# AIR QUALITY RESEARCH PROGRAM

**Texas Commission on Environmental Quality**
**Contract Number 582-10-94300**
**Awarded to The University of Texas at Austin**

**Quarterly Report**

**March 1, 2012 through May 31, 2013**

**Submitted to**

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**June 12, 2013**

**Texas Air Quality Research Program**

**Quarterly Progress Report**

**June 12, 2013**

## Overview

The goals of the State of Texas Air Quality Research Program (AQRP) are:

(i) to support scientific research related to Texas air quality, in the areas of emissions inventory development, atmospheric chemistry, meteorology and air quality modeling,

(ii) to integrate AQRP research with the work of other organizations, and

(iii) to communicate the results of AQRP research to air quality decision-makers and stakeholders.

On April 30, 2010, the Texas Commission on Environmental Quality (TCEQ) contracted with the University of Texas at Austin to administer the AQRP. For the 2010-2011 biennium, the AQRP had approximately $4.9 million in funding available. Following discussions with the TCEQ and an Independent Technical Advisory Committee (ITAC) concerning research priorities, the AQRP released its first request for proposals in May, 2010. Forty-five proposals, requesting $12.9 million in research funding were received. These proposals were reviewed by the ITAC for technical merit, and by the TCEQ for relevancy to the State's air quality research needs. The results of these reviews were forwarded to the AQRP's Advisory Council, which made final funding decisions in late August, 2010. As of November 30, 2011, all projects have been completed. Final reports on all but one project have been posted to the AQRP website.

In June 2011, the TCEQ renewed the AQRP for the 2012-2013 biennium. Funding of $1,000,000 for the FY 2012 period was awarded in February 2012. An additional $1,000,000 for the FY 2013 period was awarded in June 2012. At the same time an additional $160,000 was awarded for FY 2012, to support funding for two specific air quality projects recommended by the TCEQ. A call for proposals was released in May 2012. Thirty-two proposals, requesting $5 million in research funding were received. The proposals were reviewed by the ITAC and the TCEQ. The Advisory Council selected 14 projects for funding. Contracts have been signed with each organization and work plans have been approved, Task Orders are in place and work has begun on all projects.

In May 2013, Amendment 8 transferred an allocation of funds from FY12 funding to FY 11 funding. See the Financial Status Report section of this report for a full explanation.

## BACKGROUND

Section 387.010 of HB 1796 (81st Legislative Session), directs the Texas Commission on Environmental Quality (TCEQ, Commission) to establish the Texas Air Quality Research Program (AQRP).

> Sec. 387.010. AIR QUALITY RESEARCH. (a) The commission shall contract with a nonprofit organization or institution of higher education to establish and administer a program to support research related to air quality.
>
> (b) The board of directors of a nonprofit organization establishing and administering the research program related to air quality under this section may not have more than 11 members, must include two persons with relevant scientific expertise to be nominated by the commission, and may not include more than four county judges selected from counties in the Houston-Galveston-Brazoria and Dallas-Fort Worth nonattainment areas. The two persons with relevant scientific expertise to be nominated by the commission may be employees or officers of the commission, provided that they do not participate in funding decisions affecting the granting of funds by the commission to a nonprofit organization on whose board they serve.
>
> (c) The commission shall provide oversight as appropriate for grants provided under the program established under this section.
>
> (d) A nonprofit organization or institution of higher education shall submit to the commission for approval a budget for the disposition of funds granted under the program established under this section.
>
> (e) A nonprofit organization or institution of higher education shall be reimbursed for costs incurred in establishing and administering the research program related to air quality under this section. Reimbursable administrative costs of a nonprofit organization or institution of higher education may not exceed 10 percent of the program budget.
>
> (f) A nonprofit organization that receives grants from the commission under this section is subject to Chapters 551 and 552, Government Code.

The University of Texas at Austin was selected by the TCEQ to administer the program. A contract for the administration of the AQRP was established between the TCEQ and the University of Texas at Austin on April 30, 2010 for the 2010-2011 biennium, and was renewed in June 2011 for the 2012-2013 biennium. Consistent with the provisions in HB 1796, up to 10% of the available funding is to be used for program administration; the remainder (90%) of the available funding is to be used for research projects, individual project management activities, and meeting expenses associated with an Independent Technical Advisory Committee (ITAC).

## RESEARCH PROJECT CYCLE

The Research Program is being implemented through a 9 step cycle. The steps in the cycle are described from project concept generation to final project evaluation for a single project cycle.

1.) The project cycle is initiated by developing (in year 1) or updating (in subsequent years) the strategic research priorities. The AQRP Director, in consultation with the ITAC, and the TCEQ develop research priorities; the research priorities are released along with a Request for Proposals.

2.) Project proposals relevant to the research priorities are solicited. The Request for Proposals can be found at http://aqrp.ceer.utexas.edu/ .

3.) The Independent Technical Advisory Committee (ITAC) performs a scientific and technical evaluation of the proposals.

4.) The project proposals and ITAC recommendations are forwarded to the TCEQ. The TCEQ evaluates the project recommendations from the ITAC and comments on the relevancy of the projects to the State's air quality research needs.

5.) The recommendations from the ITAC and the TCEQ are presented to the Council and the Council selects the proposals to be funded. The Council also provides comments on the strategic research priorities.

6.) All Investigators are notified of the status of their proposals, either funded, not funded, or not funded at this time, but being held for possible reconsideration if funding becomes available.

7.) Funded projects are assigned a Project Manager at UT-Austin and a Project Liaison at TCEQ. The project manager at UT-Austin is responsible for ensuring that project objectives are achieved in a timely manner and that effective communication is maintained among investigators involved in multi-institution projects. The Project Manager has responsibility for documenting progress toward project measures of success for each project. The Project Manager works with the researchers, and the TCEQ to create an approved work plan for the project. The Project Manager also works with the researchers, TCEQ and the Program's Quality Assurance officer to develop an approved Quality Assurance Project Plan (QAPP) for each project. The Project Manager reviews monthly, annual and final reports from the researchers and works with the researchers to address deficiencies.

8.) The AQRP Director and the Project Manager for each project describe progress on the project in the ITAC and Council meetings dedicated to on-going project review.

9.) The project findings are communicated through multiple mechanisms. Final reports are posted to the Program web site; research briefings are developed for the public and air quality decision makers; and a bi-annual research conference/data workshop is held.

Steps 1 – 9 have all been completed for the initial (2010-2011) biennium. Steps 1 – 6 have been completed for the 2012 – 2013 biennium, and steps 7 and 8 are in progress. A summary of the 2012-2013 activities is described below.

Activities during the current reporting period include finalizing the last contracts, working with the investigators to finalize the project Work Plans, and working with active projects to meet project goals, as well as reporting and invoicing requirements. As of May 31, 2013, all of the projects have their Work Plans fully approved.

**Discover AQ**

In the summer of 2013, the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) program is planning to deploy NASA aircraft to make a series of flights with scientific instruments on board to measure gaseous and particulate pollution in the Houston, Texas area. The purpose, for NASA, of this campaign is to improve the use of satellites to monitor air quality for public health and environmental benefit.

To complement the NASA flight-based measurements, and to leverage the extensive measurements being funded by NASA to better understand factors that control air quality in Texas, ground-based air quality measurements will be made simultaneously by researchers from collaborating organizations, including research scientists and engineers funded wholly or in part by the AQRP and the TCEQ.

## RESEARCH PROJECTS

Research Projects for FY 2010-2011 are now completed. All projects have submitted final invoices and those invoices have been paid. The Final Report for each project, with the exception of one, is posted on the AQRP website at http://aqrp.ceer.utexas.edu/projects.cfm.

A summary of the projects approved for funding for FY 2012-2013 follows.

**Project 12-004** **STATUS: Active - March 1, 2013**

***DISCOVER-AQ Ground Sites Infrastructure Support***

University of Texas at Austin – Vincent Torres

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Erik Gribbon

**Funding Amount:** $289,200

**Executive Summary**
In the summer of 2013, the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) program is planning to deploy NASA aircraft to make a series of flights with scientific instruments on board to measure gaseous and particulate pollution in the Houston, Texas area. The purpose of this campaign, for NASA, is to improve the use of satellites to monitor air quality for public health and environmental benefit.

To complement the NASA flight-based measurements, and to leverage the extensive measurements being funded by NASA to better understand factors that control air quality in Texas, ground-based air quality measurements will be made simultaneously by researchers from collaborating organizations, including research scientists and engineers funded wholly or in part by the AQRP and the TCEQ. It is anticipated that two or three ground sites will need to be expanded or established to accommodate the instrumentation that will be brought to Houston by research collaborators. This project will centralize and coordinate the site infrastructure preparation for the ground sites identified for expansion to support DISCOVER-AQ Houston 2013.

The scope of work for this project begins with meeting with and/or contacting appropriate DISCOVER-AQ and TCEQ personnel who will be determining how many and which ground sites will be used for the study. Once that is determined, assignment of instrumentation to each site would follow. Next, to accommodate the instrumentation and the associated support equipment and supplies that will be located at the selected ground sites, these sites will require site improvements to infrastructure in advance of the intensive measurement period of the campaign that includes obtaining the necessary site access/use agreements, ground (site pad) preparation, installation of utilities (electrical and communication) and security fencing, and rental of temporary buildings to accommodate instrumentation that must be located in conditioned space. During the intensive measurements period of the campaign, some limited support may be required by the ground-based researchers should problems arise with the site accommodations. This support would also be provided as needed. At the end of the campaign, each of these sites must be decommissioned and restored to their original condition or a condition required by the property owner. This effort is also included in the scope of work proposed for this project.

**Project Update**

Teleconferences and a site visit were held in March to attempt to finalize ground site locations, understand AQRP researchers' site logistics requirements and coordinate collection of data. After analysis of the information obtained during the site visit, ground sites for the study were finalized in late March. Based on this decision and the AQRP researchers' site logistics requirements, the project team began obtaining preliminary information on the costs for site improvements, primarily electric utility modifications/upgrades and the addition of scaffolding to accommodate instrumentation that will be added for DISCOVER-AQ, and supporting the TCEQ in obtaining site access agreements for the ground sites selected. This effort, including finalizing site modification cost estimates has occupied the months of April and May. Late in the month of May, site access approval was obtained for the Galveston and La Porte sites. Work for those two sites was in the process of being scheduled as the quarter ended.

In anticipation of site access approval being received for the balance of the sites, work during the next quarter will focus on implementing the site modifications at all sites.

**Project 13-005** **STATUS: Active – January 15, 2013**

***Quantification of industrial emissions of VOCs, $NO_2$ and $SO_2$ by SOF and mobile DOAS during DISCOVER AQ***

Chalmers University – Johan Mellqvist
University of Houston – Barry Lefer

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – John Jolly

**Funding Amount:** $177,553
($129,047 Chalmers, $48,506 UH)

**Executive Summary**
Mobile remote sensing by SOF and mobile DOAS will be carried out in the Houston ship channel (HSC) area during September 2013. In this manner vertical columns will be obtained of VOCs (alkanes, alkenes), $NH_3$, $NO_2$, $SO_2$, HCHO and particles as inferred from aerosol optical depth. The optical remote data will be complemented by wind profile measurements. The data collected will have great value of its own to be applied for future ozone modeling since a good understanding of the emission variability and changes in the total emissions in the HSC will be obtained by comparison to similar studies in 2006, 2009 and 2011 [Mellqvist 2007; 2009; 2010 and Rivera 2010]. The emission data will be compared to available emission inventories and categorized in various industrial types.

Equally important, the measurements will complement the NASA Discover AQ campaign which will run in the HSC area during the targeted month. NASA will then fly a high altitude aircraft (B200) equipped with optical sensors measuring columns of $SO_2$, $NO_2$, HCHO and aerosol profiles (LIDAR). They will utilize a low flying airplane (P-3) that will make spirals in the vicinity of two ground stations in the HSC, to validate the high altitude measurements.

The spatial column data of $NO_2$, $SO_2$, and HCHO from the mobile DOAS will be directly comparable to the column data measured by the high altitude NASA aircraft, hence providing a validation data set across the whole ship channel. Secondly, by carrying out emission measurements of VOCs, $NO_2$, $SO_2$ and HCHO around the HSC, especially upwind the two sites, it will be possible to interpret the spiral measurements by the NASA P-3 and the high altitude measurements by the B200 in a better way. The combined airborne and ground based data set will be rather comprehensive and has large potential to be used for modeling of the ozone in the HSC area. This project will support the AQRP priority research area: Improving the understanding of ozone and PM formation and emission characteristics in the Houston area through supplementary measurements to the NASA Discover-AQ campaign September 2013.

**Project Update**
During the period March 1 to May 31 the project team has participated in logistical and measurement planning and started instrument preparation. This has been done by participating

in telephone meetings organized by NASA and by telephone meetings between Chalmers and University Houston.

The IR and UV measurements will be carried out in the measurement van of the University of Houston, together with a whole suite of other instruments. The equipment will be shipped from Sweden in mid-august and then installed in the van the last week of August.

