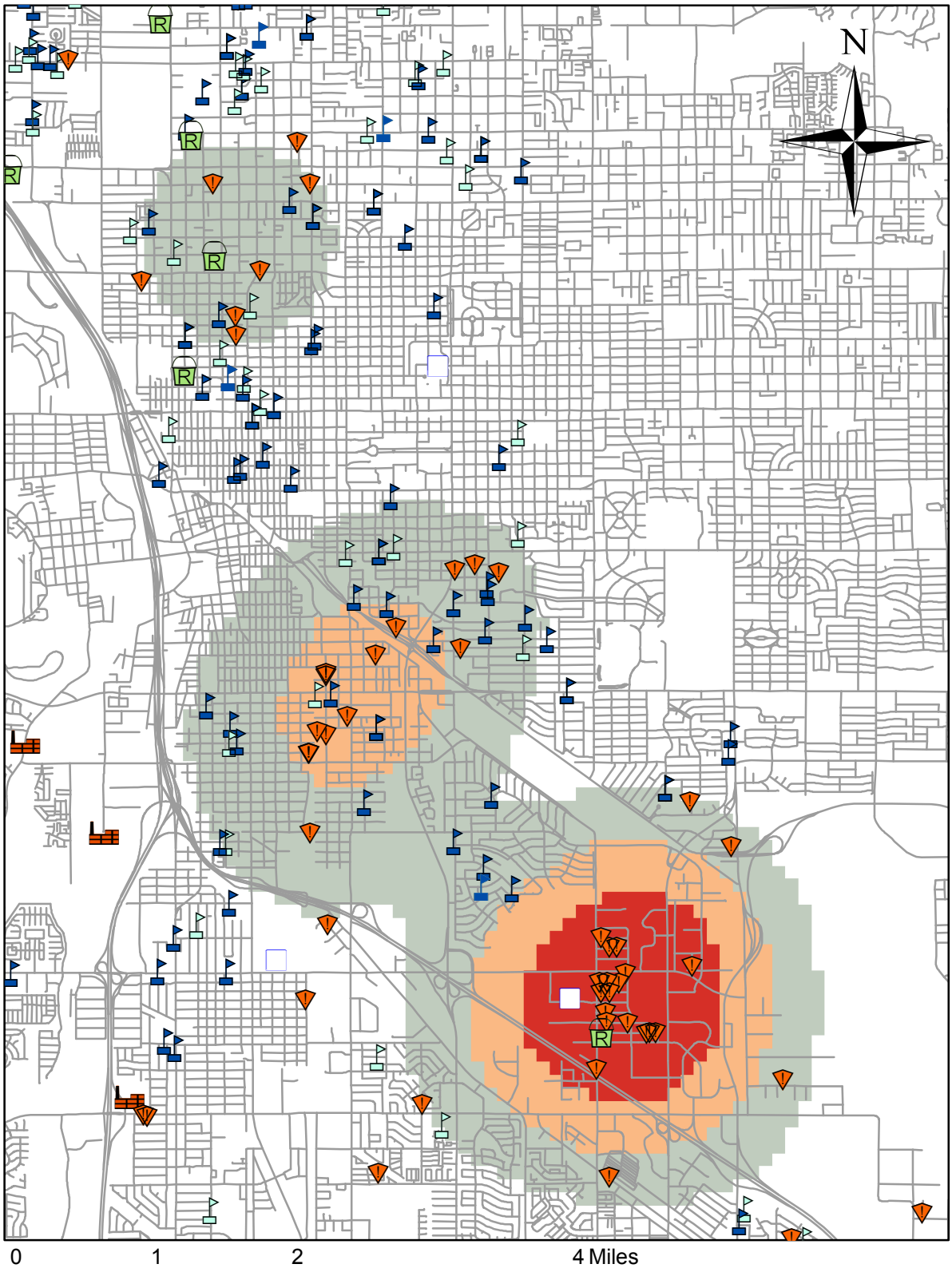
- Wastewater Treatment Facility
- Schools SERI Collected
- Salon Hair
- Recycler
- Hospital
- Daycare
- Airport
- Streets

Potential Hazard Ranking

- 0 - 143
- 141- 286
- 287 - 430
- 431 - 574

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Tucson Metropolitan Area: Soldering Welding And Sheet Metal



