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TRB
TRANSPORTATION RESEARCH BOARD

TRB WEBINAR PROGRAM

Reducing the Impact of Lead Emissions at Airports

April 25, 2017
2:00pm to 3:30pm ET

Purpose

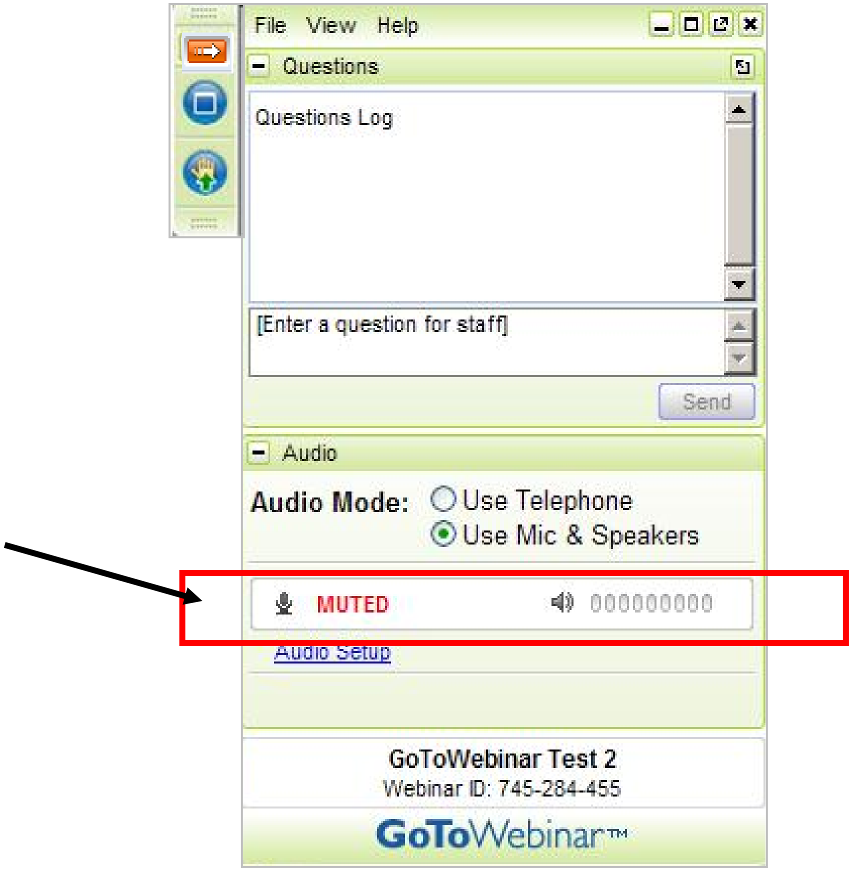
Assist airport operators in understanding measures to reduce lead emissions from general aviation aircraft operating on leaded gas, also known as AVGAS.

Learning Objectives

At the end of this webinar, you will be able to:

- Discuss lead and its effects
- Understand why lead is used in general aviation fuels
- Identify strategies for reducing lead emissions

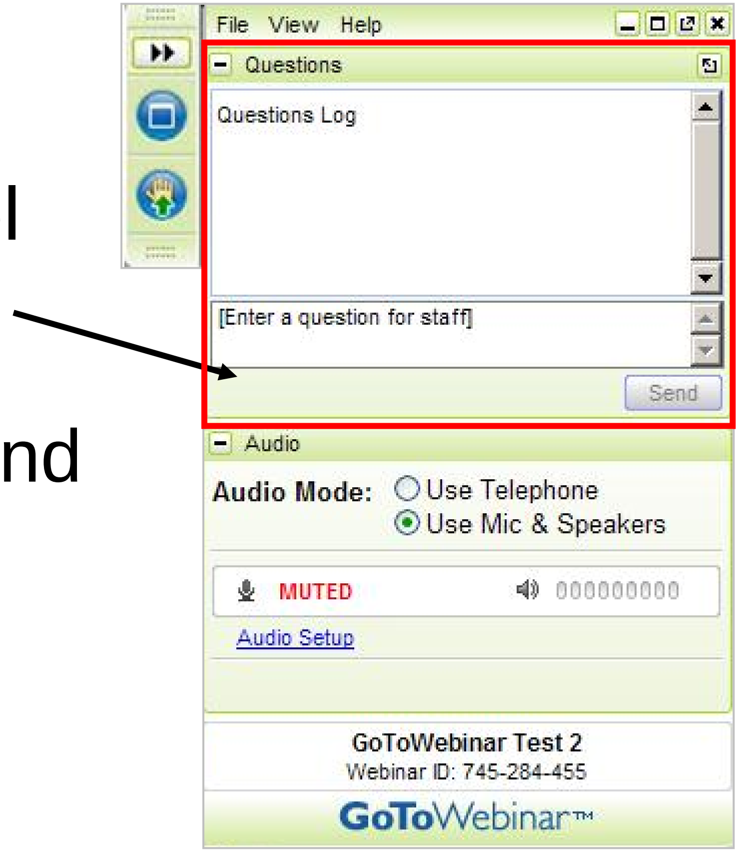
All Attendees Are Muted



Questions and Answers

- Please type your questions into your webinar control panel

- We will read your questions out loud, and answer as many as time allows



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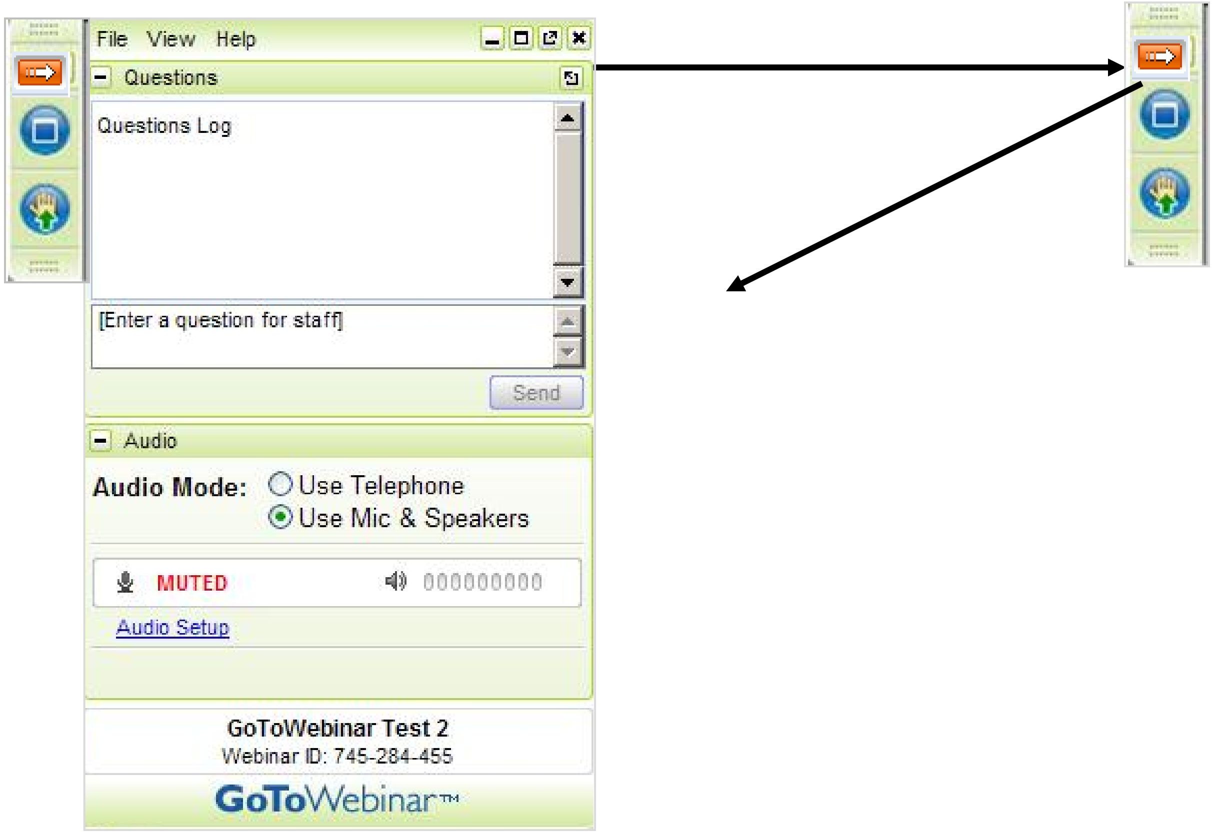

