Development of a Prototype Emission Inventory for the Pune Region

Scoping the Pune Emission Inventory Development Process

March 16-24, 2004
Pune, India

How Is This Project Going to Work?

◆ Define priorities

◆ Develop daily schedules & milestones

◆ Assign leaders to projects

◆ Individual initiative and creativity

◆ Group & facilitators provide ongoing assistance & feedback

◆ Track progress & adjust goals as needed

Milestones for Paved Road Dust Estimate

Areawide Sources	TUES	WED	THURS	FRI	WEEK END	MON	TUES	WED	Responsibility (primary, secondary)
Paved Road Dust									
Identify Staff		▣							
Evaluate Methodologies			▣						
Select Methodology			▣	▣					
Evaluate Emission Factors				▣					
Calculate Emission Factors				▣					
Evaluate Available Activity Data				▣					
Develop Activity Data				▣					
Develop Spreadsheet				▣					
Calculate Emissions						▣			
Check Assumptions & Calcs							▣		
Format Emissions for Database							▣		
Load & Validate Data							▣		
Document Methodology & Assumptions							▣		
Identify Areas for Improvement (spatial, temporal, EFs, activity, etc.)							▣		

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What Will Help?

◆ We value your feedback

◆ This has not been done before in just 7 days
– We will need to be flexible
– It will be a challenge

◆ If you are not sure what to do, talk to us

◆ We will make significant progress that can be built upon

What is an Emissions Inventory?

◆ Comprehensive listing of air pollutant emissions by source type and category
  – Point, nonpoint, motor vehicle, nonroad mobile, natural

◆ Pertinent to a specific geographic area
  – Local, district/county, state, national

◆ Developed for a specific time interval
  – Day, month, year

Most Benefit Least Effort

- ◆ Plan efforts to achieve the most benefit with the least effort
    - – It is very easy to get bogged in insignificant details

- ◆ Focus on the most important sources

- ◆ Adjust the focus to fit available time and staffing sources

- ◆ Comprehensive & precise estimates are not always needed to improve air quality

Major Project Tasks

- Scope emission inventory
  - What is the inventory to be used for?
  - Geographic extent?
  - Base year?

- Identify important source types
  - Point sources
  - Nonpoint (or area) sources
  - Motor vehicle sources
  - Nonroad mobile sources
  - Natural sources

- Emission database development
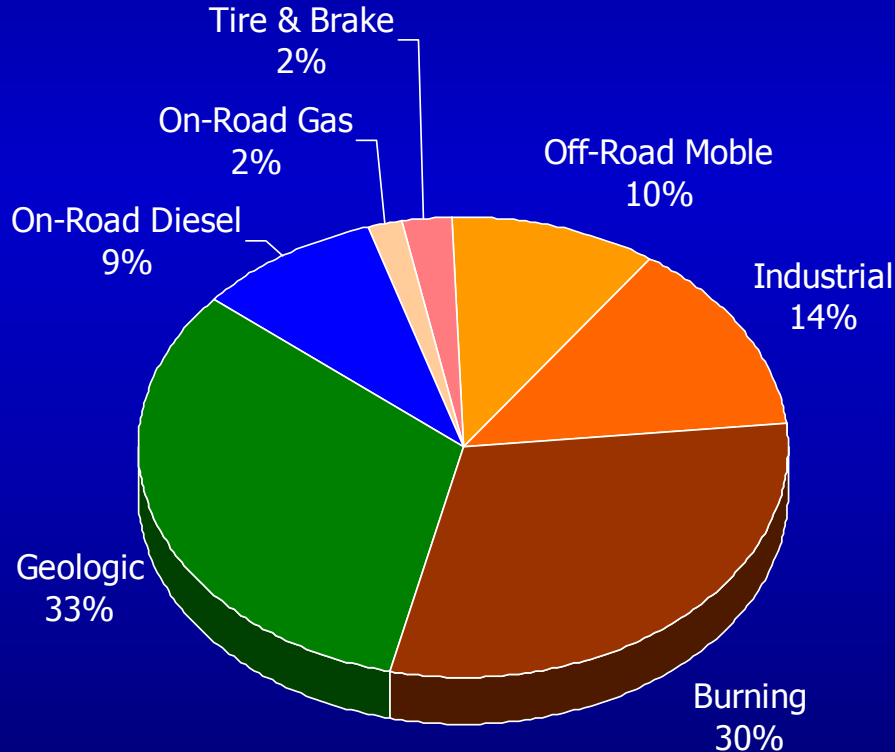
What Will You Be Using the Inventory For?
– Discussion –

- Identifying most important emission sources?