Legend

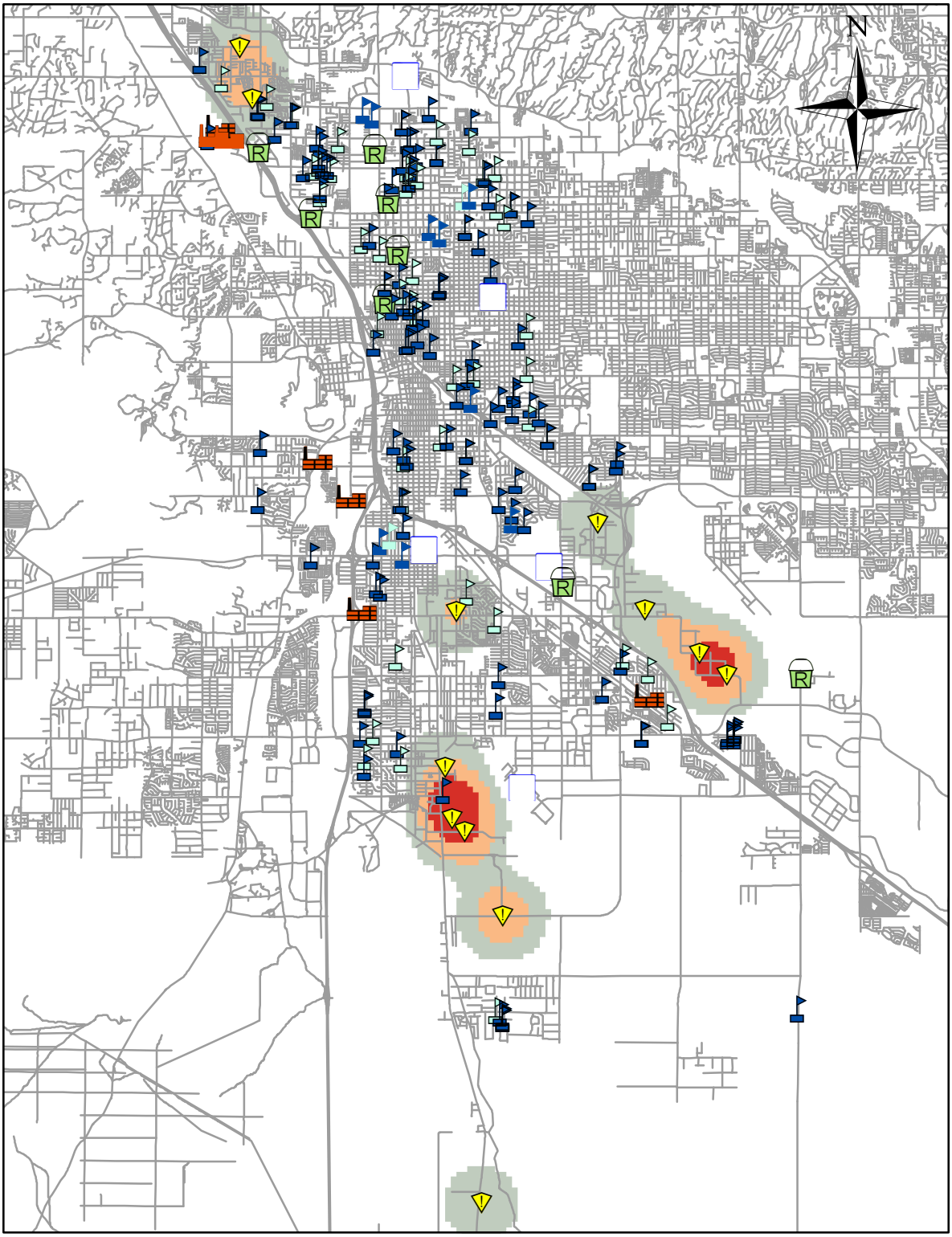
- Wastewater Treatment Facility
- Soldering Welding and Sheetmetal
- School
- Recycler
- Hospital
- Daycare
- Airport
- Streets

Potential Hazard Score

- 0-80
- 81-160
- 161-240
- 241-322

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Tucson Metropolitan Area: Surface Coating