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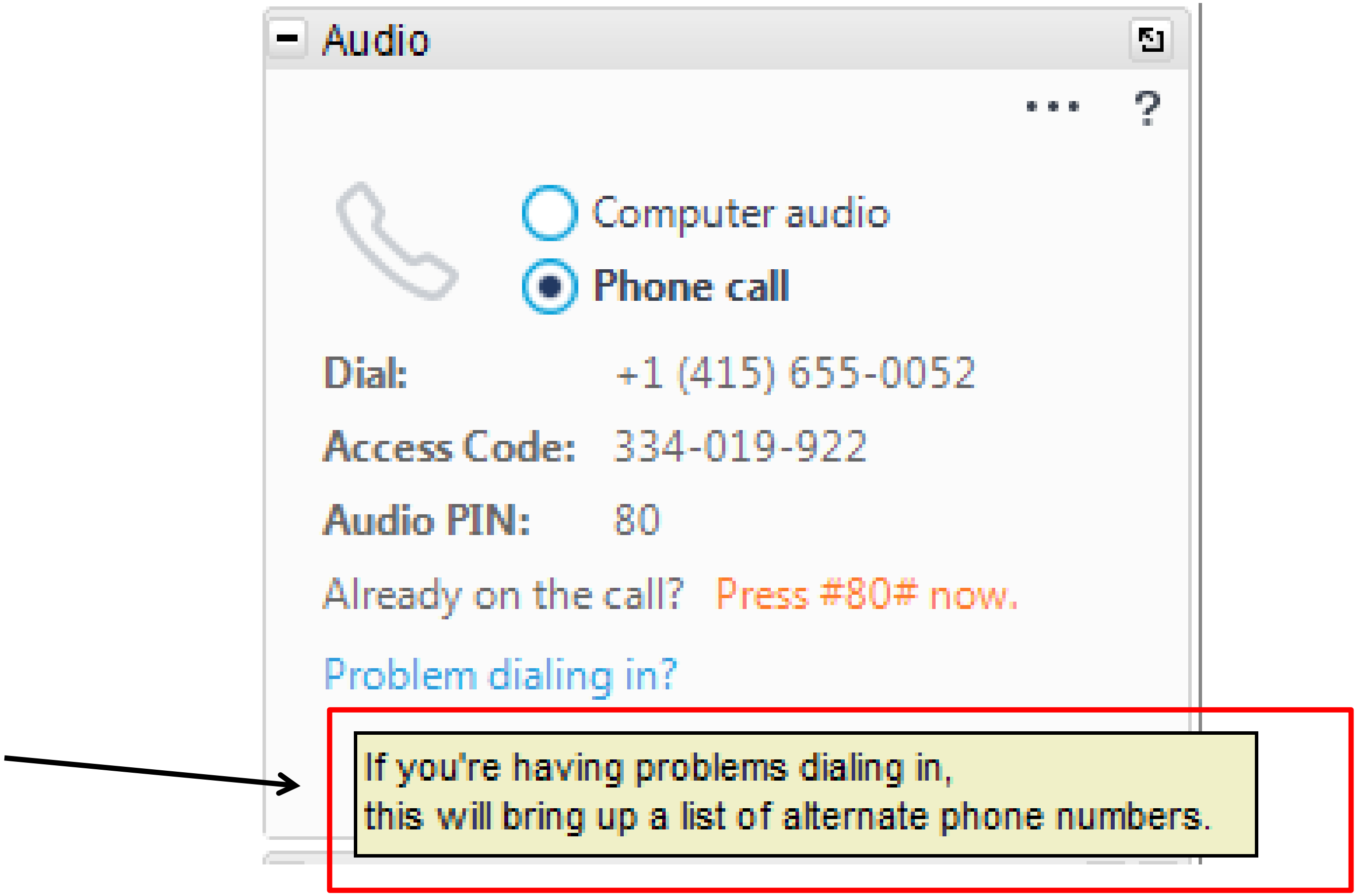


American Association of Airport Executives (AAAE)

1.5 Continuing Education Units (CEUs) are available to Accredited Airport Executives (A.A.E.)

Report your CEUs: www.aaae.org/ceu

American Institute for Certified Planners

The American Institute for Certified Planners has approved this webinar for 1.5 Certification Maintenance Credits.

Visit: www.planning.org/cm to report your credits.

Panelists Presentations

http://onlinepubs.trb.org/onlinepubs/webinars/170425.pdf

After the webinar, you will receive a follow-up email containing a link to the recording

Today's Participants

- Sam Hartsfield, *Port of Portland, Oregon,* humulus.caesar@gmail.com

- Jim Lyons, *Sierra Research*, jlyons@sierraresearch.com

- Jay Turner, *Washington University, St. Louis*, jrturner@seas.wustl.edu

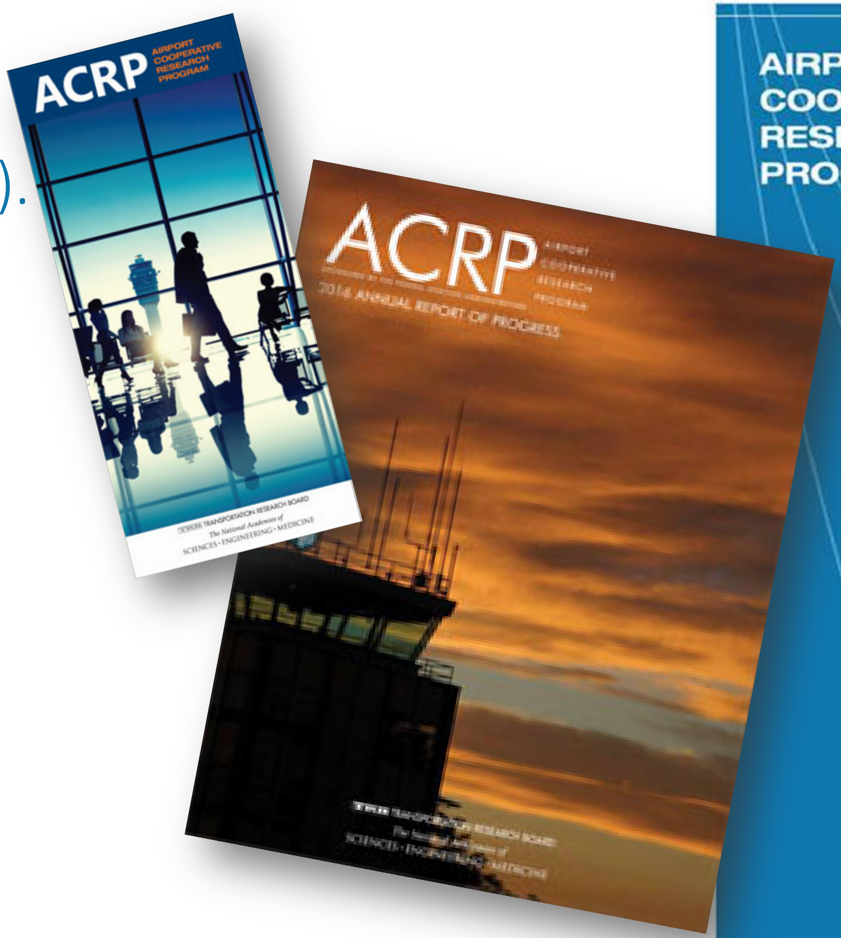
Get Involved in ACRP

- Submit a research idea to ACRP.
- Volunteer to participate on a project panel.
- Prepare a proposal to conduct research.
- Get involved in TRB's Aviation Group of committees.
- Take part in the Champion or Ambassador Programs.