**Project 12-006** **STATUS: Active – February 8, 2013**

***Environmental chamber experiments and CMAQ modeling to improve mechanisms to model ozone formation from HRVOCs***

University of California - Riverside – Gookyoung Heo
Texas A&M University – Qi Ying

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Ron Thomas

**Funding Amount:** $146,259
($101,765 UC-R, $44,494 TAMU)

**Executive Summary**

Using reliable atmospheric chemical mechanisms in regulatory models is necessary to formulate effective air quality policies for controls of secondary air pollutants such as ozone ($O_3$). It is well known that alkenes are a major contributor to radical and $O_3$ formation in Southeast Texas due to their high emissions and their high reactivities. Particularly, in Harris County, Texas, seven alkenes (ethene, propene, 1,3-butadiene, 1-butene, isobutene, trans-2-butene, and cis-2-butene) are classified as Highly Reactive Volatile Organic Compounds (HRVOCs), and HRVOC emissions have been regulated by Texas Administrative Code, Title 30, Part 1, Chapter 115 (TCEQ, 2102). However, condensed chemical mechanisms commonly used for air quality modeling in the U.S. are designed to model $O_3$ formation from typical urban ambient volatile organic compound (VOC) mixtures but are not designed to model $O_3$ formation under atmospheric conditions significantly influenced by highly variable HRVOC emissions that are dominated by a small number of VOC species. Therefore, a chemical mechanism that can be used to simulate $O_3$ formation from both urban emissions and industrial HRVOC emissions needs to be developed to accurately assess the impact on $O_3$ formation of regular and episodic HRVOC emissions from industrial sources in Southeast Texas. However, lack of environmental chamber data useful for mechanism evaluation is a critical obstacle to developing reliable mechanisms for the HRVOCs. Among the 7 alkenes regulated as HRVOCs in Southeast Texas, robust chamber data for mechanism evaluation are available only for ethene and propene. The situation is even worse for the higher molecular weight non-HRVOC alkenes. Thus, this study will develop more robust chemical mechanisms for the HRVOCs and non-HRVOC alkenes that are better suited for use under atmospheric conditions influenced by HRVOC emissions, and evaluate and update the initially proposed mechanisms by designing and carrying out environmental chamber experiments for the HRVOCs and non-HRVOC alkenes for which existing data are inadequate. The effect of the mechanism modifications on air quality predictions in Southeast Texas will be evaluated by carrying out 3-dimensional air quality modeling with the Community Multiscale Air Quality modeling system (CMAQ), using both existing mechanisms and the updated and more explicit mechanisms developed in this work.

**Project Update**

During March 1, 2013 to May 31, 2013, this project designed and carried out approximately 30 environmental chamber experiments using a large indoor environmental chamber at the University of California at Riverside to produce experimental data useful to improve atmospheric reaction mechanisms leading to ozone formation for five Highly Reactive Volatile Organic Compounds (HRVOCs; 1,3-butadiene, 1-butene, isobutene, trans-2-butene, and cis-2-butene) and five non-HRVOC alkenes (1-pentene, 1-hexene, trans-2-pentene, cis-2-pentene, and 2-methyl-2-butene). We gathered information on kinetic and mechanistic reaction parameters for the 10 alkenes, and we started to prepare model input data to carry out 3-dimentional air quality modeling with the Community Multiscale Air Quality Modeling (CMAQ) system and carried out preliminary CMAQ simulations for this project. In June and July, 2013, these newly obtained chamber experimental data and data on kinetic and mechanistic reaction parameters for the 10 alkenes will be used to develop improved reaction mechanisms that can be used in CMAQ modeling by researchers at Texas A&M University.

**Project 12-011** **STATUS: Active – January 17, 2013**

***Investigation of Global Modeling and Lightning NOx Emissions as Sources of Regional Background Ozone in Texas***

ENVIRON International – Chris Emery

AQRP Project Manager – Elena McDonald- Buller
TCEQ Project Liaison – Jim Smith

**Funding Amount:** $77,420

**Executive Summary**

The production, transport, and fate of tropospheric ozone are highly dynamic processes with contributions from a multitude of anthropogenic and natural sources spanning spatial scales from local to global. The US Environmental Protection Agency (EPA) requires the use of regional photochemical models to demonstrate that local emission control plans will achieve the federal standard for ground-level ozone. As the ozone standard is lowered, sources contributing to uncontrollable “background” ozone become more significant and must be more accurately accounted. In response, regulatory modeling applications have employed continuously larger domains to explicitly include sources over broader portions of the continent. Regional models now include worldwide contributions by deriving boundary conditions from global models. As global models continue to emerge and improve, their contributions to background ozone as represented in regional models need to be evaluated.

The Texas Commission on Environmental Quality (TCEQ) uses the Comprehensive Air quality Model with extensions (CAMx) for research and regulatory photochemical modeling. Two popular global models have been routinely coupled to CAMx: the Goddard Earth Observing System - Chemistry model (GEOS-Chem), developed and distributed by Harvard University, and the Model for OZone and Related chemical Tracers (MOZART), developed and distributed by the National Center for Atmospheric Research (NCAR). A newer global model called AM3, which is the atmospheric component of the CM3 global coupled atmosphere-oceans-land-sea ice model, is developed by Princeton University and the National Oceanic and Atmospheric Administration’s Geophysical Fluid Dynamics Laboratory (GFDL).

In this project, we will develop boundary condition inputs for CAMx utilizing output from all three global models (GEOS-Chem, MOZART, and AM3). The sensitivity of simulated ozone to regional boundary conditions will be investigated. We will develop quantitative comparisons of these global models with respect to their ability to provide accurate and reasonable boundary conditions for regional downscaling, particularly as it applies to regulatory ozone modeling.

**Project Update**

During this quarter, team members reviewed the Work Plan and QAPP, and coordinated procedures and data needs to begin the project tasks. The first priority of this work is to develop an interface program between the AM3 global model and the CAMx regional model. Princeton provided to ENVIRON a list of all chemical compounds carried by AM3 so that a mapping to CAMx compounds could be developed. From this mapping, ENVIRON informed Princeton on the minimum species list needed to be run in AM3 to support regional photochemical modeling. AM3 modeling for 2008 is expected to begin shortly.

Task 1: Evaluation of Global Modeling Products Over North America

The first priorities of this task were to run the AM3 global model for the analysis year 2008, and to develop an interface program between AM3 and the CAMx regional model from which to generate boundary condition inputs for the regional model. ENVIRON already possesses interface software for MOZART and GEOS-Chem. ENVIRON and Princeton collaboratively developed a specific list of AM3 chemical compounds from which to map to the photochemical mechanism (CB05) employed in CAMx. Princeton configured AM3 to output this compound list, performed an annual run for 2008, and post-processed the results from its native grid system to a standard latitude/longitude grid similar to that of GEOS-Chem and MOZART. ENVIRON obtained the processed AM3 output from Princeton via FTP.

Output data from two other global models (MOZART and GEOS-Chem) are needed for this project. MOZART data for 2008 were obtained via FTP from an internet data warehouse maintained by NCAR. ENVIRON performed a GEOS-Chem run for the year 2008. All three global models provided 6-hourly gridded concentration fields of gas and PM species on their specific latitude/longitude grid systems.

ENVIRON has begun an evaluation of global model performance against rural CASTNET surface ozone measurements, with a focus on the south-central US. ENVIRON collected US-wide ambient ozone and PM air quality data for the year 2008 from the EPA CASTNET system. ENVIRON also collected ozone sounding data from the NOAA ozonesonde network and from the Houston 2008 Tropospheric Ozone Pollution Project. Design and programming were completed for new graphics software that facilitates comparison of monthly ozone profiles between the global/regional models and ozonesonde measurements. An example of such comparisons is shown in Figure 1. General bias and error statistics at the surface CASTNET sites will be summarized in the next quarterly report.

Task 2: Global-Regional Model Coupling and Performance Comparison

ENVIRON procured a 2008 CAMx modeling dataset developed by Alpine Geophysics. As described in detail in the Work Plan, this dataset spans April through October 2008 and includes a continental-scale domain with 36 km grid spacing and a regional domain covering the south-central US with 12 km grid spacing. Meteorology was developed using the WRF model, and anthropogenic emissions were derived mostly from EPA's 2008 NEI, the MOVES on-road emission factor model, and TCEQ's point source inventory. Natural emission sources included biogenics from both MEGAN and GloBEIS, and wildland fires from EPA's BlueSky/SMARTFIRE system. Chemical speciation of all emissions was performed for the CB05 mechanism. This dataset was successfully transferred to ENVIRON's computer system.

ENVIRON completed the development of an AM3-CAMx interface, from which boundary condition inputs for CAMx were constructed. Mapping of compounds output by the MOZART global model to the CAMx CB05 compounds were also updated. CAMx boundary conditions were developed from 2008 MOZART and GEOS-Chem output using existing processors. The first of three runs of the 2008 CAMx modeling system was started in late May

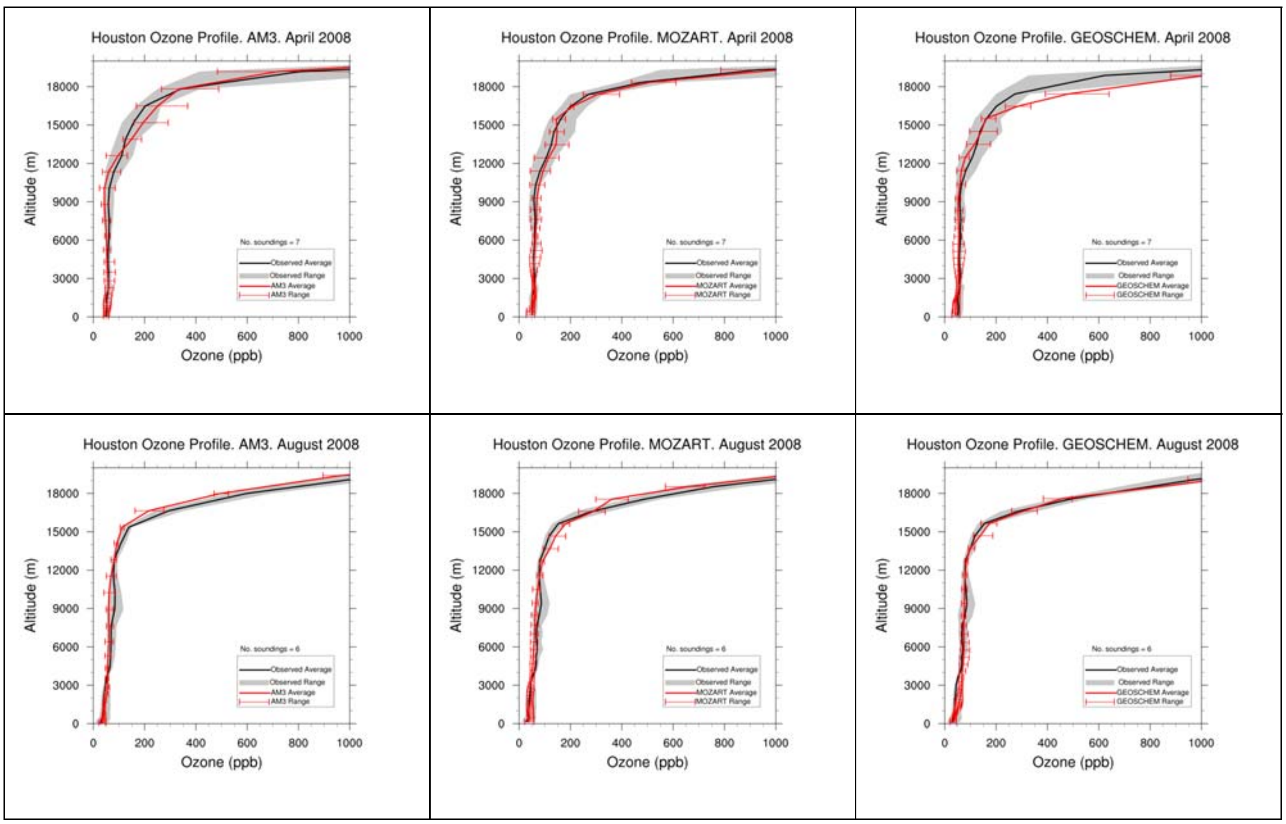



**Figure 1.** Measured (black) and predicted (red) monthly mean ozone profiles at the Houston ozonesonde site for April 2008 (top row) and August 2008 (bottom row). Minimum to maximum range are shown for measurements (grey shading) and predictions (red whiskers). Measured data were interpolated to the vertical grids for each model. Less inter-model variability occurs in the summer than in the non-summer months.

using MOZART-derived boundary conditions and the GloBEIS biogenic emissions. Results from all three CAMx runs will be summarized in the next quarterly report.

The development of software tools and processing of ozonesonde and CASTNET data for use in the global and CAMx model evaluation has progressed more slowly than expected.  We expect to complete Task 1 in June, and Task 2 in July or August.  The project remains on schedule for completion with delivery of the final AQRP-reviewed report by November 30.