- Locating the most important emission sources?

- Developing emission reduction strategies?

- Performing atmospheric modeling?

- Others?

What Is in Pune Air?

◆ Comments on ambient monitoring results from group

◆ Pollutants? Concentrations?

◆ Any size speciation? (PM10, PM2.5)

◆ Any chemical speciation? (organic carbon, elemental carbon, geologic, nitrate, sulfate)

# Direct & Secondary PM$_{2.5}$ Inventory vs Ambient Air for SCAQMD

Emissions Inventory

- Tire & Brake 2%
- On-Road Gas 2%
- On-Road Diesel 9%
- Geologic 33%
- Off-Road Moble 10%
- Industrial 14%
- Burning 30%

Does not include secondary PM

Ambient Species
(CMB analysis - all species)

Slices with lines are secondary PM

- Ammonium 17%
- Organic Carbon 18%
- Elemental Carbon 8%
- Sodium 1%
- Chloride 1%
- Geologic 6%
- Sulfate 9%
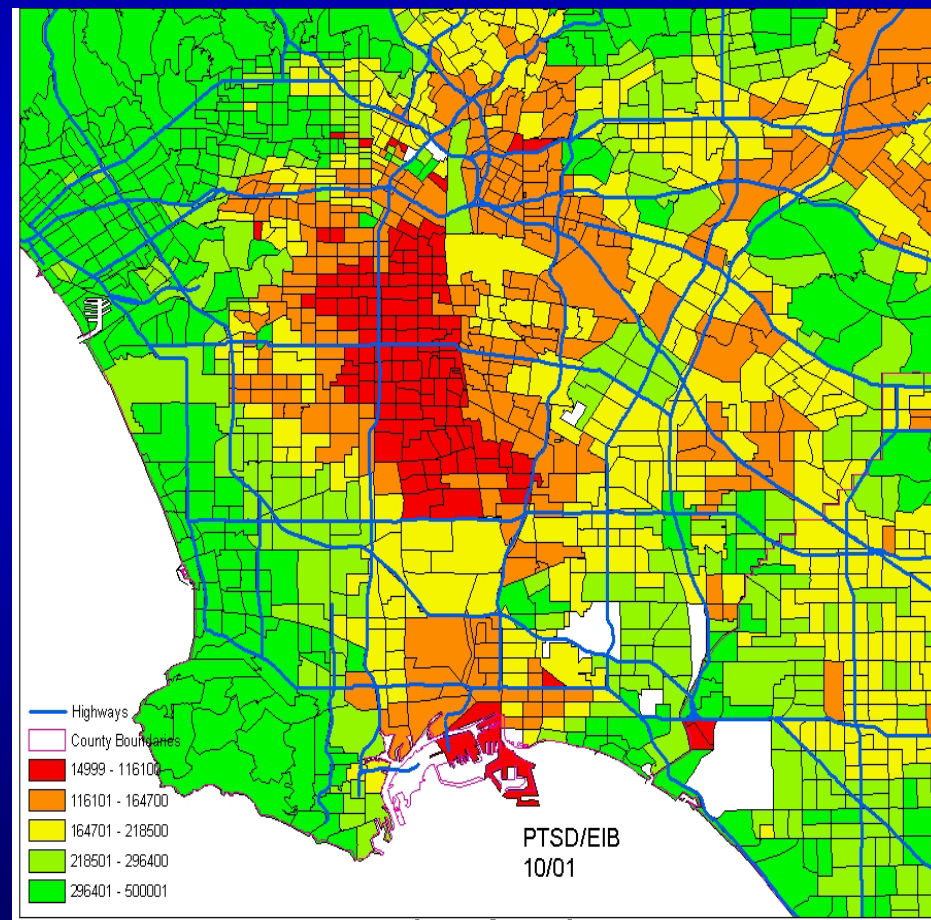- Nitrate 40%
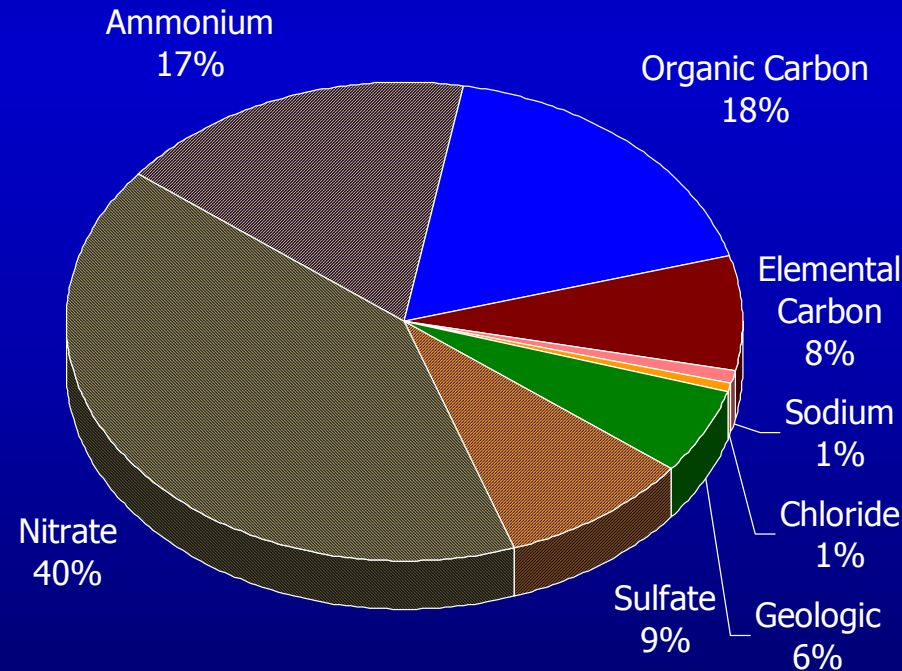
What Pollutants Do We Focus On?