For more information:
http://www.trb.org/acrp/acrp.aspx

ACRP is an Industry-Driven Program

- Managed by TRB and sponsored by the Federal Aviation Administration (FAA).
- Seeks out the latest issues facing the airport industry.
- Conducts research to find solutions.
- Publishes and disseminates research results through free publications and webinars.



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Opportunities to Get Involved!

- ACRP's Champion program is designed to help early- to mid-career, young professionals grow and excel within the airport industry.
- Airport industry executives sponsor promising young professionals within their organizations to become ACRP Champions.
- Visit ACRP's website to learn more.

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Upcoming ACRP Webinars

May 22nd

NextGen for Airports - Introduction and Overview

May 24th

NextGen for Airports – Resources and Guidebooks

June 12th

Information Technology Systems at Airports

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Additional ACRP Publications Available on this Topic

Report 71: Guidance for Quantifying the Contribution of Airport Emissions to Local Air Quality

Report 84: Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans

Report 133: Best Practices Guidebook for Preparing Lead Emission Inventories from Piston-Powered Aircraft with the Emission Inventory Analysis Tool

Report 135: Understanding Airport Air Quality and Public Health Studies Related to Airports

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Today's Speakers

Jim Lyons; Sierra Research

Jay Turner; Washington University

Presenting Report 162

Guidebook for Assessing Airport Lead Impacts

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ACRP Report 162 (Project 02-57): Assessing Impacts of Lead Emissions at General Aviation Airports

James Lyons, Sierra Research
Jay Turner, Washington University

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Principal Investigators

- James Lyons
  Principal Consultant
  Sierra Research
  a Trinity Consultants Company

- Jay Turner
  Vice Dean & Associate Professor
  Washington University in
  St. Louis

ACRP Report 162 (Project 02-57) Oversight Panel

- Michael J. Clow, Airport Director, Panel Chair
- John L. Collins, Aircraft Owners & Pilots Association, Panel Member
- Susan Fizzell, Oakland International Airport, Port of Oakland, Panel Member
- Samuel J. Hartsfield, Port of Portland (OR), Panel Member
- Leonard A. Krugler, Los Angeles World Airports, Panel Member
- Danuta Leszczynska, Jackson State University, Panel Member
- Warren Gillette, FAA Liaison
- Peggy Wade, FAA Liaison
- Meredith Pedde, Air Quality Analysis Office, Other Liaison
- Christine Gerencher, TRB Liaison
- Marci A. Greenberger, AAE, ACRP Staff
- Joseph J. Snell, ACRP Staff

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ACRP Report 162 (Project 02-57): *Assessing Impacts of Lead Emissions at General Aviation Airports*

- Identify and assess potential strategies for reducing airport Pb impacts
  - Relocate run-up areas
  - Use MOGAS in all suitable aircraft
- Public Documents
  - Guidebook for Assessing Airport Lead Impacts and FAQ document
  - Contractor’s Final Report
- Project Completed June 2016

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Outline

- Concerns with Lead Emissions
- U.S. Sources of Lead Emissions
- Use of Lead in Aviation Gasoline
- Status of EPA Activities
- Assessment of Lead Emissions at General Aviation Airports
- Assessment of Airport Mitigation Strategies

Concerns with Pb Emissions

- Lead distributes throughout the body in the blood and is accumulated in the bones.
- Lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems, and cardiovascular system.
- Infants and young children are especially sensitive to even low levels of lead, which may contribute to behavioral problems, learning deficits, and lowered IQ.
- Lead is persistent in the environment and accumulates in soils and sediments through deposition from air sources.

Pb NAAQS

- The Clean Air Act requires EPA to set NAAQS to protect public health, including the health of "sensitive" populations, such as asthmatics, children, and the elderly.
- 1978 Lead NAAQS: 1.5 µg/m^3 – average per calendar quarter
- 2008 Lead NAAQS: 0.15 µg/m^3 – rolling three-month average

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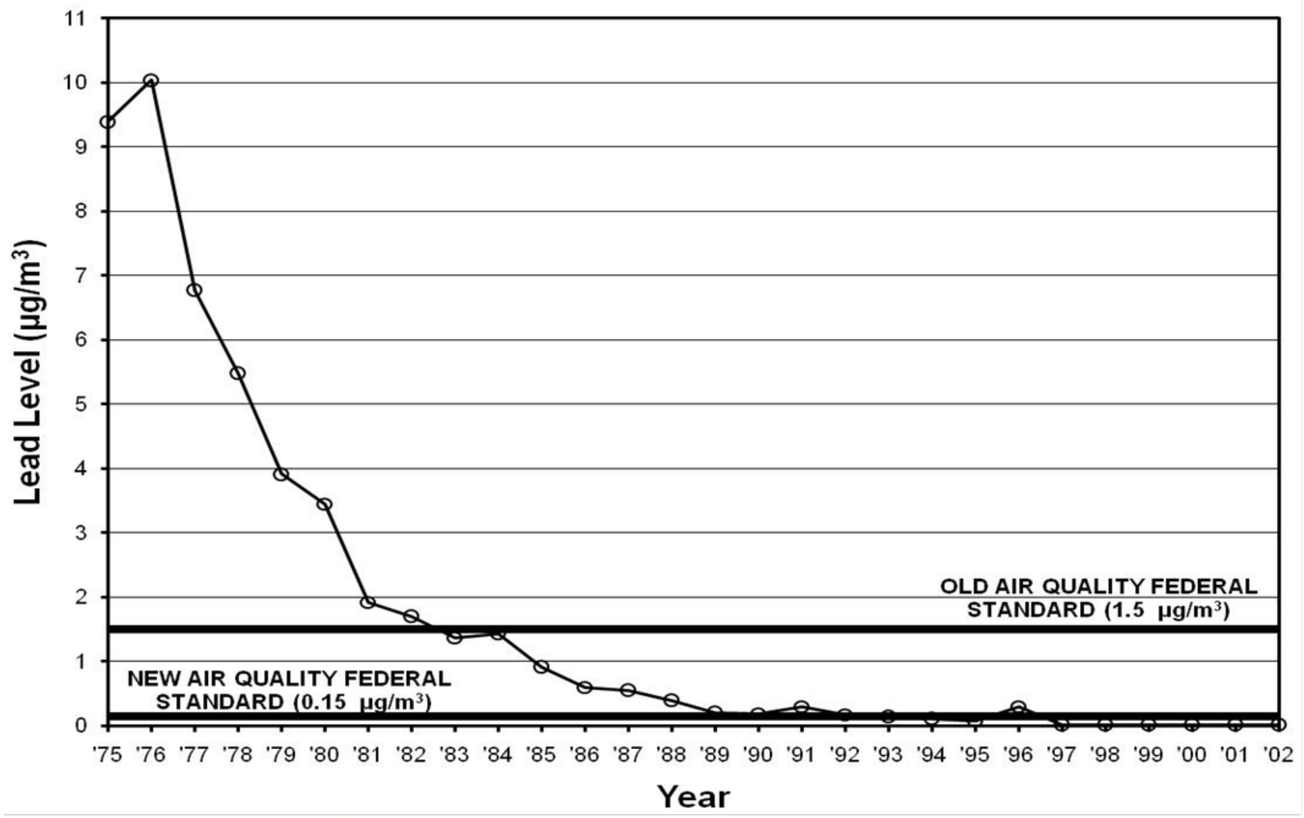
Temporal Trends in Airborne Pb