Legend

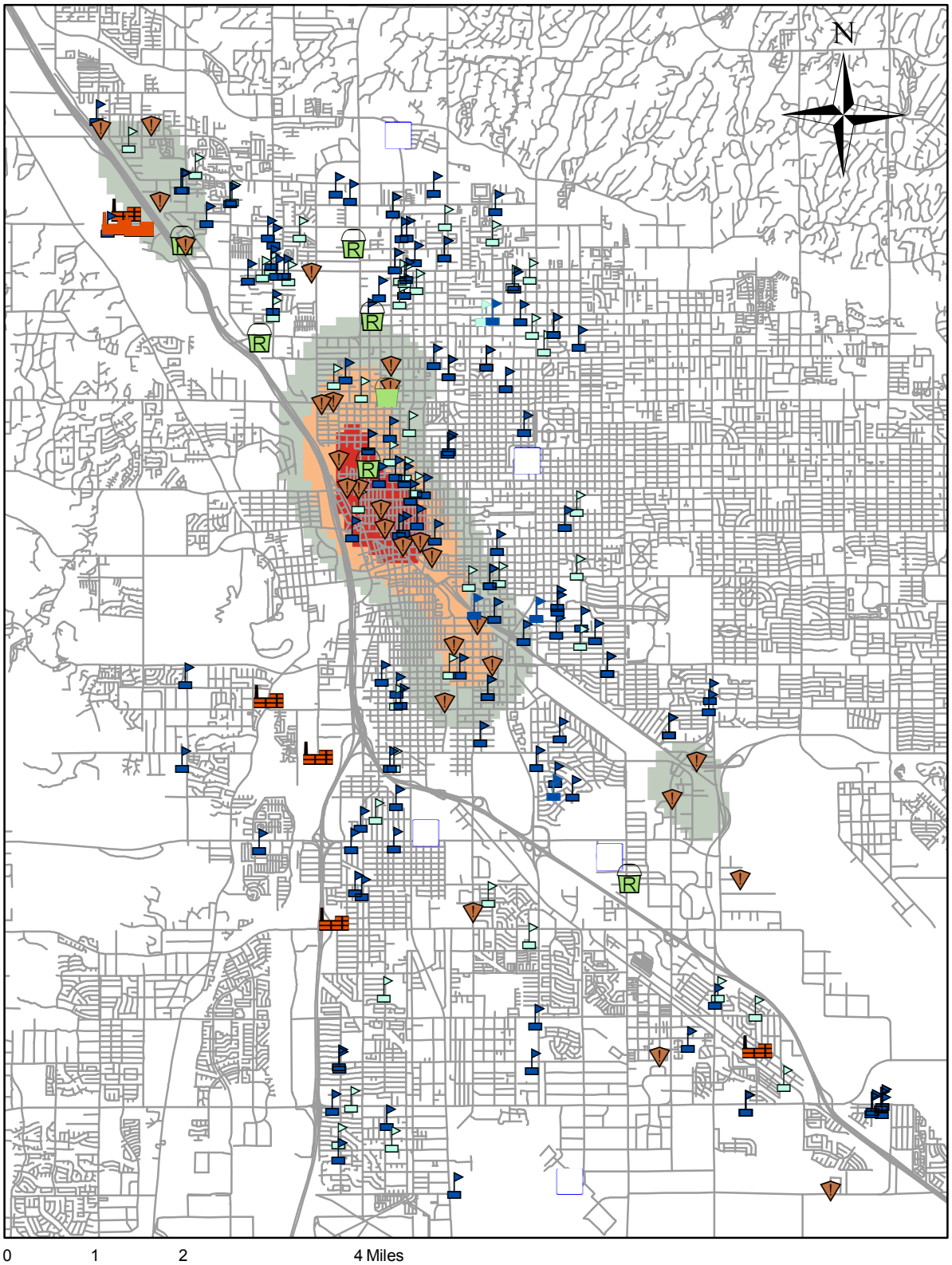
- Wastewater Treatment Facility
- Surface Coating Miscellaneous Metal Parts
- School
- Recycler
- Hospital
- Daycare
- Airport
- Streets

Potential Hazard Score

- 0
- 60- 120
- 121 -180
- 181 - 242

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09

Tucson Metropolitan Area: Woodworking



Legend

- Wastewater Treatment Facility
- School
- Recycler
- Hospital
- Daycare
- Woodworking
- Airport
- Streets

Potential Hazard Score

- 0 - 38
- 39- 76
- 77 - 115
- 116 -153

Prepared for: SERI
Prepared by: AK
Reviewed by:
Date: 07/24/09