– Discussion –

SPM — suspended particulate matter (PM)

PM_{10} — PM $\leq$ 10 microns (and other sizes?)

TOG — total organic gases

VOCs — volatile organic gases

CO — carbon monoxide

NO_x — oxides of nitrogen

SO_x — oxides of sulfur

NH3 — ammonia (secondary PM precursor)

What Is the Geographical Extent of Our Inventory?

– Discussion –

- ◆ City boundaries?

- ◆ Metropolitan area?

- ◆ Industrial areas?

- ◆ Agricultural areas?

- ◆ Determined based on the purpose of the inventory
  - – City, region, state-level analyses of air quality impacts

Highways
County Boundaries
14999 - 116100
116101 - 164700
164701 - 218500
218501 - 296400
296401 - 500001

PTSD/EIB
10/01

What Geographical Subdivisions Are Available?
– Discussion –

◆ Within the extent of the proposed inventory region, are any sub-regions clearly defined?

◆ How many geographical sub-regions do we want to divide the inventory into?

# What Will the Base Year of This Inventory Be?
– Discussion –

◆ Identifies the year for which emissions are estimated

 – For a new inventory, typically the base year is 1-2 years in the past so "activity" data such as production, fuel usage, units sold, etc., has already been collected and tabulated

◆ Provides a benchmark for comparison with previous and subsequent inventories

◆ Provides a common basis for all the emission estimates

◆ Determined based on the purpose of the inventory, regulatory requirements, and by data availability

How Much Temporal Information is Needed?

◆ Describes the variability of emissions over time

◆ Determined based on the purpose of the inventory

– Resolution can be annual, seasonal, monthly, daily
– Modeling inventory => grams/second

◆ Initial inventory will be annual, with capability to put temporal data into the database if available

Prioritization of Sources & Efforts

◆ Based on the approximate magnitude of emissions

◆ Availability and quality of existing emissions data

◆ Availability of input data for computing emissions

◆ Importance based on policy, health effects, other issues
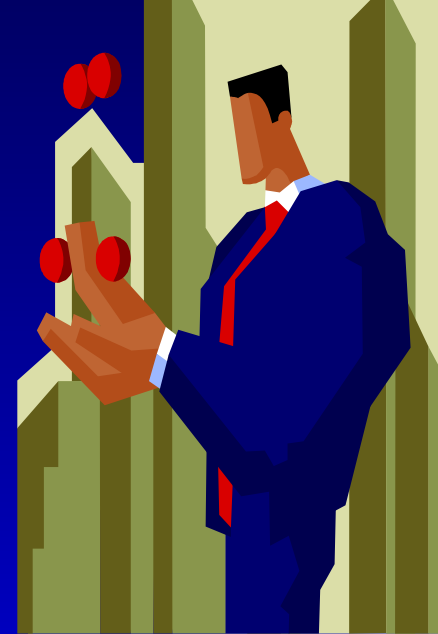
What Key Emission Sources Should We Focus On?
– Discussion –

◆ Just guessing, what are the largest sources of emissions?