- Maximum 30-Day Average Lead Levels in the Los Angeles Area



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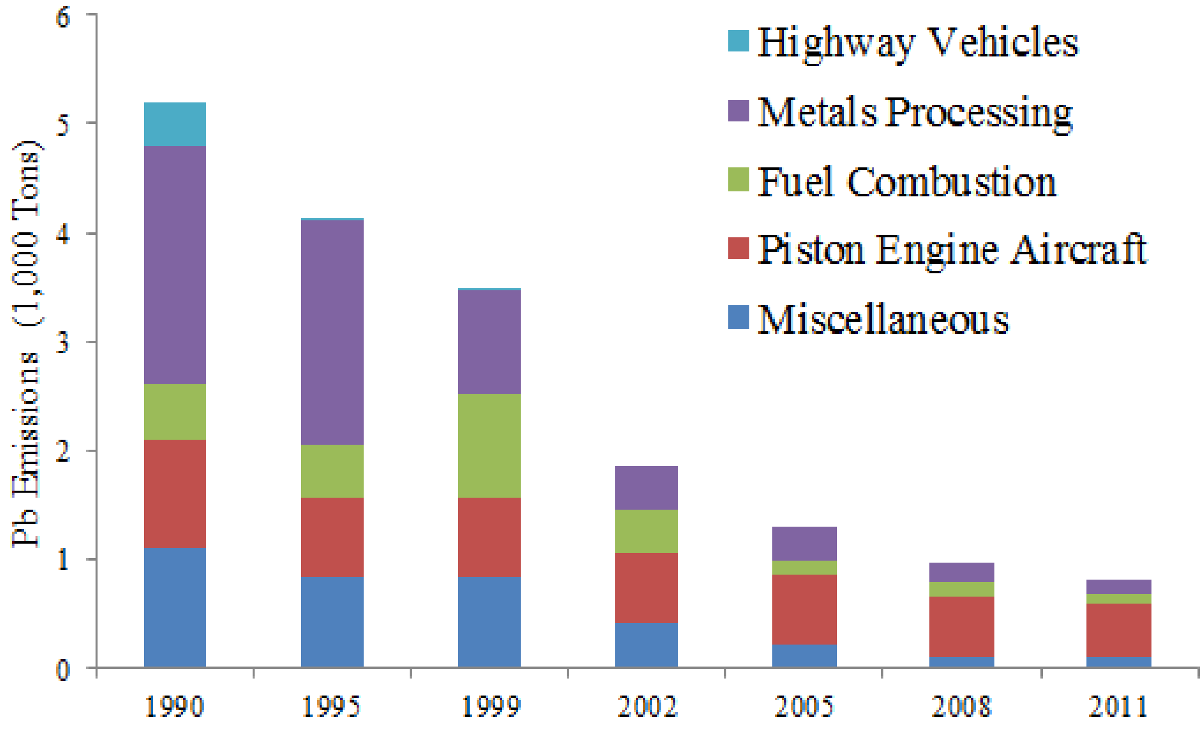
U.S. Sources of Pb Emissions

- General aviation aircraft have become a major source.



Why is Pb in AVGAS?

- Many aircraft engines are designed for high-octane gasoline to maximize power and efficiency.
  - 100 octane AVGAS is required by many, but not all, piston-engine aircraft for operational safety.
    - Low octane causes “knock,” which can lead to loss in power, engine damage, and overheating.
    - For aircraft, the most severe situation for encountering knock is at full-throttle for takeoff at sea level.
- Tetraethyl lead (TEL) is used in AVGAS to boost octane.
- Most common AVGAS is 100 LL (max 2.1 g Pb/gal).
- Other octane additives do not provide satisfactory performance.

Status of Unleaded AVGAS

- Piston Aviation Fuels Initiative (PAFI)
  - FAA program to authorize and develop ASTM specifications for unleaded AVGAS
  - Target date 2018, more time needed for widespread commercial availability
- Many aircraft can use non-oxygenated unleaded MOGAS.
  - Approximately 35% of piston-engine aircraft can use 80 octane fuel.
  - MOGAS is currently available at a small number of airports.

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EPA Focused on Pb Impacts from Airports

- In 2010, EPA indicated that it would investigate airport Pb impacts.
- In 2013, EPA conducted an ambient Pb monitoring program at 17 airports.
  - Results show high Pb concentrations at several airports in California.
- EPA is currently determining if aircraft lead emissions "cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare."
  - Scheduled to release draft finding in 2017 and final finding in 2018.

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ACRP Projects Focused on Aircraft Pb

ACRP 02-34

Quantifying Aircraft Lead Emissions at Airports

- Objective
  - Review and improve upon existing methodologies to quantify and characterize aircraft-related Pb emissions
- Completed October 2014
  - ACRP Web-Only Document 21: Technical Report - Quantifying Aircraft Lead Emissions at Airport
  - ACRP Report 133: Best Practices Guidebook
  - Emission Inventory Analysis Tool (MS Excel)

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ACRP Projects Focused on Aircraft Pb

ACRP 02-57

Reducing the Impact of Lead Emissions at Airports

- Objective
  - Identify and assess potential strategies for reducing airport Pb impacts
    - Relocate run-up areas
    - Use MOGAS in all suitable aircraft
- Project completed June 2016
  - Guidebook for Assessing Airport Lead Impacts and FAQ document
  - Contractor’s Final Report

Lessons Learned Through ACRP Projects

- Methodologies developed under ACRP 02-34 and 02-57 can be used to:
  - Quantify Pb emissions
  - Establish ambient Pb concentrations
  - Assess mitigation strategies
- Data-intensive process requires:
  - Spatial and temporal aircraft operations data resolved at the aircraft make and model level
    - Two weeks of subsampling for hourly landing and takeoff operations (LTOs), active fleet inventory, and time-in-mode data
  - Avgas Pb content data from fuel analysis or delivery certificates

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Mitigation Strategies

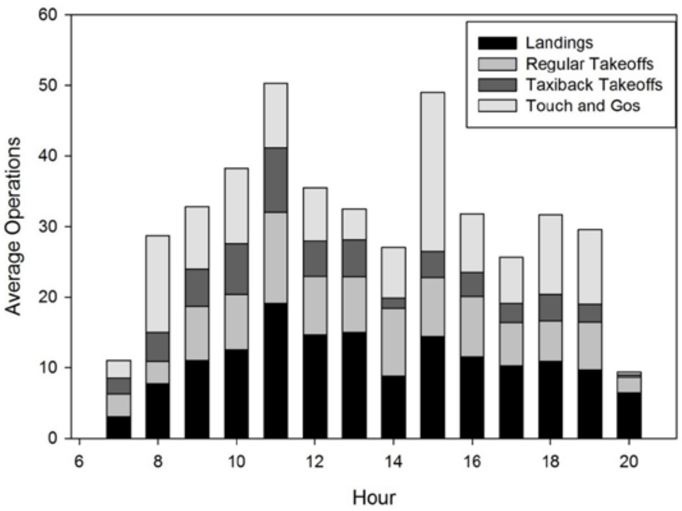
- Examples of mitigation strategies
  - Use of motor gasoline or unleaded aviation gasoline in those aircraft for which it is suitable;
  - Taxing aviation gasoline to reduce aircraft use;
  - Relocating aircraft run-up areas to minimize ambient Pb concentrations and public exposure; and
  - Imposing restrictions on aircraft operation to minimize ambient PB concentrations and public exposure.
- Using motor gasoline and relocating run-up areas were selected for analysis in ACRP 02-57

