

NASA Quesst Mission – Community Response Testing Plans



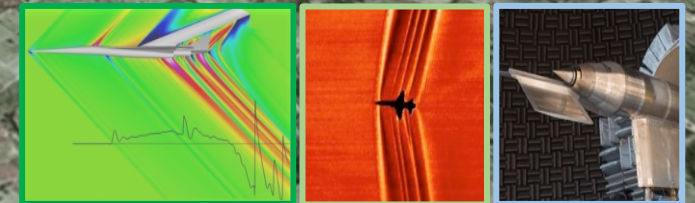
183rd Meeting of the Acoustical Society of America

Nashville, Tennessee

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Overcoming the barrier to overland flight

The Quesst Mission is specifically planned to generate key data for success in NASA's Critical Commitment to support development of en route certification standards based on acceptable sound levels

- **New environmental standards are needed to open the market to supersonic flight**
- **An en route noise standard is the biggest challenge**
 - Requires proof of new design approaches
 - Must replace current prohibitions
 - No relevant data exists to define limits
 - Community data from large, diverse population is a requirement
 - Standard must be accepted internationally

The X-59 Aircraft

Key requirements drive X-59 design

- The acoustic signal of the X-plane must effectively replicate that of future larger supersonic commercial aircraft.
- The X-plane must conduct community overflight tests using normal commercial aircraft flight maneuvers.

Design Parameters

- Length: 99' 7"
- Span: 29' 6"
- Speed: Mach 1.4 (925 mph)
- Altitude: 55,000 ft

Design Features

- New, unique airframe design with acoustic signature shaping
- Many components from existing aircraft to reduce cost
- Payload capacity: single pilot/flight test instrumentation



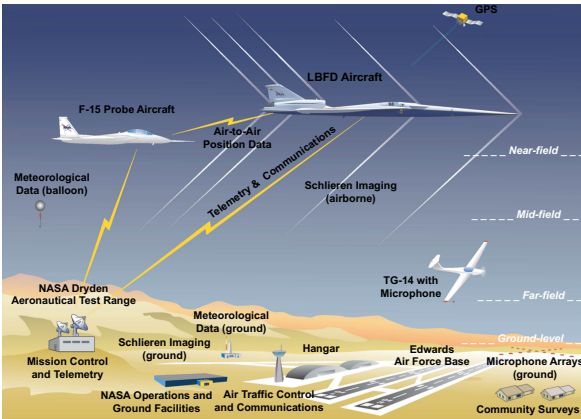
What is the NASA Quesst Mission?



Phase 1 – Aircraft Development

In progress (2018-2024)

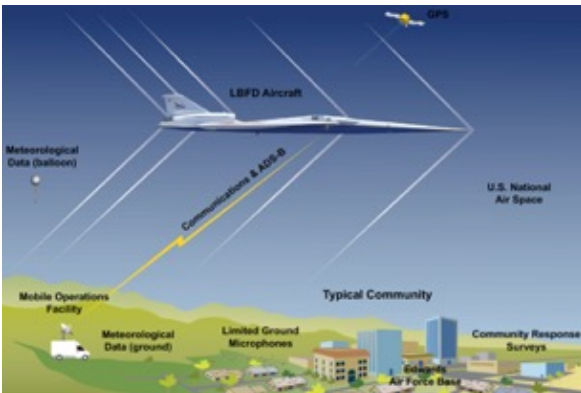
- Design, fabricate a quiet supersonic research aircraft
- Prove performance in test range flights
- Prove safety for flights in normal airspace



Phase 2 – Acoustic Validation

Preparation in progress, execution begins 2024

- Prove the acoustic characteristics match design targets
- Detailed in-flight and ground measurements in test range