◆ Which sources do people complain about most?

◆ Which sources have little or no data currently available?

◆ What special expertise do we have in the group to focus on certain sources?

◆ Which sources are being considered for regulation?

Areawide Emission Sources

Areawide Sources			Responsibility (primary, secondary)
Paved Road Dust			
Unpaved Road Dust – Non-Agricultural			
Unpaved Road Dust - Agricultural			
Agricultural Operatons (land preparation & harvest)			
Trash Burning			
Dung Burning (cooking/heating)			
Agricultural Burning			
Cooking - Commercial			
Cooking - Street Vendor & Homeless			
Cooking - Residential, LPG			
Agricultural Burning			
Managed Forest & Brush Burning			
Construction			
Woodstoves & Fireplaces			

Other Areawide Sources

Other Areawide Sources			Responsibility (primary, secondary)
Additional Categories for Consideration			
Pesticides			
Consumer products			
Architectural coatings			
Refrigerants			
Solvent evaporation			
Windblown dust from agricultural lands			
Structure and car fires			
Asphalt paving / roofing			
Portable generators			
Agricultural pumps			
Utility equipment (forklifts, etc.)			

◆ What is missing?

Stationary Emission Sources

◆ Others not listed?

Stationary Sources		Responsibility (primary, secondary)
Fuel Combustion Emission Updates		
Electric Utilities		
Cogeneration		
Oil and Gas Production		
Petroleum Refining		
Manufacturing and Industrial		
Food and Agricultural Processing		
Service and Commercial		
Waste Disposal		
Sewage Treatment		
Landfills, Incinerators		
Cleaning and Coatings		
Degreasing and Other		
Coatings and Adhesives		
Printing		
Petroleum Production & Marketing		
Oil and Gas Production		
Petroleum Refining		
Petroleum Marketing		
Industrial Processes		
Chemical		
Food and Agriculture		
Mineral Processes		
Metal Processes, Wood & Paper		
Glass and Related		

Milestones for Stationary Sources

Stationary Sources	TUES	WED	THURS	FRI	WEEK END	MON	TUES	WED	Responsibility (primary, secondary)
Stationary Source Update Process (use for each source)									
Identify Staff for Category		☐							
Identify Facility Names, Locations, Info				☐					
Evaluate Availability of Existing Data									
- Identify facility processes						☐			
- Identify facility emission sources						☐			
- Evaluate EFs for key processes						☐			
- Collect activity data for processes						☐			
Estimate Emissions for Facility						☐			
- Full facility emissions?						☐			
- Process emissions?						☐			
Check Assumptions & Calcs							☐		
Format Emissions for Database							☐		
Load & Validate Data							☐		
Document Methodology & Assumptions							☐		
Identify Areas for Improvement (spatial, temporal, EFs, activity, etc.)							☐		

Mobile Emission Sources

On-Road Mobile Sources	Responsibility (primary, secondary)
On-Road Mobile	
Light Duty Passenger	
Light Duty Trucks	
Medium & Heavy Duty Gas Truck	
Light & Med Duty Diesel Truck	
Heavy Duty Diesel Truck	
Motorcycles	
Heavy Duty Diesel Buses	
Heavy Duty Gas Buses	
School Buses	
Motor Homes	

Off-Road Mobile Sources	Responsibility (primary, secondary)
Off-Road Mobile	
Aircraft	
Trains	
Off-Road Recreational Vehicles	
Off-Road Equipment (construction)	
Farm Equipment (tractors)	
Fuel Storage and Handling	
Ships and Commercial Boats	
Recreational Boats	