All funds allocated to the project are intended to be used by 11/30/2013.

**Project 12-012** **STATUS: Active - December 19, 2012**

***Interactions Between Organic Aerosol and NOy: Influence on Oxidant Production***

University of Texas at Austin – Lea H. Ruiz
ENVIRON International – Greg Yarwood

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Mark Estes

**Funding Amount:** $148,835
($79,461 UT Austin, $69,374 Environ)

**Executive Summary**

In rural areas where emission rates of $NO_x$ (NO + $NO_2$) are relatively low, ozone formation can be sensitive to secondary $NO_x$ sources such as decomposition of organic nitrates (R-$ONO_2$). AQRP project 10-042 provided experimental evidence for $NO_x$ production when organic nitrates degrade by OH reaction and photolysis. Implementing $NO_x$ production from OH reaction with organic nitrates causes regional ozone increases that are large enough to affect model agreement with ozone observations. This implies that organic nitrates are less available to $NO_x$ recycling than previous experiments suggested. We are investigating the hypothesis that uptake of organic nitrates into secondary organic aerosol (SOA) reduces the amount of $NO_x$ recycled by organic nitrate photolysis and OH reaction.

The first task in this project is to add the uptake of organic nitrates by SOA to the Comprehensive Air quality Model with extensions (CAMx). The conceptual model of Perraud et al. (2012) is followed, in which organic nitrate molecules stick to aerosol surfaces and become irreversibly buried by accretion of SOA. Results of this initial modeling work is then used to design laboratory chamber experiments in which organic nitrates are formed from the oxidation of VOCs in the presence of $NO_x$ and the distribution of organic nitrates between the gas and particle phases is observed. New chemistries and mechanisms inferred from the experimental data are then tested by including them in a box model of the chamber experiments before they are implemented in CAMx. Finally, the partitioning of organic nitrates between the gas- and particle phase is observed in natural aerosol by conducting ambient measurements near Houston.

**Project Update**

In this quarter a box model version of the CAMx photochemical model used in chemical mechanism development under Task 1 was programmed. The box model uses the full CAMx source code but in simplified configuration which makes mechanism testing and evaluation more efficient. The box model is for version 6.0 of CAMx which was released on May 6, 2013. The box model is being used to determine how much organic nitrate is produced by different reactions in the Carbon Bond 6 (CB6) mechanism and therefore the relative importance of different nitrates.

The team continued setting up and calibrating instruments which are used in laboratory chamber experiments and ambient measurements under Tasks 2 and 4. They also installed the Teflon bag inside of which experiments are conducted. After several control experiments the team recently started to conduct experiments on the photolysis rate of organic nitrates, and on their rate of reaction with the hydroxyl radical (Task 2).

Planning continued for the ambient measurements during DISCOVER-AQ in Houston, TX (Task 4). In early March Dr. Hildebrandt Ruiz attended a planning meeting in Houston and visited several potential measurement sites. It was decided that measurements will be taken at the TCEQ measurement site in Conroe, TX (http://www.tceq.state.tx.us/cgi-bin/compliance/monops/site_photo.pl? cams=78). Instruments will be housed in a trailer which will be rented for the duration of the campaign. In addition, team members attended the annual users' meeting on March 22-26 in Boulder, CO for users of Time-of-Flight Chemical Ionization Mass Spectrometers. At this meeting the team learned about different chemical ionization techniques, best practices for field measurements as well as techniques and issues with instrument calibration methods (Tasks 2 and 4).

There have been a few delays in this project including delays in execution of the contract and delivery of newly purchased instrumentation. This is not expected to cause major problems in completion of the project. An updated timeline will be submitted with the next monthly technical report.

All funds allocated to the project are expected to be used by 11/30/2013.

| Project 12-013 | STATUS: Active – December 14, 2012 |
|---|---|

***Development of Transformation Rate of $SO_2$ to Sulfate for the Houston Ship Channel using the TexAQS 2006 Field Study Data***

ENVIRON International – Ralph Morris

AQRP Project Manager – Elena McDonald - Buller
TCEQ Project Liaison – Jim Price

**Funding Amount:** $59,974

**Executive Summary:**
On June 2, 2010, EPA promulgated a new 1-hour $SO_2$ primary NAAQS with a threshold of 75 ppb. The 1-hour $SO_2$ NAAQS is much more stringent and replaces the old 24-hour (140 ppb) and annual (30 ppb) $SO_2$ NAAQS. States are required to submit 1-hour $SO_2$ State Implementation Plans (SIPs) by February 2014 that demonstrates compliance with the NAAQS by August 2017. Preliminary modeling indicates that $SO_2$ emissions for numerous sources will result in near-by exceedances of the 1-hour $SO_2$ NAAQS. Fossil-fueled power plants (73%) and industrial facilities (20%) are the main sources of $SO_2$ emissions in the U.S. Photochemical oxidants will convert some $SO_2$ to sulfate thereby reducing $SO_2$ concentrations. However, the EPA-recommended model for near-source 1-hour $SO_2$ modeling is the AERMOD steady-state Gaussian plume model that does not treat photochemical oxidants and has a very simple treatment of chemistry (exponential decay). EPA recommends that AERMOD be run with no $SO_2$ conversion for addressing 1-hour $SO_2$ NAAQS issues. This assumption may be appropriate for fossil-fueled power plants where the high $NO_X$ concentrations inhibit photochemistry and consequently $SO_2$ oxidation near the source, but it may not be appropriate for the Houston Ship Channel where the atmosphere can be very reactive (due to HRVOC emissions) resulting in faster $SO_2$ to sulfate conversion rates.

The goal of this project is to develop a representative $SO_2$ transformation rate for the Houston Ship Channel area using measurements from the NOAA P-3 aircraft collected during the 2006 Texas Air Quality Study (TexAQS) that can be used with the AERMOD model to simulate 1-hour $SO_2$ concentrations. The proposed approach uses a grid model to simulate first-order transformation of $SO_2$ to sulfate for sources in the Houston Ship Channel. The model results with varying transformation rate are evaluated against the 2006 TexAQS P-3 aircraft measurement data to find what transformation rate best fits the observations and to determine whether one hypothetical transformation rate results in statistically better model performance than the other rates used.

**Project Update**
ENVIRON has initiated Task 1 and acquired the NOAA P-3 flight measurement data for the 12 flights during the campaign that had been pre-selected based on their relevance to the Houston Ship Channel emissions. These were further analyzed to select the flight transects to be used for

the grid model evaluation.  The focus is on the flight transects that pass the Houston Ship Channel plumes and have relatively small interferences from background and other local sources (e.g., Parish power plant). The project work was initiated in January 2013 due to a delay in the official Task Order.  Therefore, the project schedule was revised accordingly while the project completion date remains the end of November 2013.  All funds allocated to the project will be used upon the project completion.

*Task 1: Assess the TexAQS 2006 Field Study Data*

NOAA P-3 flight transect data from September 13 to October 8 during the 2006 TexAQS field campaign were examined, and five of them were selected for the grid model evaluation:

- September 19, 2006 (Houston urban plume, refineries)
- September 25, 2006 (Houston, Dallas urban plumes and power plants)
- September 26, 2006 (Houston urban plume and industrial sources)
- September 27, 2006 (Houston urban plume and industrial sources)
- October 5, 2006 (Houston urban plume and power plants)

*Task 2: Set-up Grid Modeling for the Houston region*

Based on the flight transect assessment conducted under Task 1, we have made a preliminary set-up for the grid model simulation which may be refined based on initial test results. Table 1 shows the modeling grid definitions of the 4-km master grid and 1-km sub-grids that vary by flight route.

**Table 1.** Domain definitions for grid modeling (based on the national RPO map projection).

| Modeling Grid | | Origin Coordinates (km) | | Number of Grid Cells | |
|---|---|---|---|---|---|
| | | **X** | **Y** | **Column** | **Row** |
| 4-km HGB/BPA grid | | 32 | -1264 | 92 | 65 |
| 1-km sub-grids | September 19 | 115 | -1213 | 94 | 98 |
| | September 25 | 131 | -1217 | 74 | 94 |
| | September 26 | 119 | -1185 | 94 | 66 |
| | September 27 | 131 | -1169 | 102 | 82 |
| | | 143 | -1081 | 98 | 66 |
| | October 5 | 127 | -1217 | 82 | 98 |

The 1-km sub-grids will be modeled using the CAMx flexi-nesting feature which allows arbitrarily introducing nested grids during the simulation.

The following $SO_2$ emissions for the Houston modeling region have been obtained from TCEQ:

- Hourly point source emissions derived from EPA's Acid Rain database (ARD)
- Other point source emissions from the ozone season emission data (OSD)
- Ship emissions (SHIP)
- Area source emissions (AREA)

No daily variation exists in the $SO_2$ emissions except for the ARD and AREA emissions. The Acid Rain database provides real-time emissions recorded by a continuous emission monitoring (CEM) system. For the anthropogenic area sources, three representative temporal allocations were applied to weekdays, Saturdays and Sundays. Table 2 lists domain-wide daily total $SO_2$ emissions for these source types.

**Table 2.** Domain-wide daily total $SO_2$ emissions (tons) for the selected modeling dates.

| Source Type | Sep 19 | Sep 25 | Sep 26 | Sep 27 | Oct 5 |
|---|---|---|---|---|---|
| ARD | 222 | 210 | 216 | 206 | 219 |
| OSD | 165 | 165 | 165 | 165 | 165 |
| SHIP | 80 | 80 | 80 | 80 | 80 |
| AREA | 52 | 52 | 52 | 52 | 52 |
| **Total** | **519** | **507** | **513** | **503** | **516** |

The team will be separately tracking three different $SO_2$ sources in the CAMx grid modeling: The Houston Ship Channel sources, all other sources within the 4-km modeling domain, and sources outside of the modeling domain (i.e., contribution through the boundary conditions).

Boundary concentrations of $SO_2$ and sulfate for the 4-km modeling domain were developed using the 2006 CAMx modeling of North America from the Air Quality Modeling Evaluation International Initiative (AQMEII) study.

To use the new $SO_2$ emission data that TCEQ recently developed, modeling grids were redefined using the national RPO map projection. This forced a change to the original plan of using the CAMx meteorological inputs developed for the 2006 HGB SIP modeling. TCEQ provided new WRF meteorological model outputs based on the national RPO map projection, but they need to be processed to generate CAMx model-ready met inputs. This, and an accident during the data transfer, caused a small delay in the project schedule. However, no change is expected on the project completion date.

All funds allocated to the project will be used upon the project completion.

| Project 13-016 | STATUS: Active – November 20, 2012 |
|---|---|

***Ozonesonde launches from the University of Houston and Smith Point, Texas in Support of DISCOVER AQ***

Valparaiso University – Gary Morris
University of Houston – Barry Lefer

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Dave Westenbarger

**Funding Amount:** $86,667
($66,821 Valparaiso, $19,846 UH)

**Executive Summary**

An intensive series of ozonesonde launches during DISCOVER AQ (September 2013) provides insight into the recirculation of ozone over Galveston and Trinity Bays. With potential operational launch sites at LaPorte, the University of Houston Main Campus, and Smith Point, the coordinated set of ozone profiles will permit us further insights into the importance of re-circulated ozone on exceedence events during the late Summer high ozone season in Houston, Texas.

**Project Update**

This report summarizes work on this project from the initiation of the contract through 31 May 2013. The investigators on this team developed a Work Plan, revised the Budget request as counseled, revised the Budget Justification accordingly, and developed a Quality Assurance Project Plan for this project. Program managers for the Air Quality Research Program (AQRP) at the University of Texas and at the Texas Commission on Environmental Quality (TCEQ) reviewed and approved these documents.

Once these documents had been approved, the investigators requested price quotes for the equipment and supplies necessary to fulfill the research objectives of this project, then ordered the supplies and equipment from the appropriate vendors. In particular, the project acquired the 2B Tech Model 205 surface ozone monitor, a portable but accurate instrument that allows us to validate our ozonesonde measurements prior to release of the balloons into the atmosphere. This instrument is especially valuable when ozonesondes are launched from sites without a nearby surface ozone monitor operated by TCEQ, the City of Houston, or the Environmental Protection Agency (EPA), as will likely be the case during the DISCOVER-AQ project for at least some ozonesonde releases. Investigators at Valparaiso University confirmed the quality of 2B Tech ozone readings by using an ozone generator, then sampling ozone at a variety of concentrations with the 2B Tech and an EPA standard instrument, the Thermo-Electron Corporation 49i Ozone Analyzer. The readings agreed with one another to within 1% over the range of ozone concentrations from 0 to >200 ppbv.

The investigators also ordered the supplies necessary for 30 ozonesonde releases in support of DISCOVER-AQ.  These instruments will be launched during the September 2013 period during which the measurement campaign will take place.

During this quarter, the lead investigator participated in site visits with NASA, TCEQ, and local staff to identify the best places for a variety of measurements, including ozonesonde releases, around the greater Houston region.

Finally, the lead investigator has also initiated conversations with the Federal Aviation Administration to secure permission for the ozonesonde releases at the desired sites around the greater Houston region.