Aircraft Activity: Selected Observations…

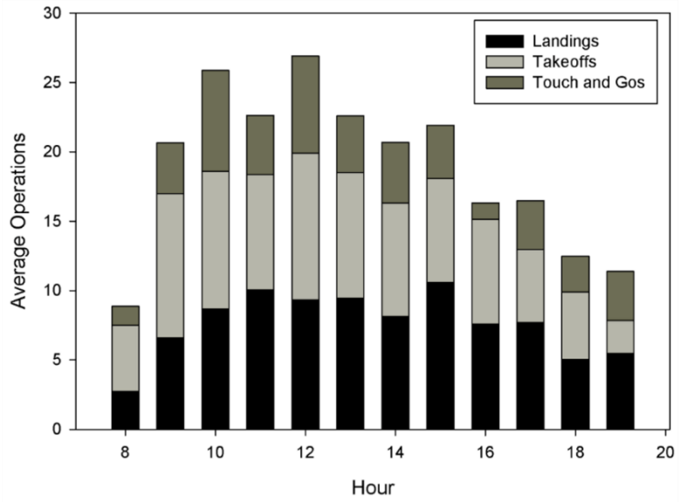
… more details in the ACRP 02-34 and ACRP 02-57 technical reports

- Many operations are not conventional landings and takeoffs

Airport A



Airport B*



* Taxibacks not distinguished from conventional LTOs

Aircraft Activity: Selected Observations (2)

- Active fleet typically quite different from ground-based fleet

  fraction of unique active aircraft accounting for…

Airport	…1/3 of LTOs	…1/2 of LTOs
A	4%	7%
B	5%	12%
C	5%	10%

- Flight schools disproportionately large portion of activities

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Aircraft Activity: Selected Observations (3)

- Run-up area times have relatively large variance

  run-up area time (mean ± 1σ):

Airport	Magneto Test, sec	Total Time, sec
A	47 ± 27	266 ± 189
B	69 ± 56	296 ± 150
C	61± 52	328 ± 215

- Observed LTOs often differ from ATADS-reported LTOs

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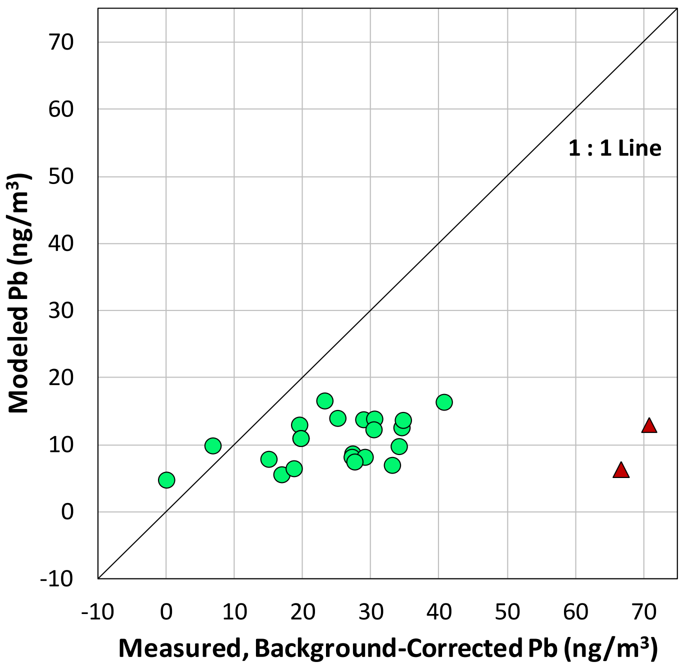
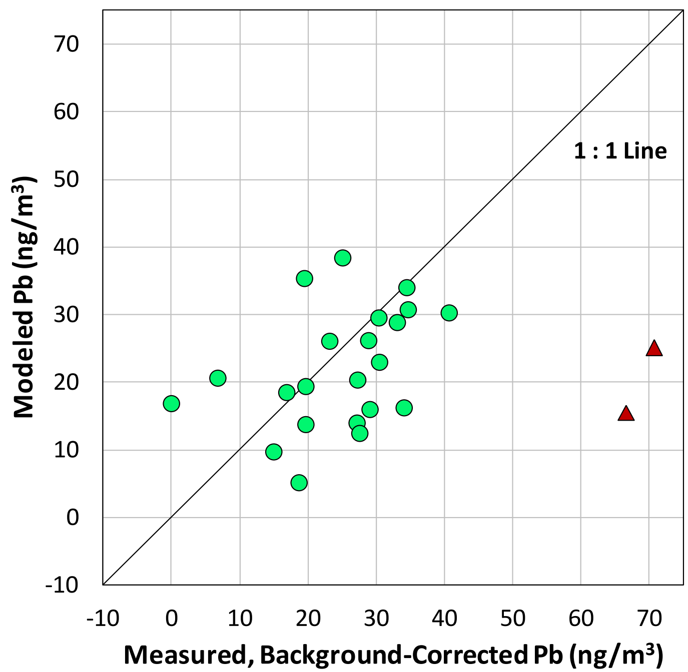
Methodology Demonstration

Measured vs. Modeled Pb
Using Publicly Available Data



Measured vs. Modeled Pb
Using Site-Specific Data



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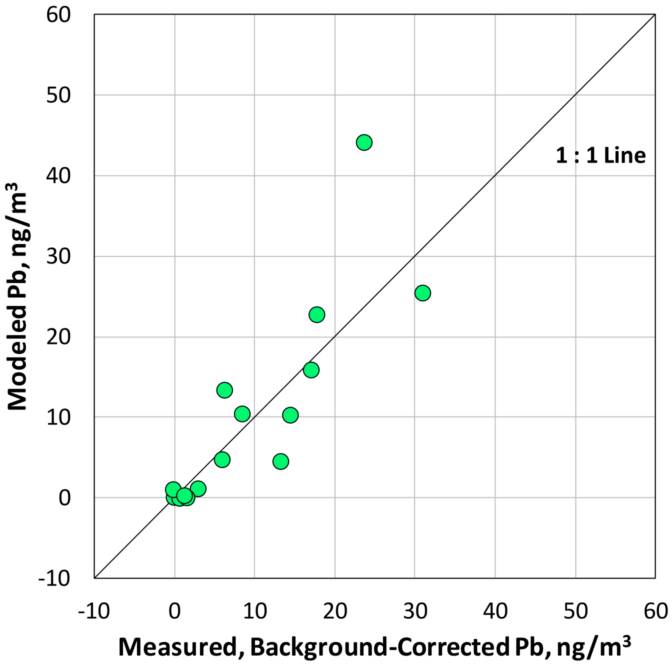
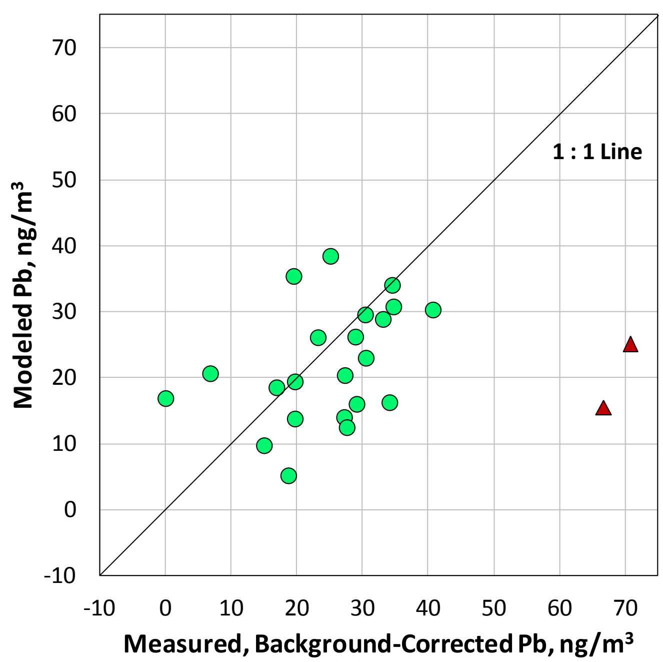
Methodology Demonstration