Phase 3 – Community Response Testing

Preparation in progress, execution begins 2025

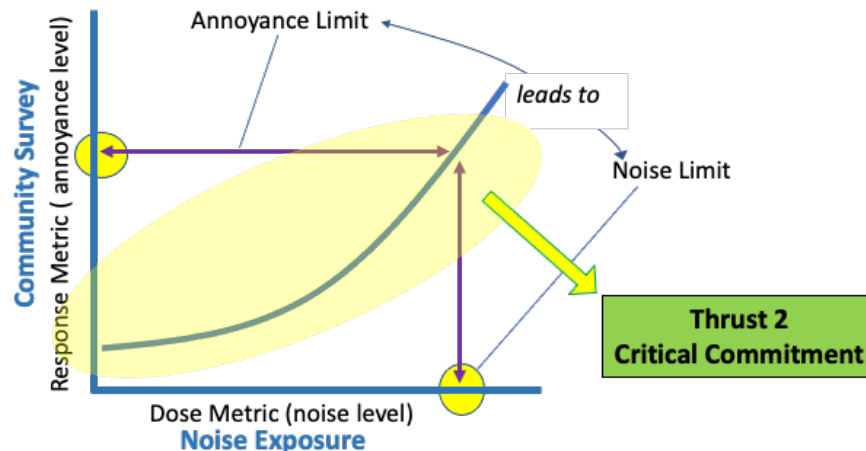
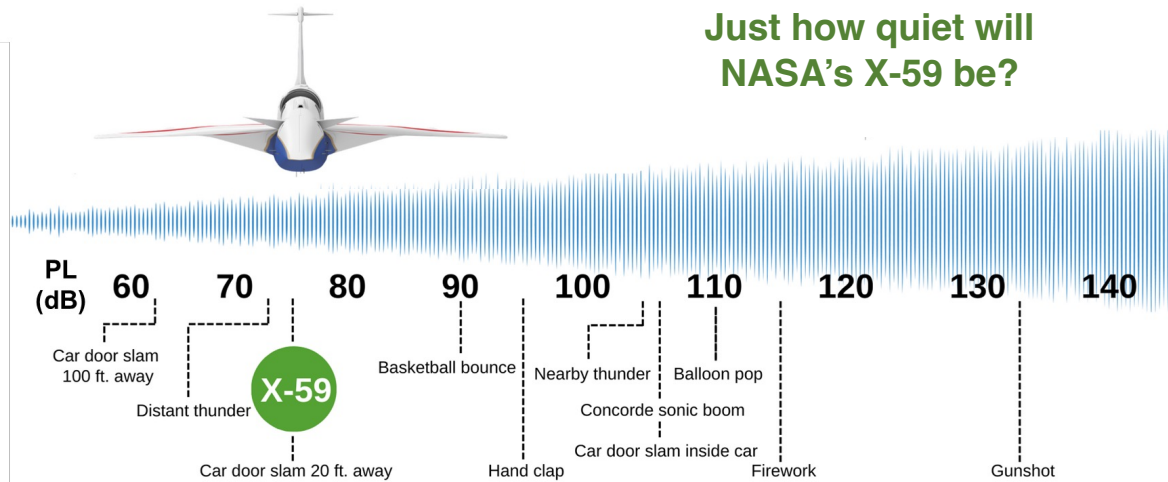
- Select communities
- Outreach and engagement (including STEM)
- Obtain necessary approval
- Plan surveys and recruit participants
- Collect ground measurements

**Systematic
Approach Leading
to Community
Testing**

Quesst Phase 3 - Community Response Testing



Just how quiet will
NASA's X-59 be?