**Project 12-018** **STATUS: Active – January 8, 2013**

***The Effects of Uncertainties in Fire Emissions Estimates on Predictions of Texas Air Quality***

University of Texas at Austin – Elena McDonald-Buller
ENVIRON International – Chris Emery

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Clint Harper

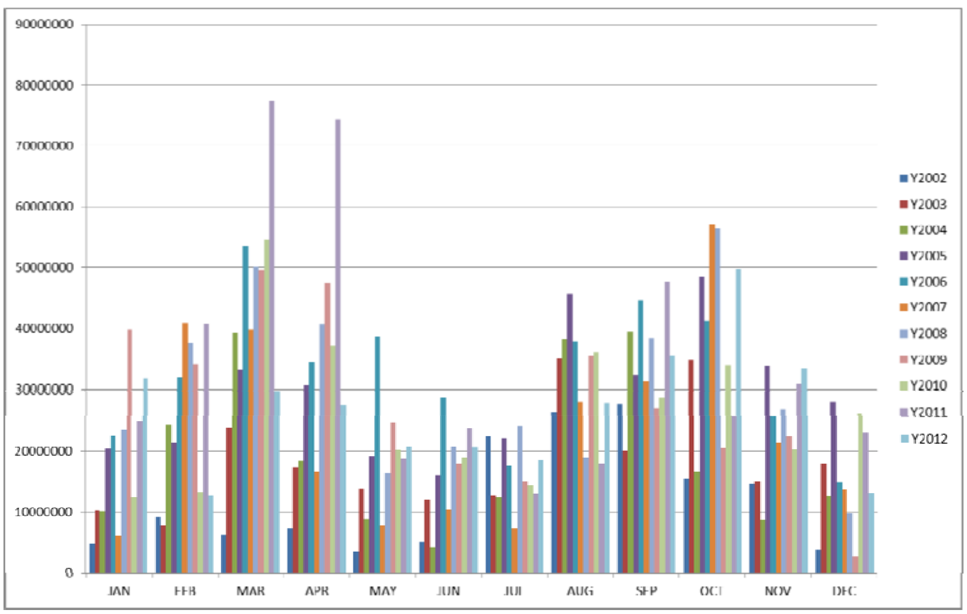
**Funding Amount:** $106,970
($85,282 UT Austin, $21,688 Environ)

**Executive Summary**
Wildland fires and open burning can be substantial sources of nitrogen oxides ($NO_x$), carbon monoxide (CO), and non-methane hydrocarbons (NMHCs), which are precursors to ozone formation, as well as particulate matter (PM), sulfur dioxide ($SO_2$), and ammonia ($NH_3$). Fire emissions are often transported over long distances and can contribute to exceedances of air quality standards at local and regional levels. Achieving attainment with the National Ambient Air Quality Standards (NAAQS) for ozone has been the primary focus of State Implementation Plans (SIPs) for Texas. Accurate characterization of fire events is necessary for understanding their influence on measured ambient concentrations, for providing a weight of evidence for exceptional event exclusions if necessary, and for conducting air quality modeling for planning and attainment demonstrations. In addition, if more stringent federal standards for ozone are considered in the future, emissions of its precursors from regional sources, such as fires in the Western U.S., Mexico, and Central America, that can contribute to background concentrations will become increasingly important for understanding the relative effectiveness of local and regional emissions control programs. This project examines the effects of uncertainties in fire emissions estimates on modeled ozone and particulate matter concentrations in Texas using the Fire INventory from NCAR (FINN) and the Comprehensive Air Quality Model with extensions (CAMx).

**Project Update**
The team focused work on four tasks this quarter: (1) development of a 10-year climatology of fires in Texas, its surrounding states, Mexico, and Central America; (2) a review of previous studies and relevant background literature to briefly describe current fire emissions estimation methods and input data sources, to examine applications of FINN emissions estimates in regional chemical transport models, and to identify new data resources and appropriate variations in input parameters for sensitivity analyses; (3) Base Case fire emissions modeling; and (4) transfer of the 2008 CAMx episode from ENVIRON to the University of Texas at Austin (UT).

An analysis of the 10-year climatology of fires in Texas, Mexico, 11 western states (New Mexico, Colorado, Wyoming, Montana, Idaho Washington, Oregon, California, Arizona, and Utah), and Central America (Guatemala, Belize Nicaragua, Costa Rica) using the default configuration of FINN has been completed. Predicted carbon monoxide (CO) emissions for 2002-2012 were used as a proxy for other emission estimates; results for Texas are shown below in Figure 1 as an example. Inter-annual variations in CO emissions are evident and may exceed a factor of two. Texas, Mexico, and Central America experienced relatively higher emissions in the spring and early fall of 2011 than in many other years. In Texas, emissions exhibit a bi-modal distribution with most activity during March-April and August-October. This temporal profile reflects the combination of prescribed burning, burning in agricultural areas, and wildfires. Typically, the emissions in the first half of the year are dominated by fires in grasslands and range lands/shrub lands. Emissions from forests in the state have been observed to increase in the summer and fall months.

**Figure 1.** The 10-year climatology of fire emissions, represented by predicted CO emissions (kg/month) from the FINN default configuration in Texas.




A review of previous studies and relevant background literature has been completed and documented in a working draft of the project report. The 2008 base case fire emissions modeling with the FINN default configuration has also been completed. Estimates of key fire emissions, e.g., CO, $NO_x$, volatile organic compounds (VOCs), and fine particulate matter ($PM_{2.5}$) are being summarized and will form the base case to which the sensitivity analyses will be compared. An EPS3 processing algorithm for FINN emissions has been developed and is currently being applied to obtain a fire emissions inventory in a suitable format for CAMx.

Transfer of the 2008 CAMx modeling database from ENVIRON/Alpine Geophysics to UT has been completed. UT installed the episode on the Lonestar 4 system at the Texas Advanced

Computing Center (TACC) and completed the simulation without issue. The original episode included fire emissions estimates from BlueSky/SMARTFIRE 2. Regional domain-wide (12-km) and state-level summaries of emissions of CO, $NO_x$, VOCs, and $PM_{2.5}$ from BlueSky/SMARTFIRE 2 have been provided in the working draft of the project report. Estimates from BlueSky/ SMARTFIRE 2 products are currently being compared to those from the FINN default configuration (i.e., base case) over the April - October 2008 episode. Because both emissions models are used for regional air quality model simulations in the U.S., it is valuable not only to compare their emissions estimates, but also their resulting impacts on simulated air quality.

At this time, all funds allocated to the project are intended to be used by 11/30/2013.

| Project 13-022 | STATUS: Active – January 29, 2013 |
|---|---|

***Surface Measurements of PM, VOCs, and Photochemically Relevant Gases in Support of DISCOVER-AQ***

Rice University – Robert Griffin
University of Houston – Barry Lefer

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Jocelyn Mellberg

**Funding Amount:** $206,815
($89,912 Rice,  $116,903 UH)

**Executive Summary:**
The City of Houston and Harris County have a long history of air quality issues because of their large population, extensive industrial activity, and sub-tropical climate. These issues predominantly have been manifested through ozone ($O_3$) mixing ratios that exceed the National Ambient Air Quality Standards (NAAQS) established by the United States Environmental Protection Agency (EPA). However, recent measurements indicate that Harris County levels for particulate matter (PM), specifically for particles with diameters less than or equal to 2.5 micrometers ($PM_{2.5}$), are very close to the relevant NAAQS.

In recent years, the National Aeronautics and Space Administration (NASA) has placed considerable emphasis on the use of satellite remote sensing in the measurement of species such as $O_3$ and PM that constitute air pollution. However, additional data are needed to aid in the development of methods to distinguish between low- and high-level pollution in these measurements. To that end, NASA has established a program titled Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ). DISCOVER-AQ began in summer 2011 with work in the Mid-Atlantic Coast that featured satellite, airborne, and ground-based sampling. The DISCOVER-AQ program will conduct operations in and near Houston in September 2013.

During the Houston operations of DISCOVER-AQ, there will be a need for ground-based measurement support. This project will fill that need by providing quantitative measurements of sub-micron particle size and composition and mixing ratios of volatile organic compounds (VOCs) and other photochemically relevant gases such as $O_3$ and oxides of nitrogen ($NO_x$ = nitric oxide (NO) plus nitrogen dioxide ($NO_2$)). The instrumentation for these measurements will be deployed using the University of Houston (UH) mobile laboratory.

The measurements made on the mobile laboratory generally will operate in two modes. First, during periods when DISCOVER-AQ flight patterns spiral over a given location, the mobile laboratory will operate at the ground surface beneath these spirals in a stationary mode in which surface air quality parameters are monitored continuously. Additional stationary mode measurements will be made at other locations of interest. When not in stationary mode, the mobile laboratory will be deployed to perform Lagrangian studies of air quality within plumes from major sources of primary pollutants, as well as downwind of the major metropolitan area, to characterize secondary processes at surface level.

**Project Update**

Over the period March 1 – May 31, 2013, the team for project 22 has been preparing for deployment of the air quality mobile laboratory during September 2013 (DISCOVER-AQ). This has included participation in DISCOVER-AQ planning meetings/conference calls on a bi-weekly basis, training of staff on instrumentation, construction and installation of mock instrumentation frames to ensure that the instrumentation will fit appropriately within the mobile laboratory, purchase of supplies, having team meetings/discussions regarding deployment driving patterns, and enhancing sheltered facilities on the University of Houston campus to allow for easy calibration of instrumentation while it is already loaded on the laboratory.

| Project 13-024 | STATUS: Active – February 20, 2013 |
|---|---|

***Surface Measurement of Trace Gases in Support of DISCOVER-AQ in Houston in Summer 2013***

University of Maryland – Xinrong Ren

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Erik Gribbon

**Funding Amount:** $90,444

**Executive Summary:**
The link between ozone ($O_3$) and $NO_X$ (= $NO + NO_2$) photochemistry has been extensively studied for decades, yet new discoveries have revealed the need to improve scientific understanding of ozone formation chemistry. In order to improve the interpretation of aircraft and satellite observations to diagnose near-surface conditions relating to air quality, high-quality surface observations of ozone and particulate matter (PM) precursors are needed, especially in urban environments like Houston. To support the NASA DISCOVER-AQ study in Houston in summer 2013, we will make surface measurements of trace gases, including $O_3$, $NO/NO_2/NO_Y$, and $SO_2$. Research-grade instrumentation to measure these traces gases will be deployed at two of the science sites identified by TCEQ/AQRP. These measurements will be compared to concurrent aircraft measurements for the periods when the NASA P-3B aircraft conducts spiral profiles over the sites. Vertical distributions of these gases will be observed and compared with surface observations with the aim of improving the capability of transport models for air quality simulations. Data collected in the field study will be analyzed with regard to the source regions and emission profiles, reactive nitrogen budget, and relationship between $NO_Z$ and $O_3$. Results from this project will be presented to AQRP/TCEQ and published in peer-reviewed journals. These activities will not only meet the program goals of DISCOVER-AQ, but will also strengthen our understanding of $O_3$ and PM formation in Houston, which is essential to meet the primary and secondary National Ambient Air Quality Standards for ozone and PM.

**Additional Information:**
During the period from March 1, 2013 to May 31, 2013, the teams at University of Maryland College Park and NOAA's Air Resources Laboratory have accomplished the following tasks:

(1) Selected two deployment sites in Houston during DISCOVER-AQ: Galveston and Manvel Croix, with the help from Barry Lefer at University of Houston, Vincent Torres and Jim Thomas at University of Texas, Raj Nadkarni at TCEQ, and James Crawford at NASA Langley. The team has sent instrument logistics information (space, power, and sampling location, etc.) to Vincent Torres and Raj Nadkarni.
(2) Secured the loan of the Cavity Ring-Down (CRD) $NO_2$ instrument from Russ Dickerson at University of Maryland, which will be deployed at the Manvel Croix site during DISCOVER-AQ. The instrument was calibrated initially in the lab based on the gas

phase titration (GPT). Excellent correlation coefficient was obtained during the calibration.

(3) Placed a few orders to prepare for the field deployment, including $SO_2/NO_2/NO$ gas mixture standards used to calibrate the instruments, the temperature controlled sample line (umbilical), a pump repair kit to refurbish the vacuum pump used for the $NO/NO_2/NO_Y$ system, and two air compressors for zero air generators.

(4) Finished the preparation of hardware and software for the data acquisition during the field deployment.

During the next quarter, the following tasks are anticipated to be accomplished:

(1) Test the $NO\text{-}NO_2\text{-}NO_Y$ system and the Cavity Ring-Down $NO_2$ analyzer side by side in the laboratory for calibration and ambient measurements to make sure that everything works for both instruments before the field deployment.

(2) Apply a few modifications to the $SO_2$ and ozone analyzers (including adding a serial output and repairing the mercury lamp heater for the ozone analyzer) before the field deployment.

(3) In late August, install instruments at the Galveston and Manvel Croix sites to make sure all instruments will be operational by the end of August.