- Airports with modeling for days with aircraft activity data collection and $PM_{2.5}$-Pb sampling

Airport B



Airport C



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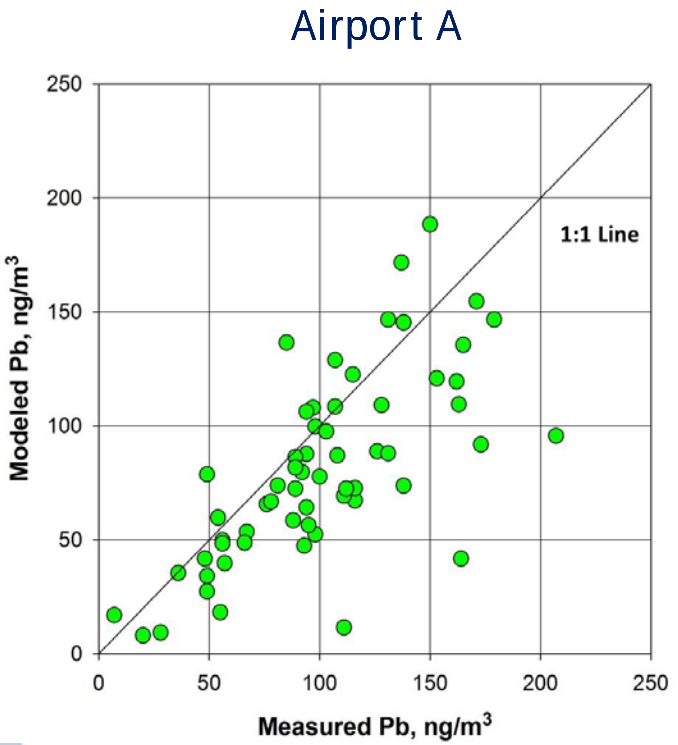
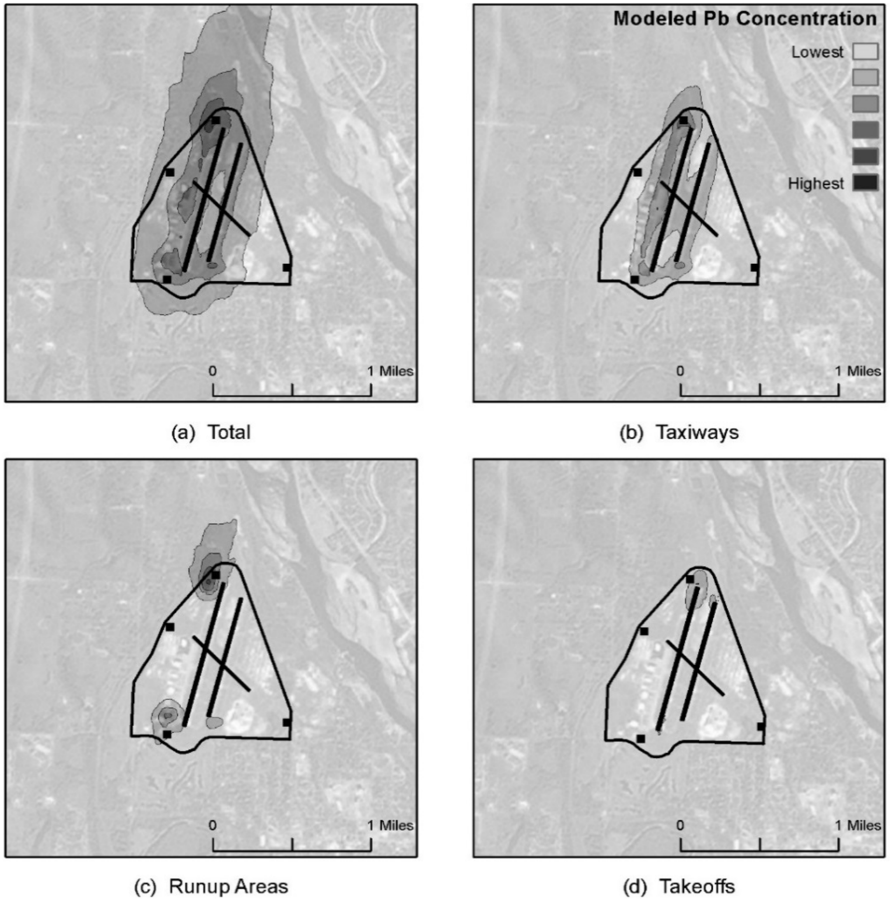
Methodology Demonstration

- Airport with modeling for days with PM_{10}-Pb sampling, but different year from aircraft activity data and fuel Pb content data collection