Milestones for On-Road Mobile Sources

On-Road Mobile Sources	TUES	WED	THURS	FRI	WEEK END	MON	TUES	WED	Responsibility (primary, secondary)
Stationary Source Update Process (use for each source)									
On-Road Mobile Source Update Process (use for each source)									
Identify Staff		◼							
Evaluate Pune IVEM Study			◼						
Confirm Assumptions in Model				◼					
Assign Source Categories				◼					
Extract Emission Factor Data				◼					
Extract Activity Data				◼					
Evaluate Spatial Range of Study				◼					
Evaluate Spatial Extrapolation Methods				◼		◼			
Develop Spreadsheet for Study Data						◼			
Summarize Emissions						◼			
Check Assumptions & Calcs							◼		
Format Emissions for Database							◼		
Load & Validate Data							◼		
Document Methodology & Assumptions							◼		
Identify Areas for Improvement (spatial, temporal, EFs, activity, etc.)							◼		

Emission Inventory Planning

- ◆ Quick scan through plan
  - Someone to adapt for Pune region

- ◆ Who we have here

- ◆ Preliminary areas of interest, expertise

- ◆ Initial work assignments?

Who Is Doing What?

- Emission Estimation
  - Oversight Manager
  - Point Sources
  - Mobile Sources
  - Areawide sources

- Database
  - Oversight Manager
  - Data structures
  - System development & coding

- Documentation & Tracking

Participants

Policy Makers:

Mr. Bonala, PMC

Mr. Khade, RTO

Mr. Chaudhary, MPCB

Mr. Shinde, Dy. Commissioner, Traffic Police

Mr. Bhanot / Chaudhary, ARAI

Atmospheric Modelers:

Mr. Mohit Dalvi, CDAC

Mr. Komawar, ARAI

GIS Users and Developers:

Mr. Jatin Kulkarni, Snehal Road Safety Products

Uday Patil, student, CDAC

Database Development Staff:

Database Project Management and Oversight:

Mr. Kulkarni, PMC

Database Developers, Data Managers:

Mr. Dighe, PMC

Mr. Jadhay, PMC

Kiran Singh, ARAI

Students: 2 Nos.

UOP student

UOP student

Emissions Estimation Staff:

Emission Project Management and Oversight:

Mr. Iyer, SIAM

Emission Estimation Analysts and Engineers:

Point Sources:

Mr. More, MPCB

Mr. Avinash Gaikwad, PMC

Area Sources:

Ms. Elizabeth, NEERI

Mr. Vikrant Kapse, PMC

Mr. Pawar / Mulay, ARAI

Mobile Sources:

Mr. Ajay Ozha, NEERI

Mr. Dhapte, RTO, Pune

Students:

Mr. Snigdha Mehta, Student IIT

Mr. Naval Kishor Chaudhary, student, IIT

UOP Student

UOP Student

Additional Participants

Mr. Khairkar, PMC

Mr. Rakesh Kumar, NEERI

Dr. U. Mukherjee, Scientist C, CPCB, Baroda

Mr. Naresh Bhadwar, Asst. Engineer, CPCB, Delhi

Mr. R. Debroy, Asst Engineer, CPCB, Delhi

Sri P.Veeranna, JSO, APPCB

Sri Satyanarayana, Analyst, APPCB

Resource Availability

- Computer access
  - Software
  - Internet
  - Printers

- Workspace (hotel, office, university)

- Personnel resources

- Time resources

Tomorrow's Schedule

◆ Start at 9:00

◆ General discussions

◆ Split into groups

◆ Start inventory development

Day 2 – Wednesday	
Morning – 9:00 a.m.	

Primary Participants: Technical Staff & Team Leaders

General comments and discussion (15 minutes)
Review planning document and confirm milestones (30 minutes)

Emission Estimation Track	*Database Development Track*
1) Case study example, discuss approximations, limitations (30 min) 🗐 2) More clarification and identification of emission sources (1 hr) 🗐 ▪ Prioritizing efforts ▪ Point sources ▪ Area sources ▪ Mobile sources 3) Volunteers to lead source category emission development (30 min) 4) Volunteer to do background sections of planning document 5) Provide inventory source worksheets (15 min) 6) Discussion of methods & data sources (15 minutes) 🗐 ▪ U.S. EPA and CARB methods ▪ International methods 7) Get started identifying methods and data (3 hrs) 8) Review some source worksheets (30 minutes) 9) Check in with problems & frustrations (30 min)	1) Discuss database needs and trade-offs (1.5 hrs) 🗐 o Complexity o Software o Growth potential o Ease of update & maintenance 2) Discuss source category coding schemes (2 hr) 🗐 3) Sketch out initial database design, data relationships, data tables, reference data tables (2 hrs)
Afternoon (Day 2 – Wednesday)	
Emission Estimation Track	*Database Development Track*
▪ Continue identifying methods and data discussed in the morning	▪ Continue database work
▪ Full group check-in and discussion of issues (15-30 minutes)	

End Tuesday

Tuesday Schedule

- ◆ Introduction
- ◆ Inventory Scope & Needs
- ◆ Inventory Planning & Milestones
- ◆ Identification of Staff
- ◆ Discussion of Resources
- ◆ Questions?