**Project 10-028** **STATUS: Active – January 29, 2013**

***Implementation and evaluation of new HONO mechanisms in a 3-D Chemical Transport Model for Spring 2009 in Houston***

University of Houston – Barry Lefer
UCLA – Jochen Stutz
Environ – Greg Yarwood
UNC at Chapel Hill – Will Vizuette

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Doug Boyer

**Funding Amount:** $117,269
($19,599 UH, $17,944 UCLA, $44,496 Environ, $35,230 UNC)

**Executive Summary:**

Although portions of the chemistry that lead to the formation of ozone have been understood for decades, new discoveries have revealed the need to improve scientific understanding of ozone formation chemistry. Radical production in Houston and other urban areas appear to be underestimated by chemical mechanisms. The roles of some radical precursors such as HONO, HCHO, and reactive VOCs in ozone formation in Houston and other Texas cities have not been well understood. Research based on both modeling and field measurements by the University of Houston, ENVIRON, University of California – Los Angeles, and the University of North Carolina – Chapel Hill has shown that nitrous acid (HONO) significantly affects the HOx budget in urban environments like Houston. These chemical processes connect surface emissions, both anthropogenic and natural, to local and regional air quality.

From April 15th to May 30th, 2009, a team of more than 40 scientists representing more than 15 different institutions collected a relatively complete suite of atmospheric measurements, including NO, $NO_2$, $NO_Y$, HONO, $HNO_3$, $O_3$, CO, $SO_2$, HCHO, HOOH, OH, $HO_2$, OVOCs, VOCs, actinic flux, PBL height, $O_3$ production rates, and vertical profiles (nominally 40m, 150m, 300m) of $NO_2$, HONO, $O_3$, $SO_2$, and HCHO, during the Study of Houston Atmospheric Radical Precursor (SHARP). The SHARP dataset provides us a unique opportunity to examine and improve our understanding of atmospheric HONO formation processes and how they may be implemented into the Comprehensive Air quality Model with extensions (CAMx) 3-D chemical transport model commonly used for SIP evaluations. The objective of the study is to develop, implement, and evaluate missing pathways for HONO formation in a photochemical model, CAMx, that is used routinely for regulatory applications in Texas and other areas. This model update is expected to improve the model's ability to simulate ozone concentrations, because HONO is a potential daytime source of the hydroxyl radical, OH, which plays an important role in the ozone formation cycle. Measurements during the SHARP study in Houston showed that radical production in the early morning was dominated by HONO photolysis.

The modeling strategy is to take advantage of the SHARP data analysis in a previous AQRP project (Project 10-032) to develop parameterizations, based on current understanding of the important processes governing HONO formation, and implement and refine these parameterizations in CAMx using existing modeling databases for the Houston area during the SHARP period. Model performance evaluation will make use of process analysis tools to evaluate how HONO formation pathways influence radical budgets and ozone formation within CAMx simulations.

**Project Update**

The project team (UH, UCLA, UNC, and ENVIRON) made considerable progress on Task numbers 4a (Develop HONO parameterizations) and Task 4b (Initial HONO Implementation). The group has worked together to develop the framework for the new HONO production processes. The next major accomplishment was that ENVIRON team has rewritten the CAMx surface model to enable us to implement the following HONO processes into CAMx:

P1) Emission of "primary" HONO at a rate of 0.8% of NOx surface emissions.

P2a) Unimolecular conversion of $NO_2$ to HONO in the dark as a function of relative humidity.

P2b) Photoinduced conversion of $NO_2$ to HONO during the daytime.

P3) Empirical relationship between $NO_2$ and solar irradiance as determined by the UCLA group.

P4) Photolysis of surface $HNO_3$ to HONO.

At this point there are several caveats for each of these processes that are be explored in more detail . Regarding P1, surface NOx emissions were reduced by 0.8% to preserve the mass balance. The team was concerned that some of these were empirical relationships (e.g. P3) solved for the "missing" HONO, so simultaneous implementation of all of the new processes could generate too much HONO. There were two concerns regarding P4, first the team was unsure what photolysis frequency to use. Recent work suggests that *j*-$HNO_3$ or *j*-nitrate may be too low of a frequency and that using 10-30 times higher may be appropriate. The second concern regarding P4 involves how long the $HNO_3$ surface deposition should be allowed to accumulate on the ground surface in the model. As a starting point the group agreed to have an artificial "sink" or "decay" for surface $HNO_3$ that would prevent it from building up for more than three days.

This idea that surface $HNO_3$ accumulation could be important resulted to a new action item for the UH and UCLA groups before the next conference call. Specifically, these groups will look at the precipitation data during the 2009 SHARP project and examine the ambient HONO data to see if "cleansing" or "washing" of $HNO_3$ from the ground surface resulted in lower photolytic HONO production the subsequent day. Analysis of SHARP 2009 data revealed there is no evidence of a relationship between ambient surface HONO mixing ratios and time since the last rain event.

The UNC group has been providing the project team with modeling data to help in HONO parameterizations.  These new CAMx HONO parameterizations will work with CAMx 6.0 so the UNC has been working to install new source code and verify it is working properly.  The UNC group is also implementing a parallel version of CAMx on the UNC clusters which will provide them with the ability to re-run the simulation faster for analysis of results.

Recently, ENVIRON delivered to UNC gridded NOx emissons for both the base case and the "P1 - Primary HONO 0.8% of NOx" case in a format compatible with CAMx 6.0.

The project team is continuing to work on details to implement HONO projection processes P2a, P2b, P3, and P4.  Now that ENVIRON has finished the development of the revised CAMx land surface model, this should be accomplished in the next several weeks.

**Project 10-032** **STATUS: Active – January 25, 2013**

***Collect, Analyze, and Archive Filters at two DISCOVER-AQ Houston Focus Areas: Initial Characterization of PM Formation and Emission Environmental Chamber Experiments to Evaluate NOx Sinks and Recycling in Atmospheric Chemical Mechanisms***

Baylor University – Rebecca Sheesley

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Fernando Mercado

**Funding Amount:** $45,972

**Executive Summary:**

DISCOVER-AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality) is a multi-year air quality research study set to focus on Houston, TX in September 2013. NASA's P-3B and B200 aircraft will be deployed to sample vertical profiles over specific focus areas using a spiraling vertical profile flight plans for selected days during the one month sampling campaign. In this study, we will measure elemental carbon (EC), organic carbon (OC), and optical black carbon (BC) at two of these vertical spiral sites during the DISCOVER-AQ mission. Baylor University's research group will collect, analyze, and archive particulate filters collected concurrently with DISCOVER-AQ 2013 Houston-based sampling campaign. Specifically, we will continuously measure OC, EC and (BC at two surface sites on each day of the month that the NASA aircraft will be deployed. Collection will occur at two field stations located directly below aircraft focus areas (i.e. vertical profile sites). Results from the carbon measurements taken during the campaign will be disseminated to DISCOVER-AQ investigators and other external research groups. We will also archive particulate filters for future research opportunity. Access to these archived filters will be provided to DISCOVER-AQ investigators and external research groups.

Specific goals of this project are to:

1) Characterize OC and EC concentrations using fine particulate matter ($PM_{2.5}$) and total suspended particulate (TSP) air filter samples collected at two of DISCOVER-AQ Houston's focus areas.
    a. Focus areas include ground stations near Katy and H-NET Jones Forest.
    b. Archive filters for two years at -10°C for future research opportunities.
    c. Provide access of filters to DISCOVER-AQ project leadership and external research groups and collaborators.
2) Measure optical BC using a seven channel aethalometer at the H-NET Jones Forest ground station.
3) Compare ground-based OC, EC, and optical BC with other aerosol measurements made directly over focus areas on NASA's P-3B and B200 aircraft (i.e. water soluble organic carbon and BC).

**Project Update**

In the past three months, progress has been made in the planning and preparation for the September DISCOVER-AQ sampling campaign. PIs Sheesley and Usenko have participated in the field campaign conference calls led both by AQRP and by NASA. PI Sheesley also visited at the University of Houston to meet with fellow AQRP PIs Lefer, Griffin and Flynn to plan sampling at the Moody Tower and Manvel Croix ground sites. PIs Sheesley and Usenko have also been working directly with Vince Torres on mobile trailer site needs at Manvel Croix.

Field instrumentation preparation including filter substrate prep and aethalometer maintenance and testing are in process. In addition, we are finalizing collaborations with other AQRP funded and NASA DISCOVER-AQ collaborators: specifically focusing on sampling logistics and aerosol research. By reaching out to various AQRP and NASA collaborators we have succeeded in expanding the number of samplers at Manvel Croix and Moody Towers. This will:

a. Improves sampling logistics.

b. Increase sampling resolution: Improve coverage of events (i.e. pollution or fights).

c. Increases mass of particulates sampled.

d. Expands to opportunity of collaboration.

Do to the early stages of the project; there are no delays or issues to report. It is anticipated that all funds allocated to this project will be utilized by November 30th, 2013.

| Project 12-TN1 | STATUS: Active – February 21, 2013 |
|---|---|

***Investigation of surface layer parameterization of the WRF model and its impact on the observed nocturnal wind speed bias***

University of Maryland – Daniel Tong
Pius Lee

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Bright Dornblaser

**Funding Amount:** $64,994

**Executive Summary:**

This study investigates surface layer parameterizations in the Weather Research and Forecasting (WRF) model. The parameterization of energy fluxes from the surface layer significantly impacts the modeled near-surface winds. The WRF model tends to over-predict the surface wind speeds in eastern Texas in the evening hours, especially in coastal regions. This project examines the various similarity theories that parameterize the momentum fluxes of the surface layer used in the WRF meteorological model.

The investigation and possible remedy recommendation for rectifying the high wind-speed-bias is carried out in multiple steps: (A) Understand the sensitivities of the different surface layer schemes, (B) Examine the sensitivity of the flux-profile relationships with regards to synoptic and atmospheric stability conditions, and (C) Investigate the universal flux profile functions and the range of parameter values used by the functions to suggest potential modifications for improvement – especially for the stable regimes. These details of the surface layer schemes are important as they govern the correct timing of the decoupling of near-surface and surface phenomena which are critical in the redistribution of kinetic energy from the residual layer to the surface. The rate of transfer of energy affects the evolution of wind speeds in the lowest layers.

A series of sensitivity runs of the WRF model is devised and conducted with possible recommendation on adjusted values for several of the tunable constants in the surface layer similarity theory parameterizations. Although the runs will focus on an early summer period for the Houston-Galveston-Brazoria area, they should provide insight on the rate and strength of the coupling and decoupling between the surface layer and the lowest model level in a large range of land-use and meteorological conditions.

**Project Update**

In this first phase of the project a literature survey on surface layer theories and their parameterization schemes in the WRF model have been conducted aiming to identify parameters sensitive to the rate of surface layer momentum and heat fluxes.

1. Surface Layer Scheme provides lower boundary conditions to PBL schemes

The literature survey focused on four sets of surface similarity scheme and Planetary Boundary Layer (PBL) scheme pairs provided in meteorological model WRF-ARW version 3.4 due to their relevance to the previous and current TCEQ projects on model wind bias studies: (1) The fifth-generation Pennsylvania State University—National Center for Atmospheric Research Mesoscale Model (MM5) surface layer similarity scheme (Zhang and Anthes 1982) with the Yonsei University (YSU) PBL scheme, (2) The Pleim-Xiu (PX) surface similarity scheme (Pleim 2006) with the Asymmetric Convective Model version 2 (ACM2) PBL scheme (Pleim 2007), (3) The MM5 surface layer similarity scheme with ACM2 PBL scheme, and (4) the Eta surface layer similarity (Janjic 1990) with the Mellor-Yamada-Janjic (MYJ) PBL scheme (Janjic 2001).

2. NCAR's MM5 surface layer similarity scheme with the YSU PBL scheme

In the YSU PBL scheme, there are four variables that are directly linked to parameters used in the MM5 surface similarity scheme: (1) gradient adjustment terms $\gamma_c$ that account for non-local mixing of PBL (Eq. 2 in Shin and Hong 2011), (2) the temperature excess term $\theta_T$ due to surface buoyance flux and the temperature at $z_1$, (Eq. A12 in Hong et al., 2006) (3) vertical diffusivities, $Kc$ , proportional to the mixed layer velocity scale $w_s$, and (4) the non-dimensional stability function $\phi_m$ (Eqs. A5 and A6 in Hong et al., 2006). These variables among others will be further investigated in the remainder of the study with the WRF modified to output them in rapid frequencies either in its final forms or intermediate forms during their numerical derivations.

| **Project 12-TN2** | **STATUS: Active – February 21, 2013** |
|---|---|

***Development of IDL-based geospatial data processing framework for meteorology and air quality modeling***

| | |
|---|---|
| University of Maryland – Daniel Tong | AQRP Project Manager – Gary McGaughey |
| HyunCheol Kim | TCEQ Project Liaison – Bright Dornblaser |

**Funding Amount:** $69,985

**Executive Summary:**

This project investigates basic computational algorithms to handle Geographic Information System (GIS) data and satellite data, which are essential in regional meteorological and chemical modeling. It develops a set of generalized libraries within a geospatial data processing framework aiming to process geospatial data more efficiently and accurately. The tool can process GIS data both in vector format (e.g., ESRI shapefiles) and raster format (e.g., GEOTIFF and IMG) for any given domain. Processing speeds will be improved through selective usages of polygon-clipping routines and other algorithms optimized for specific applications. The raster tool will be developed utilizing a histogram reverse-indexing method that enables easy access of grouped pixels. It generates statistics of pixel values within each grid cell with improved speed and enhanced control of memory usage. Spatial allocating tools that use polygon clipping algorithms require huge computational power to calculate fractional weighting between GIS polygons (and/or polylines) and gridded cells. To overcome the speed and computational accuracy deterioration issues, an efficient polygon/polyline clipping algorithm is crucial. A key for faster spatial allocation is to optimize computational iterations in both polygon clipping and map projection calculations.