Results
Airport B - Operational Impacts



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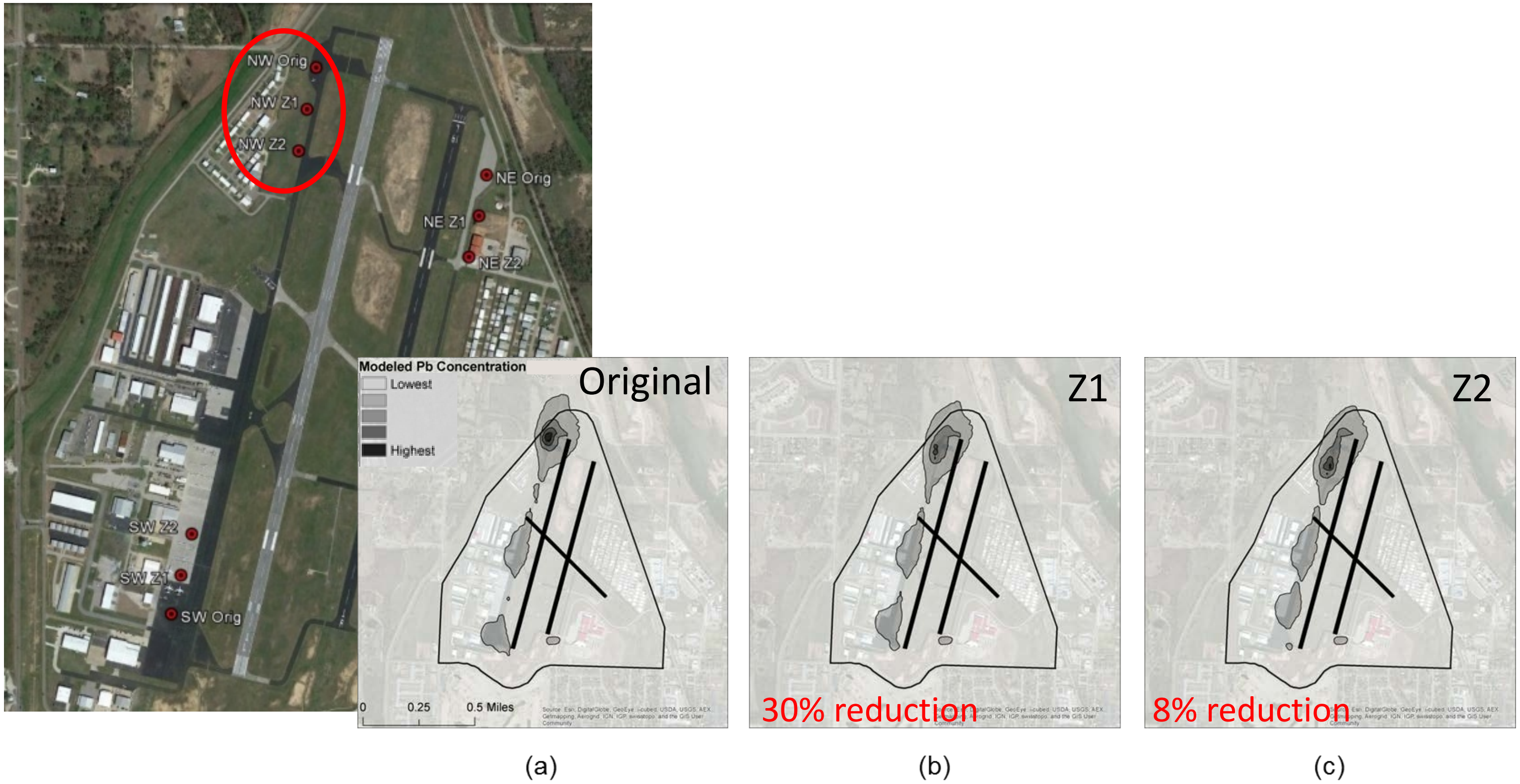
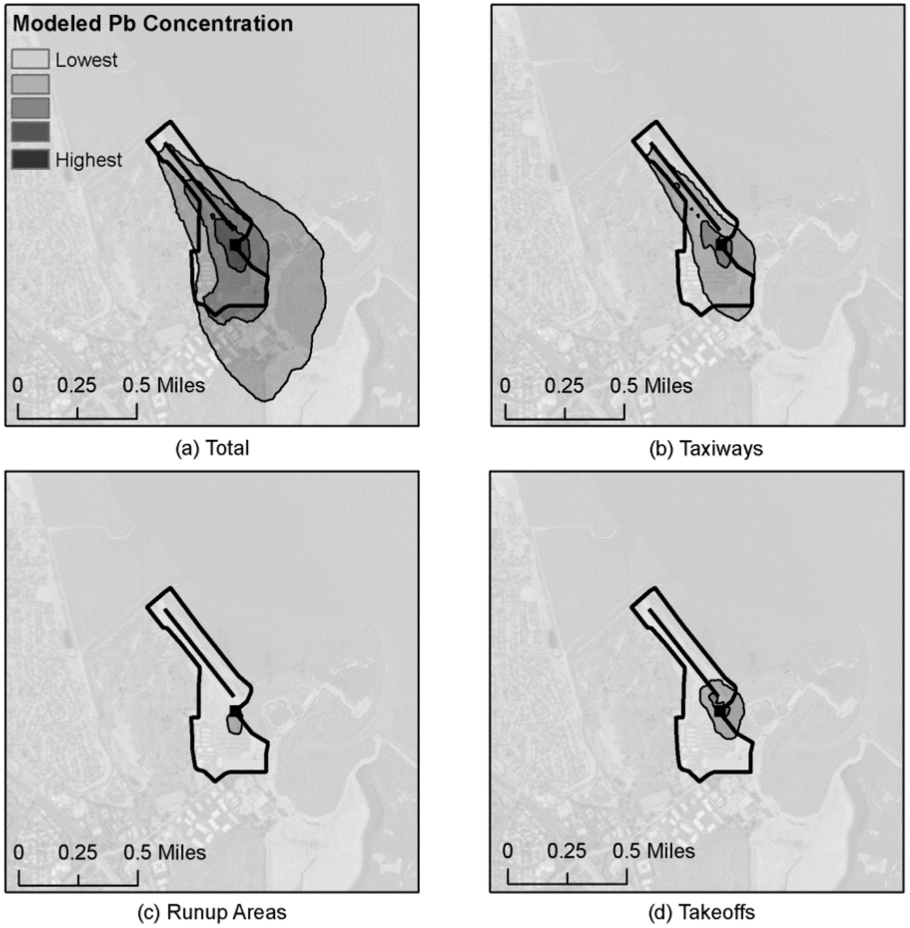
Results
Airport B – Move Run-up area



Results
Airport A - Operational Impacts



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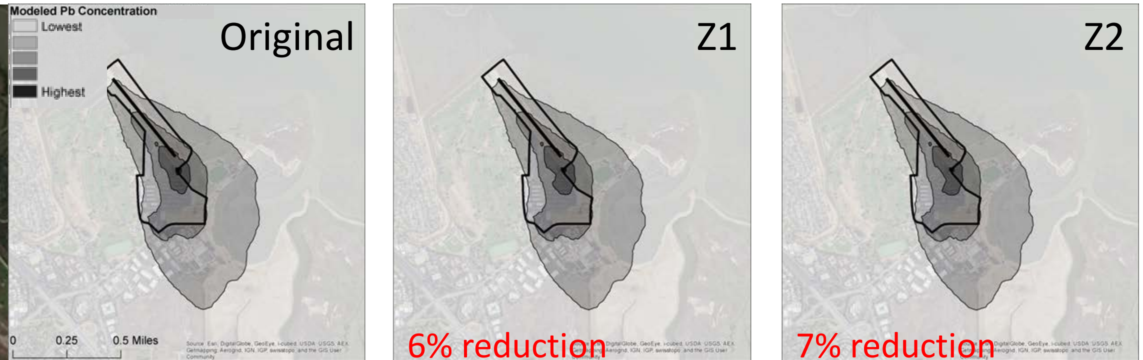
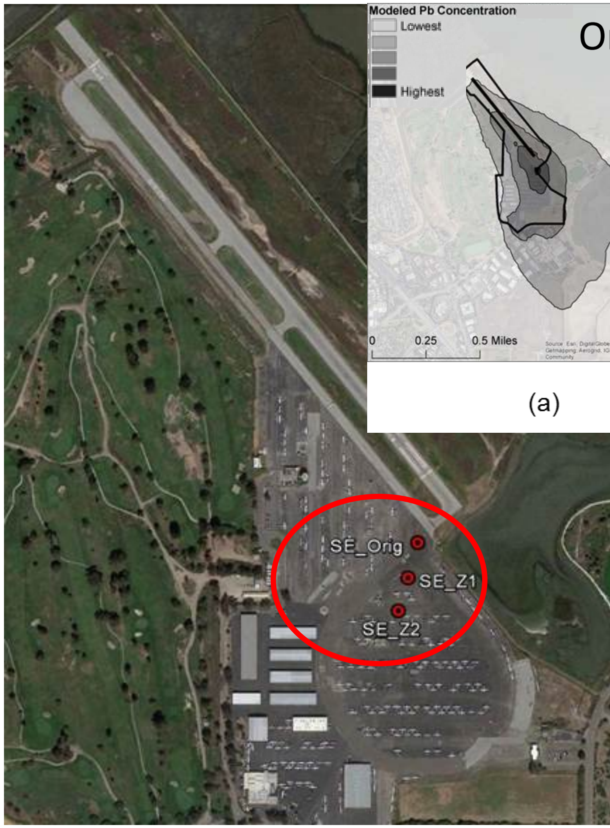
Results
Airport A – Move Run-up area



(a) (b) (c)



Results – MOGAS

- Identify aircraft models and engines certified to use MOGAS, set their Pb emissions to zero