Day 1 - Tuesday

Morning - 9:00 a.m. Start

Participants: All Management, Policy, and Technical Staff

Introductions (45 min)
- Pune leadership & management
- Other India representatives
- EPA
- Facilitators
- India technical staff

Overview of Project, Limitations, Goals (10 min)
Walk Through Schedule (5 min)
Inventory Methods and Database Overview (30 min)

Break

Emission Inventory Scope and Needs (2 hrs)
- Immediate and longer term uses of the inventory
  - Identifying most important sources of air pollution
  - Air quality policy decisions
  - Atmospheric modeling
- Spatial extent of inventory
- Key emission sources
- Database development issues
- Data development & database ownership issues

Afternoon

Emission Inventory Planning (3 hrs)
- Identify key tasks for inventory and database
- Identify preliminary milestones (inventory & database)
- Discuss available personnel resources
- Discuss participant interest and availability for inventory, database, and miscellaneous efforts
- Discuss available computer and other resources
- Other issues and concerns

Summary Schedule for Remaining Days

Wednesday Schedule

- ◆ Start at 9:00
- ◆ General discussions
- ◆ Split into groups
- ◆ Start inventory development

Day 2 – Wednesday	
Morning – 9:00 a.m.	
Primary Participants: Technical Staff & Team Leaders General comments and discussion (15 minutes) Review planning document and confirm milestones (30 minutes)	
Emission Estimation Track	*Database Development Track*

1) Case study example, discuss approximations, limitations (30 min) 📑
2) More clarification and identification of emission sources (1 hr) 📑
   ▪ Prioritizing efforts
   ▪ Point sources
   ▪ Area sources
   ▪ Mobile sources
 	
3) Volunteers to lead source category emission development (30 min)
4) Volunteer to do background sections of planning document
5) Provide inventory source worksheets (15 min)
6) Discussion of methods & data sources (15 minutes) 📑
   ▪ U.S. EPA and CARB methods
   ▪ International methods
7) Get started identifying methods and data (3 hrs)
8) Review some source worksheets (30 minutes)
9) Check in with problems & frustrations (30 min)
	1) Discuss database needs and trade-offs (1.5 hrs) 📑
	   ○ Complexity
	   ○ Software
	   ○ Growth potential
	   ○ Ease of update & maintenance
	2) Discuss source category coding schemes (2 hr) 📑
	3) Sketch out initial database design, data relationships, data tables, reference data tables (2 hrs)

Afternoon (Day 2 – Wednesday)	
Emission Estimation Track	*Database Development Track*
▪ Continue identifying methods and data discussed in the morning	▪ Continue database work
▪ Full group check-in and discussion of issues (15-30 minutes)	

Thursday Schedule

Day 3 - Thursday

Morning – 9:00 a.m.

Primary Participants: Technical Staff & Team Leaders

Check progress on workplan milestones (15 minutes)

Discuss inventory source category coding (45 minutes)
- Source categories
- Spatial regions
- Temporal data

Discuss data needs for database (15 min)

Emission Estimation Track	*Database Development Track*

1) Full group input on problems & roadblocks (1 hr)
 2) Show example spreadsheets (point, area, mobile) (45 min)
 3) Staff create spreadsheets for assigned categories
 4) Begin populating spreadsheets with data
	1) Meeting user needs (1.5 hrs)
	     o Data input/output
	     o Updating data
	     o Data reports
	     o Modeling, growth, toxics
	 2) Define coding schemes, reference tables (2 hrs)
	 3) Begin development of database tables, coding database

Afternoon (Day 3 – Thursday)

Emission Estimation Track	*Database Development Track*
▪ Continue emissions collection and development	▪ Continue database work
▪ Full group check-in and discussion of issues (15-30 minutes)	

Friday Schedule

Day 4 - Friday
Morning – 9:00 a.m.