The project has the following specific objectives: (A) To develop an optimized geospatial data processing tool that can handle raster data format and vector data format with enhanced processing time and accuracy, for any given target domain. (B) To collect and to process sample GIS and satellite data. Applications will include a spatial regridding method for emissions and satellite data, such as the Moderate Resolution Imaging Spectroradiometer (MODIS) Aerosol Optical Depth (AOD), the Ozone Monitoring Instrument (OMI), and the Global Ozone Monitoring Experiment (GOME)-2 $NO_2$ column data. (C) To perform an engineering test with processed fine resolution LULC data.

**Project Update**

During the period, Mar. 1 ~ May 31, 2013, the team has focused on the investigation of polygon (e.g. vector) processing algorithms and their implementation as IDL libraries.

1. Basic polygon clipping algorithms

A literature review was started for basic polygon clipping algorithms. The Sutherland-Hodgman polygon clipping algorithm, introduced first in 1974, is one of well known polygon clipping algorithm. It works by extending each line of the convex clip polygon in turn and selecting only vertices from the subject polygon that lies on the visible side. The algorithm begins with an input list of all vertices in the subject polygon, and one side of the clip polygon is extended infinitely in both directions, and the path of the subject polygon is traversed. Vertices from the input list are inserted into an output list if they lie on the visible side of the extended clip polygon line, and new vertices are added to the output list where the subject polygon path crosses the extended clip polygon line. This process is repeated iteratively for each clip polygon side, using the output list from one stage as the input list for the next. Once all sides of the clip polygon have been processed, the final generated list of vertices defines a new single polygon that is entirely visible.

2. Spatial regridding algorithms

The team has also developed two algorithms for spatial data regridding. Spatial regridding is a commonly performed procedure in satellite data processing. It converts a data set between different map projections and resolutions. Among numerous spatial regridding methods, interpolation and pixel aggregation are two of the most common methods. Interpolation is preferred when the target domain resolution is finer than the raw data pixels, on the other hand, pixel aggregation is the preferred way to average all the pixels inside each domain cell when the grid cell size is bigger than the raw data pixel size. Despite their popularity, the need for more mathematically complete method for spatial regridding has been raised, especially in dealing with fine resolution data and/or where conservation of measured quantity is required. A case in point is processing emission data. It requires great caution on spatial data handling because mass conservation is strictly applied. EPA's spatial allocator used in their Sparse Matrix Operator Kernel Emissions (SMOKE) processing, is one of the examples to handle emission data without a loss of emission quantity. It calculates fractional areas of overlapping polygons between raw data pixels and modeling grid cells. In order to build a lossless spatial regridding tool, the team utilized polygon clipping algorithms, and developed a tool to perform accurate spatial regridding of satellite data. Two key algorithms for the regridding tool are developed and implemented: "Conservative remapping" algorithm performs lossless spatial remapping, and "Downscaling" algorithm is designed to generate fine structure out of coarse resolution input data (e.g. satellite pixels), with additional information from fine resolution data set (e.g. fine resolution model simulation).

## FINANCIAL STATUS REPORT

Initial funding for fiscal year 2010 was established at $2,732,071.00. In late May 2010 an amendment was issued increasing the budget by $40,000. Funding for fiscal year 2011 was established at $2,106,071, for a total award of $4,878,142 for the FY 2010/2011 biennium.

In February 2012, funding of $1,000,000 was awarded for FY 2012. In June 2012, an additional $160,000 was awarded in FY 2012 funds and $1,000,000 was awarded in FY 2013 funds, for a total of $2,160,000 in funding for the FY 2012/2013 biennium.

In April 2013, the grant was amended to reduce the FY 2012 funds by $133,693.60 and increase the FY 2011 funds by the same amount.

As of May 31, 2013, $100,376.31 remains unspent. Of these funds, $100,202.37 are contractual/research funds. $20,168.90 will be used to partially support Project 13-016 and the remaining funds will be used to partially support project 13-004. It is expected that these funds will be fully expended by June 30, 2013. The non-contractual/research funds that are currently unspent will be used to purchase supplies for the Project Managers and will be fully expended by the end of June 2013.

All of these funds were distributed across several different reporting categories as required under the contract with TCEQ. The reporting categories are:

Program Administration – limited to 10% of the overall funding (per Fiscal Year)
This category includes all staffing, materials and supplies, and equipment needed to administer the overall AQRP. It also includes the costs for the Council meetings.

ITAC
These funds are to cover the costs, largely travel expenses, for the ITAC meetings.

Project Management – limited to 8.5% of the funds allocated for Research Projects
Each research project will be assigned a Project Manager to ensure that project objectives are achieved in a timely manner and that effective communication is maintained among investigators in multi-institution projects. These funds are to support the staffing and performance of project management.

Research Projects / Contractual
These are the funds available to support the research projects that are selected for funding.

### Program Administration

Program Administration includes salaries and fringe benefits for those overseeing the program as a whole, as well as, materials and supplies, travel, equipment, and other expenses. This category allows indirect costs in the amount of 10% of salaries and wages.

During the reporting period several staff members were involved, part time, in the administration of the AQRP. Dr. David Allen, Principal Investigator and AQRP Director, is responsible for the overall administration of the AQRP. James Thomas, AQRP Manager, is responsible for assisting Dr. Allen in the program administration. Maria Stanzione, AQRP Grant Manager, with assistance from Rachael Bushn, Melanie Allbritton, and Susan McCoy each provided assistance with program organization and financial management. This included assisting with the contracting process. Denzil Smith is responsible for the AQRP Web Page development and for data management.

Fringe benefits for the administration of the AQRP were initially budgeted to be 22% of salaries and wages across the term of the project. It should be noted that this was an estimate, and actual fringe benefit expenses have been reported for each month. The fringe benefit amount and percentage fluctuate each month depending on the individuals being paid from the account, their salary, their FTE percentage, the selected benefit package, and other variables. For example, the amount of fringe benefits is greater for a person with family medical insurance versus a person with individual medical insurance. At the end of the project, the overall total of fringe benefit expensed is expected to be at or below 22% of the total salaries and wages. Actual fringe benefit expenses to date are included in the spreadsheets above.

As discussed in previous Quarterly Reports, the AQRP Administration requested and received permission to utilize funds in future fiscal years. This is for all classes of funds including Administration, ITAC, Project Management, and Contractual. As of the writing of this report, the FY 10 funds have been fully expended. The intent is to fully expend the FY 11 funds, by June 2013. This same procedure will be followed for the FY 12 funds.

In June 2011, UT-Austin received a Contract Extension for the AQRP. This extension will continue the program through December 29, 2013.

Table 1: AQRP Administration Budget

**Administration Budget (includes Council Expenses)**
**FY 2010/2011**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Budget Category** | | **FY10 Budget** | **FY11 Budget** | **Total** | **Expenses** | **Pending Expenses** | **Remaining Balance** |
| | | | | | | | |
| Personnel/Salary | | $202,816.67 | $173,520.24 | $376,36.91 | $375,518.73 | $0 | $818.18 |
| Fringe Benefits | | $38,665.65 | $33,902.95 | $71,765.34 | $72,568.60 | $0 | ($803.26) |
| Travel | | $346.85 | $0 | $346.85 | $346.85 | | $0 |
| Supplies | | $15,096.14 | $4.51 | $15,100.65 | $15,100.65 | $96.73 | ($96.73) |
| Equipment | | $0 | $0 | $0 | | | $0 |
| | | | | | | | |
| Total Direct Costs | | $256,925.31 | $206,624.44 | $463,549.75 | $463,534.83 | $0 | ($81.81) |
| | | | | | | | |
| Authorized Indirect Costs | | $20,281.69 | $17,352.02 | $37,663.71 | $37,550.09 | | $81.81 |
| 10% of Salaries and Wages | | | | | | | |
| **Total Costs** | | **$277,207** | **$223,976.46** | **$501,183.46** | **$501,084.92** | **$0** | **$0** |
| | | | | | | | |
| Fringe Rate | | 22% | 22% | | 19% | | |

**Administration Budget (includes Council Expenses)**
**FY 2012/2013**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Budget Category** | | **FY12 Budget** | **FY13 Budget** | **Total** | **Expenses** | **Pending Expenses** | **Remaining Balance** |
| | | | | | | | |
| Personnel/Salary | | $68,340.00 | $70,040 | $138,380.00 | $58,325.82 | $0.00 | $80,054.18 |
| Fringe Benefits | | $14,606.64 | $12,606 | $27,212.64 | $13,367.77 | $0.00 | $13,844.87 |
| Travel | | $2,850.00 | $350 | $3,200.00 | $339.13 | | $2,860.87 |
| Supplies | | $10,000.00 | $10,000 | $20,000.00 | $1,496.72 | $0.00 | $18,503.28 |
| Equipment | | $0.00 | $0 | $0 | | | $0 |
| | | | | | | | |
| Total Direct Costs | | $95,796.64 | $92,996 | $188,792.64 | $73,529.44 | $0.00 | $115,263.20 |
| | | | | | | | |
| Authorized Indirect Costs | | $6,834.00 | $7,004 | $13,838.00 | $5,832.58 | $0.00 | $8,005.42 |
| 10% of Salaries and Wages | | | | | | | |
| **Total Costs** | | **$102,630.64** | **$100,000** | **$202,630.64** | **$79,362.02** | **$0.00** | **$123,268.62** |
| | | | | | | | |
| Fringe Rate | | 22% | 22% | | 23% | | |

## ITAC

No ITAC activities occurred in the quarter being reported. Travel expenses in the amount of $2803.33 for Jim Thomas and Vince Torres were charged to the FY 2012 ITAC account until the account for the Discover AQ Infrastructure Project was set up. These charges will be removed from the ITAC account in June 2013 and charged to the correct account.

Table 2: ITAC Budget

**ITAC Budget**
**FY 2010/2011**

| Budget Category | | FY10 Budget | FY11 Budget | Total Budget | Expenses | Pending Expenses | Remaining Balance |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Personnel/Salary | | | | | | | |
| Fringe Benefits | | | | | | | |
| Travel | | $16,378.86 | $6,292.97 | $22,671.83 | $22,671.83 | $0.00 | $0 |
| Supplies | | $1,039.95 | $284.67 | $1,324.62 | $1,324.62 | $0.00 | 0 |
| | | | | | | | |
| Total Direct Costs | | $17,418.81 | $6,577.64 | $23,996.45 | $23,996.45 | $0.00 | $0 |
| | | | | | | | |
| Authorized Indirect Costs | | | | | | | |
| 10% of Salaries and Wages | | | | | | | |
| **Total Costs** | | **$17,418.81** | **$6,577.64** | **$23,996.45** | **$23,996.45** | **$0.00** | **$0** |

**ITAC Budget**
**FY 2012/2013**

| Budget Category | | FY12 Budget | FY13 Budget | Total Budget | Expenses | Pending Expenses | Remaining Balance |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Personnel/Salary | | | | | | | |
| Fringe Benefits | | | | | | | |
| Travel | | $10,000 | $0 | $10,000 | $2,803.33 | $0 | $7,196.67 |
| Supplies | | $500 | $0 | $500 | $0 | | $500 |
| | | | | | | | |
| Total Direct Costs | | $10,500 | $0 | $10,500 | $2,803.33 | $0 | $7,696.67 |
| | | | | | | | |
| Authorized Indirect Costs | | | | | | | |
| 10% of Salaries and Wages | | | | | | | |
| **Total Costs** | | **$10,500** | **$0** | **$10,500** | **$2,803.33** | **$0** | **$7,696.67** |

## Project Management

In August 2012, Project Managers were assigned to the FY 2012-2013 Research Projects. During the quarter ending May 31, 2013, Project Managers continued to work with Investigators to develop and finalize the Project Work Plans (Scope of Work, Budget, and QAPP). As projects transitioned into Active status, they made sure Investigators had all reporting templates and met reporting deadlines.