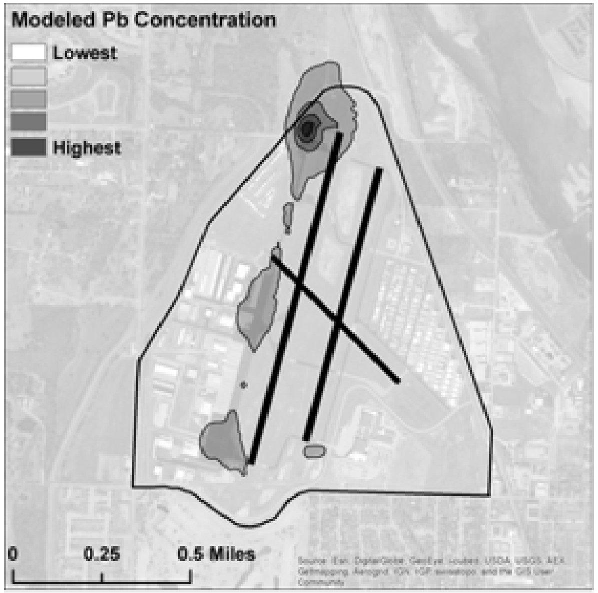
Airport	% of fleet MOGAS-certified		% reduction at hotspot max
	Active fleet	Activity-weighted	
A	27%	35%	30%
B	33%	45%	35%
C	18%	30%	20%

- Differences between active and activity-weighted fleets from flight schools with MOGOS-certified aircraft performing multiple operations per day

Results
Airport B - Impacts of Mitigation

- Use of MOGAS and Run-up Area Relocation

Base Case



(a)

Combination of Strategies

(b)

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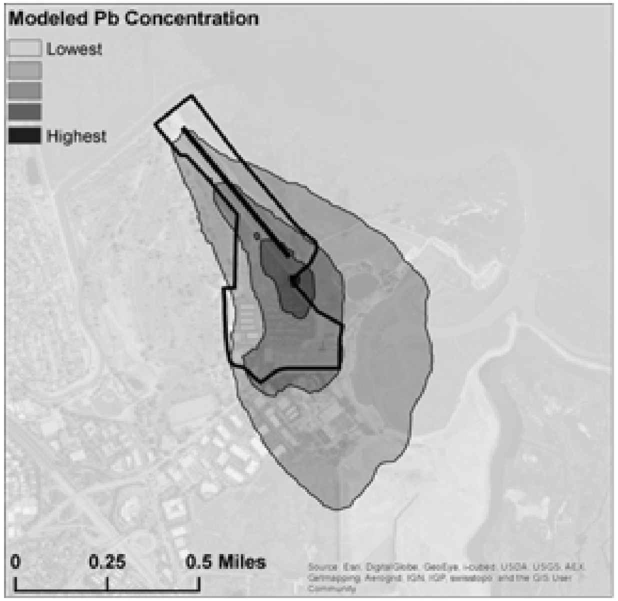
Results
Airport A - Impacts of Mitigation

- Use of MOGAS and Run-up Area Relocation

Base Case

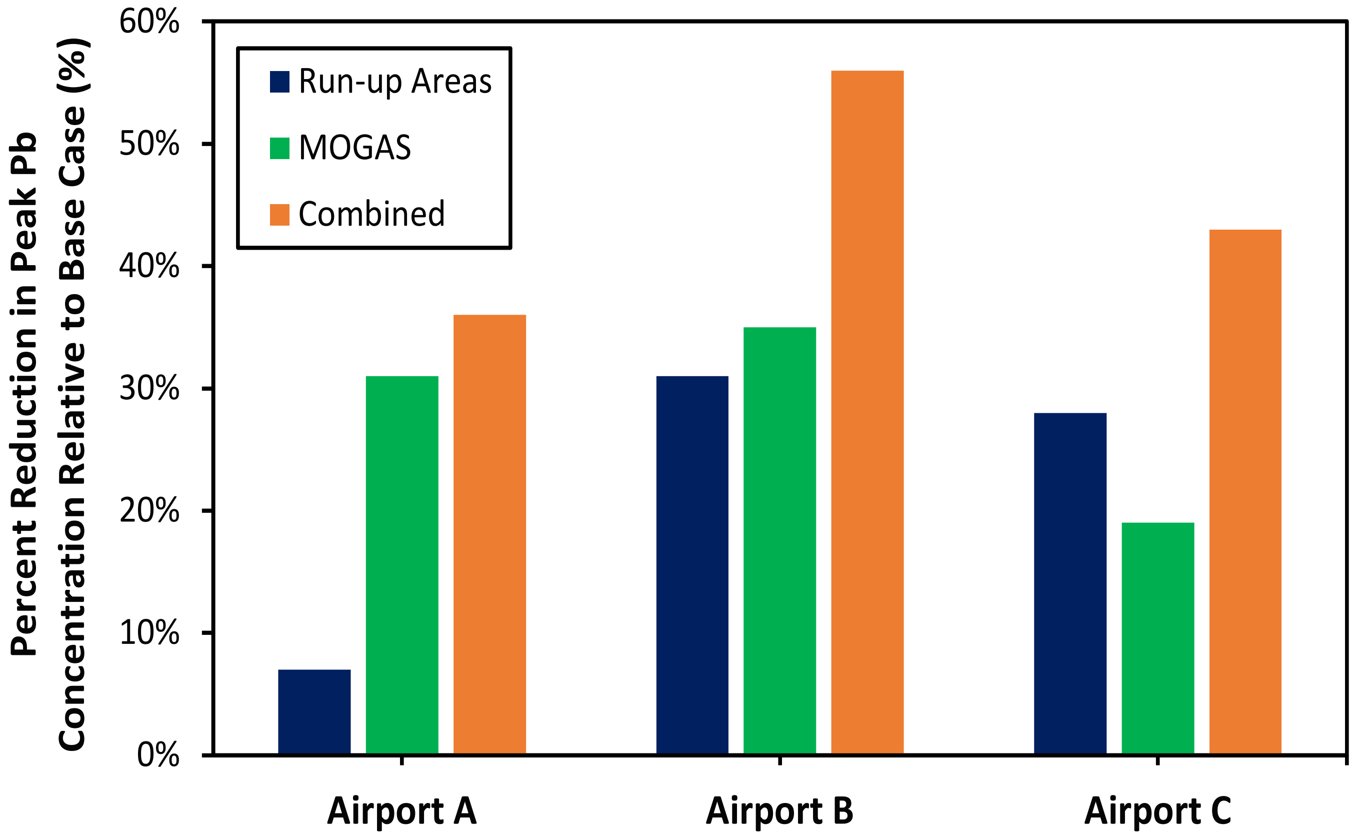


(a)

Combination of Strategies

(b)

Summary of ACRP 02-57 Results



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Considerations for Run-Up Area Relocation

- Several possible approaches
  - Increase size of existing run-up areas
  - Simultaneously use multiple run-up areas
  - Move existing run-up areas to new locations, e.g., site along runway but farther from runway end
- Operational impacts
- Safety Protocols
- Infrastructure Costs
- Noise

Considerations for Making MOGAS Available

- Fraction of active fleet, and aircraft operations, that could use MOGAS
- Commercial availability of MOGAS
- Price differential with 100LL
- Infrastructure costs
- Safety protocols to prevent misfueling

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Summary

- ACRP projects have led to the development of methodologies for estimating Pb emissions and assessing ambient Pb concentrations at airports.
- Airport-specific data collection and air quality dispersion modeling are required for rigorous assessments.
- Studies can:
  - Assess ambient Pb concentrations at and around airports
  - Resolve impacts from different operations
  - Determine benefits from mitigation measures

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For additional information:

ACRP Report 162 (Project 02-57)

Assessing Impacts of Lead Emissions at General Aviation Airports

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