Primary Participants: Technical Staff & Team Leaders

Check progress on workplan milestones (15 minutes)
Revision of milestones and schedule based on actual progress (30 min)

Emission Estimation Track	*Database Development Track*
Continue emission estimation development efforts	Continue database and data system development efforts.

Afternoon (Day 4 – Friday)	

Emission Inventory and GIS (60 min)
- Presentation and discussion of incorporating GIS into emission inventory systems
- Discussion of spatially allocating emissions

Emission Estimation Track	*Database Development Track*
1) Rating data for quality (methods, emission factors, activity data) (45 min) 2) Group feedback and assistance on key emission sources (1hr) 3) Ongoing emissions work	1) Meeting user expectations (30 min) 2) Define methods for getting emissions into database (entry forms, data loader, etc.) (45 min) 3) Ongoing database work

- Full group check-in and discussion of issues (45 min hour)
    - Data formats needed for database
    - Source codes needed for database, region codes
- Evaluation of readiness for loading data to database Tuesday morning (45 min)
    - Key bottlenecks
    - Necessary simplifications and compromises by emissions and database groups

Monday Schedule

Day 5 - Monday	
Morning – 9:00 a.m.	

Primary Participants: Technical Staff & Team Leaders

Check progress on workplan milestones (15 minutes)
Feedback on process, concerns, frustrations (30-60 minutes)

Emission Estimation Track	*Database Development Track*

1) Continue data development
2) Presentation of draft emission estimates by staff for each source
   ▪ Point (30 min)
   ▪ Mobile (15 min)
   ▪ Area (1.5 hrs)
   ▪ Mobile sources
3) Evaluate emissions for reasonableness
4) Identify any quick fixes needed
	1) Database development
	2) Database evaluation with test emission data sets
	3) Prepare for data loading

Afternoon (Day 5 – Monday)	

Emission Estimation Track	*Database Development Track*
1) Finalize emissions for all sources 2) Briefly document methods and assumptions using worksheets or more detailed write-ups 3) Format data as needed for database group	1) Ongoing work 2) Develop database documentation

▪ Full group check-in. Where are we? Problems? (30-60 minutes)
▪ Evaluation of project objectives
▪ Loading data to database issues

Tuesday Schedule

Day 6 - Tuesday

Morning – 9:00 a.m.

Primary Participants: Technical Staff & Team Leaders

Progress and milestone updates (15 minutes)
Are data ready to load? Is database ready? Problems & solutions. (30 minutes)

Emission Estimation Track	*Database Development Track*
1) Resolve remaining issues 2) Work to get data loaded to database 3) Continue documentation 4) Resolve QA and other issues raised by database group	1) Load data into database 2) Perform initial quality assurance 3) Revise database as needed, fix problems 4) Provide feedback to emissions staff regarding potential data problems 5) Database documentation

Afternoon (Day 6 – Tuesday)

Emission Estimation Track	*Database Development Track*
1) Complete, at a minimum, 1 page documentation for each source including methods, assumptions, and data sources 2) Finalize emissions estimation spreadsheets 3) Compile all documentation and assemble all spreadsheets in a common location	1) Resolve remaining issues 2) Prepare emission inventory report and graphics showing sources and emission magnitudes 3) Compile data dictionary, assemble documentation

- Present emissions report, reality check (30 min)
- Discuss integrating documentation into workplan appendix (10 min)
- Discuss deficiencies, problems, and concerns (30 min)

Wednesday Schedule

Morning – 9:00 a.m.

Participants: All Management, Policy, and Technical Staff

Final visit to workplan document and milestones. How did we do? (20 min)

Presentations
- Inventory Emission Methods (1 hour)
  - Key issues and problems
  - Lessons learned
  - Areas for improvement
  - Feedback and concerns

- Inventory Database (1 hour)
  - Key issues and problems
  - Lessons learned
  - Areas for improvement

- Emission Inventory Data (30 minutes)
  - How does it look?
  - What have we gained?

Afternoon (Day 7 – Wednesday)

- Identify and prioritize future tasks
  - Emission estimation (45 min)
  - Database (45 min)

- Develop overall milestones and timelines (30 min)

- Discuss future progress
  - Management oversight and responsibility
  - Agency interests and available staffing
  - Ongoing work assignments

- Schedule follow-up monthly meetings or teleconferences for participants to track progress (need lead person for arrangements)

- Celebrate and relax