Table 3: Project Management Budget

**Project Management Budget**
**FY 2010/2011**

| Budget Category | | FY10 Budget | FY11 Budget | Total Budget | Expenses | Pending Expenses | Remaining Balance |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Personnel/Salary | | $145,337.70 | $121,336.64 | $266,674.34 | $266,663.34 | $0 | $11.00 |
| Fringe Benefits | | $28,967.49 | $23,090.56 | $52,058.05 | $52,070.09 | $0 | ($12.04) |
| Travel | | $0 | $0 | $0 | $0 | | $0 |
| Supplies | | $778.30 | $209.02 | $987.32 | $911.98 | $75.40 | ($0.06) |
| | | | | | | | |
| Total Direct Costs | | $175,083.49 | $144,636.22 | $319,719.71 | $319,645.41 | $0 | ($1.10) |
| | | | | | | | |
| Authorized Indirect Costs | | $14,533.77 | $12,133.66 | $26,667.43 | $26,666.33 | $0 | $1.10 |
| 10% of Salaries and Wages | | | | | | | |
| **Total Costs** | | **$189,617.26** | **$156,769.88** | **$346,387.14** | **$346,311.74** | **$0** | **$0.00** |

**Project Management Budget**
**FY 2012/2013**

| Budget Category | | FY12 Budget | FY13 Budget | Total Budget | Expenses | Pending Expenses | Remaining Balance |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Personnel/Salary | | $48,900.00 | $46,000 | $94,900.00 | $28,565.54 | $0.00 | $66,334.46 |
| Fringe Benefits | | $9,106.00 | $8,400 | $17,506.00 | $5,833.93 | $0.00 | $11,672.07 |
| Travel | | $500 | $0 | $500.00 | $0.00 | | $500.00 |
| Supplies | | $7,279.76 | $6,000 | $13,279.76 | $752.03 | | $12,527.73 |
| | | | | | | | |
| Total Direct Costs | | $65,785.76 | $60,400 | $126,185.76 | $35,151.50 | $0.00 | $91,034.26 |
| | | | | | | | |
| Authorized Indirect Costs | | $4,890.00 | $4,600 | $9,490.00 | $2,856.55 | $0.00 | $6,633.45 |
| 10% of Salaries and Wages | | | | | | | |
| **Total Costs** | | **$70,675.76** | **$65,000** | **$135,675.76** | **$38,008.05** | **$0.00** | **$97,667.71** |

**Research Projects**

Table 4 on the following 2 pages illustrates the 2010-2011 Research Projects, including the funding awarded to each project and the total expenses reported on each project as of May 31, 2013.

As of the end of May there was $100,202.37 of FY 2011 funding available in Research Projects. This funding has been allocated to project 13-016 Valparaiso and project 13-004 Discover AQ Infrastructure. Valparaiso has utilized their funds ($20,168.90) to purchase supplies in preparation for their summer research activities. The invoice will be paid in June 2013. FY 2011 funds in the amount of $116,000 (of $289,200) were allocated to project 13-004 Discover AQ Infrastructure. The remaining FY 2011 funds are expected to be fully expended by June 30, 2013.

The FY 10 Research/Contractual budget was originally funded at $2,286,000. After all transfers, it has been increased by $1,827.93. The FY 11 Research/Contractual budget was originally funded at $1,736,063. After all transfers, it has been increased by $377.62, plus an additional $116,000 from FY12 funds that were changed to FY 11 funds. This is an overall net increase of $13,205.55 to the Research/Contractual funds (and net reduction in Project Management/ITAC funds). ($105,000 in FY 2012 research funds were transferred to FY 2011, the remaining $11,000 were transfers from Project Management funds.)

Table 5 illustrates the 2012-2013 Research Projects, including the funding awarded to each project and the total expenses reported on each project as of May 31, 2013.

Table 4: 2010/2011 Contractual Expenses

## Contractual Expenses

| | | | | |
|---|---|---|---|---|
| **FY 10 Contractual Funding** | | **$2,286,000** | | |
| **FY 10 Contractual Funding Transfers** | | $1,827.93 | | |
| **FY 10 Total Contractual Funding** | | **$2,287,827.93** | | |
| Project Number | | Amount Awarded (Budget) | Cumulative Expenditures | Remaining Balance |
| 10-008 | Rice University | $128,851 | $126,622.32 | $2,228.68 |
| 10-008 | Environ International | $49,945 | $49,944.78 | $0.22 |
| 10-009 | UT-Austin | $591,332 | $591,306.66 | $25.34 |
| 10-021 | UT-Austin | $248,786 | $248,786.41 | -$0.41 |
| 10-022 | Lamar University | $150,000 | $132,790.80 | $17,209.20 |
| 10-032 | University of Houston | $176,314 | $176,314 | $0 |
| 10-032 | University of New Hampshire | $23,054 | $18,850.65 | $4,203.35 |
| 10-032 | UCLA | $49,284 | $47,171.32 | $2,112.68 |
| 10-034 | University of Houston | $195,054 | $186,657.54 | $8,396.46 |
| 10-042 | Environ International | $237,481 | $237,479.31 | $1.69 |
| 10-045 | UCLA | $149,773 | $142,930.28 | $6,842.72 |
| 10-045 | UNC - Chapel Hill | $33,281 | $33,281 | $0 |
| 10-045 | Aerodyne Research Inc. | $164,988 | $164,988.10 | -$0.10 |
| 10-045 | Washington State University | $50,000 | $50,000 | $0 |
| 10-DFW | UT-Austin | $37,857 | $37,689.42 | $167.58 |
| FY 10 Total Contractual Funding Awarded | | $2,286,000 | | |
| FY 10 Contractual Funding Expended (Init. Projects) | | | $2,244,812.59 | |
| FY 10 Contractual Funds Remaining Unspent after Project Completion | | | | $41,187.41 |
| FY 10 Additional Projects | | | | |
| | Data Storage | $7,015.34 | $7,015.34 | $0 |
| 10-SOS | State of the Science | $36,000.00 | $36,000.00 | $0 |
| FY 10 Contractual Funds Expended to Date* | | | $2,287,827.93 | |
| FY 10 Contractual Funds Remaining to be Spent | | | | $0 |

| | | | | |
|---|---|---|---|---|
| **FY 11 Contractual Funding** | | $1,736,063.00 | | |
| **FY 11 Contractual Funding Transfers** | | $116,377.62 | | |
| **FY 11 Total Contractual Funding** | | **$1,852,440.62** | | |
| Project Number | | Amount Awarded (Budget) | Cumulative Expenditures | Remaining Balance |
| 10-006 | Chalmers University of Tech | $262,179 | $262,179 | $0 |
| 10-006 | University of Houston | $222,483 | $217,949.11 | $4,533.89 |
| 10-015 | Environ International | $201,280 | $201,278.63 | $1.37 |
| 10-020 | Environ International | $202,498 | $202,493.48 | $4.52 |
| 10-024 | Rice University | $225,662 | $223,769.99 | $1,892.01 |
| 10-024 | University of New Hampshire | $70,747 | $70,719.78 | $27.22 |
| 10-024 | University of Michigan | $64,414 | $60,597.51 | $3,816.49 |
| 10-024 | University of Houston | $98,134 | $88,914.46 | $9,219.54 |
| 10-029 | Texas A&M University | $80,108 | $78,276.97 | $1,831.03 |
| 10-044 | University of Houston | $279,642 | $277,846.38 | $1,795.62 |
| 11-DFW | UT-Austin | $50,952 | $29,261.75 | $21,690.25 |
| FY 11 Total Contractual Funding Awarded | | $1,758,099 | | |
| FY 11 Contractual Funds Expended (Init. Projects) | | | $1,713,287.06 | |
| FY 11 Contractual Funds Remaining Unspent after Project Completion | | | | $44,811.94 |
| FY 11 Additional Projects | | | | |
| | Data Storage | $2,984.66 | $2,984.66 | $0.00 |
| | 12-016 Valparaiso | $20,168.90 | $0.00 | $21,168.90 |
| | 12-004 Discover AQ Infrastructure | $116,000.00 | $35,966.53 | $80,033.47 |
| FY 11 Contractual Funds Expended to Date* | | | $1,52,238.25 | |
| FY 11 Contractual Funds Remaining to be Spent | | | | $100,202.37 |
| Total Contractual Funding | | $4,022,063.00 | | |
| Total Contractual Funding Transfers | | $118,205.55 | | |
| Total Contractual Funding Available | | $4,140,268.55 | | |
| Total Contractual Funds Expended to Date* | | | $4,040,066.18 | |
| Total Contractual Funds Remaining | | | | $100,202.37 |

*(Expenditures Reported as of May 31, 2103.)

Table 5. 2012/2013 Contractual Expenses

## Contractual Expenses

| | |
|---|---|
| **FY 12 Contractual Funding** | $815,000 |
| **FY 12 Contractual Funding Transfers** | $27,500 |
| **FY 12 Total Contractual Funding** | **$842,500** |

| Project Number | | Amount Awarded (Budget) | Cumulative Expenditures | Remaining Balance |
|---|---|---|---|---|
| 12-004 | UT-Austin (Torres) | $4,820 | | $4,820.00 |
| 12-006 | UC-Riverside | $101,765 | $13,224.86 | $88,540.14 |
| 12-006 | TAMU/TEES | $44,494 | | $44,494.00 |
| 12-011 | Environ International | $77,420 | $28,265.35 | $49,154.65 |
| 12-012 | UT-Austin (Hildebrandt) | $79,463 | $23,877.10 | $55,585.90 |
| 12-012 | Environ International | $69,374 | $5.077.64 | $64,296.36 |
| 12-013 | Environ International | $59,974 | $24,198.15 | $35,775.85 |
| 12-018 | UT-Austin (McDonald-Buller) | $85,282 | $16,557.03 | $68,724.97 |
| 12-018 | Environ International | $21,688 | $1,023.10 | $20,664.90 |
| 12-028 | University of Houston | $19,599 | | $19,599.00 |
| 12-028 | UCLA | $17,944 | | $17,944.00 |
| 12-028 | Environ International | $44,496 | $8,184.54 | $36,311.46 |
| 12-028 | UNC - Chapel Hill | $35,230 | $1,181.13 | $34,048.87 |
| 12-032 | Baylor | $45,972 | | $45,972.00 |
| 12-TN1 | Maryland | $64,994 | | $64,994.00 |
| 12-TN2 | Maryland | $69,985 | | $69,985.00 |
| | | | | |
| FY 12 Total Contractual Funding Awarded | | $565,706 | | |
| FY 12 Contractual Funds Remaining to be Awarded | | $0 | | |
| FY 12 Contractual Funds Expended to Date | | | $121,589 | |
| FY 12 Contractual Funds Remaining to be Spent | | | | $693,411 |

| | | | | |
|---|---|---|---|---|
| **FY 13 Contractual Funding** | | $835,000 | | |
| **FY 13 Contractual Funding Transfers** | | $0 | | |
| **FY 13 Total Contractual Funding** | | **$835,000** | | |
| Project Number | | Amount Awarded (Budget) | Cumulative Expenditures | Remaining Balance |
| 13-004 | UT-Austin (Torres) | | | $0.00 |
| 13-005 | Chalmers University of Tech | $129,047 | | $129,047.00 |
| 13-005 | University of Houston | $48,506 | | $48,506.00 |
| 13-016 | Valparaiso | $46,652 | | $46,652.10 |
| 13-016 | University of Houston | $19,846 | | $19,846.00 |
| 13-022 | Rice University | $89,912 | $471.41 | $89,440.59 |
| 13-022 | University of Houston | $116,903 | $22,536.81 | $94,366.19 |
| 13-024 | Maryland | $90,444 | $10,294.72 | $80,149.28 |
| | | | | |
| FY 13 Total Contractual Funding Awarded | | $541,310 | | |
| FY 13 Contractual Funding Remaining to be Awarded | | $293,690 | | |
| FY 13 Contractual Funds Expended to Date | | | $33,303 | |
| FY 13 Contractual Funds Remaining to be Spent | | | | $801,697 |
| | | | | |
| Total Contractual Funding | | $1,677,500 | | |
| Total Contractual Funding Awarded | | $1,383,810 | | |
| Total Contractual Funding Remaining to be Awarded | | $293,690 | | |
| Total Contractual Funds Expended to Date | | | $154,892 | |
| Total Contractual Funds Remaining to be Spent | | | | $1,495,108 |

# Appendix A

## Financial Reports by Fiscal Year

## FY 10 and 11

(Expenditures reported as of May 31, 2013.)

**Administration Budget (includes Council Expenses)**

**FY 2010**

| Budget Category | | FY10 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| Personnel/Salary | | $202,816.67 | $202,816.67 | | $0 |
| Fringe Benefits | | $38,665.65 | $38,665.65 | | $0 |
| Travel | | $346.85 | $346.85 | | $0 |
| Supplies | | $15,096.14 | $15,096.14 | | $0 |
| Equipment | | $0 | | | $0 |
| Other | | | | | |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $256,925.31 | $256,925.31 | | $0 |
| | | | | | |
| Authorized Indirect Costs | | $20,281.69 | $20,281.69 | | $0 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$277,207** | **$277,207.00** | **$0** | **$0** |

**Administration Budget (includes Council Expenses)**

**FY 2011**

| Budget Category | | FY11 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| Personnel/Salary | | $173,520.24 | $172,702.06 | $0 | $818.18 |
| Fringe Benefits | | $33,099.69 | $33,902.95 | $0 | ($803.26) |
| Travel | | $0 | | | $0 |
| Supplies | | $4.51 | $4.51 | $96.73 | ($96.73) |
| Equipment | | | | | |
| Other | | $0 | | | $0 |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $206,624.44 | $206,609.52 | $96.73 | ($81.81) |
| | | | | | |
| Authorized Indirect Costs | | $17,352.02 | $17,268.40 | $1.81 | $81.81 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$223,976.46** | **$223,877.92** | **$98.54** | **$0** |

**ITAC Budget**

**FY 2010**

| Budget Category | | FY10 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | | | | |
| Fringe Benefits | | | | | |
| Travel | | $16,378.86 | $16,378.86 | $0 | $0 |
| Supplies | | $1039.95 | $1,039.95 | | $0 |
| Equipment | | | | | |
| Other | | | | | |
| | | | | | |
| Total Direct Costs | | $17,418.81 | $17,418.81 | $0 | $0 |
| | | | | | |
| Authorized Indirect Costs | | | | | |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$17,418.81** | **$17,418.81** | **$0** | **$0** |

**ITAC Budget**

**FY 2011**

| Budget Category | | FY11 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | | | | |
| Fringe Benefits | | | | | |
| Travel | | $6,292.97 | $6,292.97 | $0.00 | $0 |
| Supplies | | $284.67 | $284.67 | $0.00 | $0 |
| Equipment | | | | | |
| Other | | | | | |
| | | | | | |
| Total Direct Costs | | $6,577.64 | $6,577.64 | $0.00 | $0 |
| | | | | | |
| Authorized Indirect Costs | | | | | |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$6,577.64** | **$6,577.64** | **$0.00** | **$0** |

**Project Management Budget**

**FY 2010**

| Budget Category | | FY10 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $145,337.70 | $145,337.70 | | $0 |
| Fringe Benefits | | $28,967.49 | $28,967.49 | | $0 |
| Travel | | $0 | $0 | | $0 |
| Supplies | | $778.30 | $778.30 | | $0 |
| Equipment | | | | | |
| Other | | | | | |
| | | | | | |
| Total Direct Costs | | $175,083.49 | $175,083.49 | $0 | $0 |
| | | | | | |
| Authorized Indirect Costs | | $14,533.77 | $14,533.77 | | $0 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$189,617.26** | **$189,617.26** | **$0** | **$0** |

**Project Management Budget**

**FY 2011**

| Budget Category | | FY11 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $121,336.64 | $121,325.64 | $0 | $11.00 |
| Fringe Benefits | | $23,090.56 | $23,102.60 | $0 | ($12.04) |
| Travel | | $0 | | | $0 |
| Supplies | | $209.02 | $133.68 | $75.40 | ($0.06) |
| Equipment | | | | | |
| Other | | | | | |
| | | | | | |
| Total Direct Costs | | $144,636.22 | $144,561.92 | $75.40 | ($1.10) |
| | | | | | |
| Authorized Indirect Costs | | $12,133.66 | $12,132.56 | $0 | $1.10 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$156,769.88** | **$156,694.48** | **$75.40** | **$0.00** |

**AQRP Budget**

**FY 2010**

| | | | | | |
|---|---|---|---|---|---|
| **Budget Category** | | **FY10 Budget** | **Cumulative Expenditures** | **Pending Expenditures** | **Remaining Balance** |
| | | | | | |
| Personnel/Salary | | $202,816.67 | $202,816.67 | $0.00 | $0.00 |
| Fringe Benefits | | $38,665.65 | $38,665.65 | $0.00 | $0.00 |
| Travel | | $346.85 | $346.85 | $0.00 | $0.00 |
| Supplies | | $15,096.14 | $15,096.14 | $0.00 | $0.00 |
| Equipment | | $0 | $0.00 | $0.00 | $0.00 |
| Other | | $0 | $0.00 | $0.00 | $0.00 |
| Contractual | | $2,287,827.93 | $2,287,827.93 | $0.00 | $0.00 |
| ITAC | | $17,418.81 | $17,418.81 | $0.00 | $0.00 |
| Project Management | | $189,617.26 | $189,617.26 | $0.00 | $0.00 |
| | | | | | |
| Total Direct Costs | | $2,751,789.31 | $2,751,789.31 | $0.00 | $0.00 |
| | | | | | |
| Authorized Indirect Costs | | $20,281.69 | $20,281.69 | $0.00 | $0.00 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$2,772,071.00** | **$2,772,071.00** | **$0.00** | **$0.00** |

**AQRP Budget**

**FY 2011**

| Budget Category | | FY11 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $173,520.24 | $172,702.06 | $0.00 | $818.18 |
| Fringe Benefits | | $33,099.69 | $33,902.95 | $0.00 | ($803.26) |
| Travel | | $0 | $0.00 | $0.00 | $0.00 |
| Supplies | | $4.51 | $4.51 | $96.73 | ($96.73) |
| Equipment | | $0 | $0.00 | $0.00 | $0.00 |
| Other | | $0 | $0.00 | $0.00 | $0.00 |
| Contractual | | $1,852,440.62 | $1,752,238.25 | $0.00 | $100,202.37 |
| ITAC | | $6,577.64 | $6,577.64 | $0.00 | $0.00 |
| Project Management | | $156,769.88 | $156,694.46 | $75.40 | $0.00 |
| | | | | | |
| Total Direct Costs | | $2,222,412.58 | $2,122,119.89 | $172.13 | $100,120.56 |
| | | | | | |
| Authorized Indirect Costs | | $17,352.02 | $17,268.40 | $1.81 | $81.81 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$2,239,764.60** | **$2,139,388.29** | **$173.94** | **$100,202.37** |

# Appendix B

## Financial Reports by Fiscal Year

## FY 12 and 13

(Expenditures reported as of May 31, 2013.)

**Administration Budget (includes Council Expenses)**

**FY 2012**

| Budget Category | | FY12 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $68,340.00 | $54,579.64 | $0.00 | $13,760.36 |
| Fringe Benefits | | $14,606.64 | $12,535.61 | $0.00 | $2,071.03 |
| Travel | | $2,850.00 | $339.13 | | $2,510.87 |
| Supplies | | $10,000.00 | $1,420.39 | $0.00 | $8,579.61 |
| Equipment | | $0.00 | | | $0.00 |
| Other | | | | | |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $95,796.64 | $68,874.77 | $0.00 | $26,921.87 |
| | | | | | |
| Authorized Indirect Costs | | $6,834.00 | $5,457.96 | $0.00 | $1,376.04 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$102,630.64** | **$74,332.73** | **$0.00** | **$28,297.91** |

**Administration Budget (includes Council Expenses)**

**FY 2013**

| Budget Category | | FY13 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $70,040.00 | $3,746.18 | | $66,293.82 |
| Fringe Benefits | | $12,606.00 | $832.16 | | $11,773.84 |
| Travel | | $350.00 | $0.00 | | $350.00 |
| Supplies | | $10,000.00 | $76.33 | | $9,923.67 |
| Equipment | | | | | |
| Other | | $0.00 | $0.00 | | $0.00 |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $92,996.00 | $4,654.67 | $0.00 | $88,341.33 |
| | | | | | |
| Authorized Indirect Costs | | $7,004.00 | $374.62 | | $6,629.38 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$100,000.00** | **$5,029.29** | **$0.00** | **$94,970.71** |

## ITAC Budget
## FY 2012

| Budget Category | | FY12 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | | | | |
| Fringe Benefits | | | | | |
| Travel | | $10,000.00 | $2,803.33 | 0.00 | $7,196.67 |
| Supplies | | $500.00 | | | $500.00 |
| Equipment | | | | | |
| Other | | | | | |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $10,500.00 | $2,803.33 | $0.00 | $7,696.67 |
| | | | | | |
| Authorized Indirect Costs | | | | | |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$10,500.00** | **$2,803.33** | **$0.00** | **$7,696.67** |

## ITAC Budget
## FY 2013

| Budget Category | | FY13 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | | | | |
| Fringe Benefits | | | | | |
| Travel | | $0.00 | $0.00 | | $0.00 |
| Supplies | | $0.00 | $0.00 | | $0.00 |
| Equipment | | | | | |
| Other | | | | | |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $0.00 | $0.00 | $0.00 | $0.00 |
| | | | | | |
| Authorized Indirect Costs | | | | | |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$0.00** | **$0.00** | **$0.00** | **$0.00** |

**Project Management Budget**

**FY 2012**

| Budget Category | | FY12 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $48,900.00 | $28,565.54 | $0.00 | $20,334.46 |
| Fringe Benefits | | $9,106.00 | $5,833.93 | $0.00 | $3,272.07 |
| Travel | | $500.00 | | | $500.00 |
| Supplies | | $7,279.76 | $752.03 | | $6,527.73 |
| Equipment | | | | | |
| Other | | | | | |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $65,785.76 | $35,151.50 | $0.00 | $30,634.26 |
| | | | | | |
| Authorized Indirect Costs | | $4,890.00 | $2,856.55 | $0.00 | $2,033.45 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$70,675.76** | **$38,008.05** | **$0.00** | **$32,667.71** |

**Project Management Budget**

**FY 2013**

| Budget Category | | FY13 Budget | Cumulative Expenditures | Pending Expenditures | Remaining Balance |
|---|---|---|---|---|---|
| | | | | | |
| Personnel/Salary | | $46,000.00 | | | $46,000.00 |
| Fringe Benefits | | $8,400.00 | | | $8,400.00 |
| Travel | | $0.00 | | | $0.00 |
| Supplies | | $6,000.00 | | | $6,000.00 |
| Equipment | | | | | |
| Other | | | | | |
| Contractual | | | | | |
| | | | | | |
| Total Direct Costs | | $60,400.00 | $0.00 | $0 | $60,400.00 |
| | | | | | |
| Authorized Indirect Costs | | $4,600.00 | | | $4,600.00 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$65,000.00** | **0.00** | **$0.00** | **$65,000.00** |

**AQRP Budget**

**FY 2012**

| | | | | | |
|---|---|---|---|---|---|
| **Budget Category** | | **FY12 Budget** | **Cumulative Expenditures** | **Pending Expenditures** | **Remaining Balance** |
| | | | | | |
| | | | | | |
| Personnel/Salary | | $68,340.00 | $54,579.64 | $0.00 | $13,760.36 |
| Fringe Benefits | | $14,606.64 | $12,535.61 | $0.00 | $2,071.03 |
| Travel | | $2,850.00 | $339.13 | $0.00 | $2,510.87 |
| Supplies | | $10,000.00 | $1,420.39 | $0.00 | $8,579.61 |
| Equipment | | $0.00 | $0.00 | $0.00 | $0.00 |
| Other | | $0.00 | $0.00 | $0.00 | $0.00 |
| Contractual | | $950,000.00 | $121,588.90 | $0.00 | $828,411.10 |
| ITAC | | $10,500.00 | $2,803.33 | $0.00 | $7,696.67 |
| Project Management | | $70,675.76 | $38,008.05 | $0.00 | $32,667.71 |
| | | | | | |
| Total Direct Costs | | $1,126,972.40 | $231,275.05 | $0.00 | $895,697.35 |
| | | | | | |
| Authorized Indirect Costs | | $6,834.00 | $5,457.96 | $0.00 | $1,376.04 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$1,133,806.40** | **$236,733.01** | **$0.00** | **$897,073.39** |

**AQRP Budget**

**FY 2013**

| | | | | | |
|---|---|---|---|---|---|
| **Budget Category** | | **FY13 Budget** | **Cumulative Expenditures** | **Pending Expenditures** | **Remaining Balance** |
| | | | | | |
| | | | | | |
| Personnel/Salary | | $70,040.00 | $3,746.18 | $0.00 | $66,293.82 |
| Fringe Benefits | | $12,606.00 | $832.16 | $0.00 | $11,773.84 |
| Travel | | $350.00 | $0.00 | $0.00 | $350.00 |
| Supplies | | $10,000.00 | $76.33 | $0.00 | $9,923.67 |
| Equipment | | $0.00 | $0.00 | $0.00 | $0.00 |
| Other | | $0.00 | $0.00 | $0.00 | $0.00 |
| Contractual | | $835,000.00 | $33,302.94 | $0.00 | $801,697.06 |
| ITAC | | $0.00 | $0.00 | $0.00 | $0.00 |
| Project Management | | $65,000.00 | $0.00 | $0.00 | $65,000.00 |
| | | | | | |
| Total Direct Costs | | $992,996.00 | $37,957.61 | $0.00 | $955,038.39 |
| | | | | | |
| Authorized Indirect Costs | | $7,004.00 | $374.62 | $0.00 | $6,629.38 |
| 10% of Salaries and Wages | | | | | |
| **Total Costs** | | **$1,000,000.00** | **$38,332.23** | **$0.00** | **$961,667.77** |