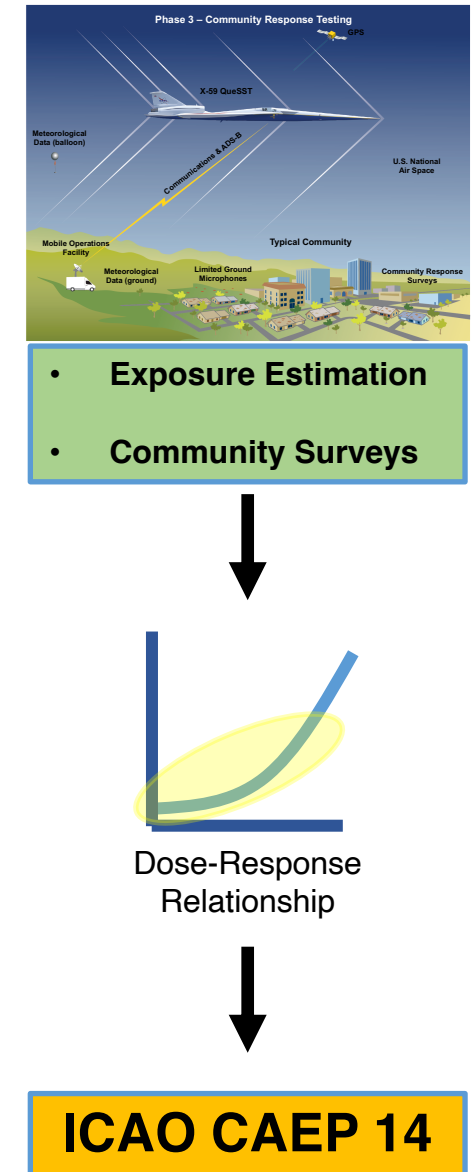
Some aspects of community tests

- 4-6 tests in different communities across the US
- Location selection will consider:
 - Variation in climate zones
 - Population demographics
 - Urbanization level
- Each test approximately 1 month long
- Daytime/waking hours
- Range of sound levels
- Acquire community response representative of the general population

Key Technical Elements of Community Response Testing



- Test site selection
 - Ensure representativeness
 - Deployment coordination/logistics
 - Public engagement
- Survey Design and Analysis
 - Participant recruitment
 - Data analysis/statistical methods
 - Tests of survey implementation, automated data processing methods
- Exposure Design and Estimation
 - Acoustic monitor placement strategies
 - Recording and extraction of signature
 - Characterization of carpet over test area (combining prediction and measurements)
- Developing Dose-Response Relationship and Delivery to ICAO
 - Matching exposure levels with participant location
 - Aggregating of multiple community test results
 - Ensuring validity/acceptance of technical approach



X-59 Community Response Testing Contract



- **Support contract to aid in all elements of planning and execution of community tests**
 - Community survey methods
 - Acoustical and meteorological data collection and analysis
 - Noise exposure planning and execution
 - Combining survey and acoustical data
 - Deployment activities
- **NASA technical roles**
 - Oversight and SME guidance to contractor team
 - Complementary SME research related to Phase 3 community testing
 - Identify, address, and mitigate technical gaps in planning/execution as needed
- **Build-out of joint government and industry team**
 - Multiple specialized subcontractors
 - SME from Volpe Center via IAA
 - Skillset overlaps to minimize gaps

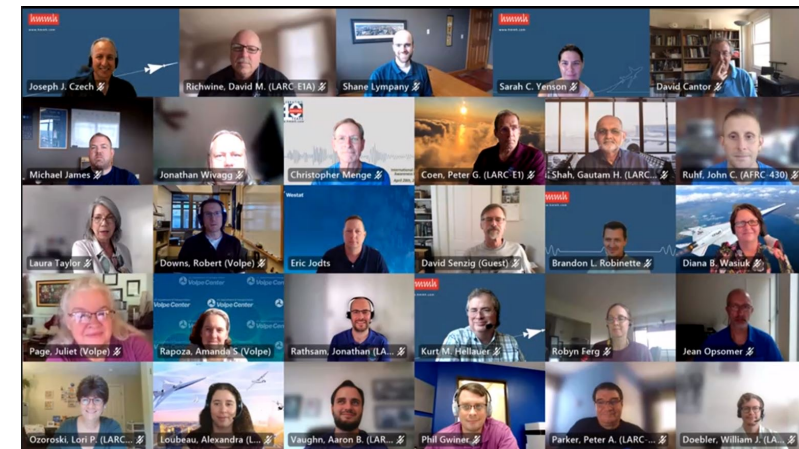


Prime Contractor



Harris Miller Miller & Hanson Inc.
Burlington MA

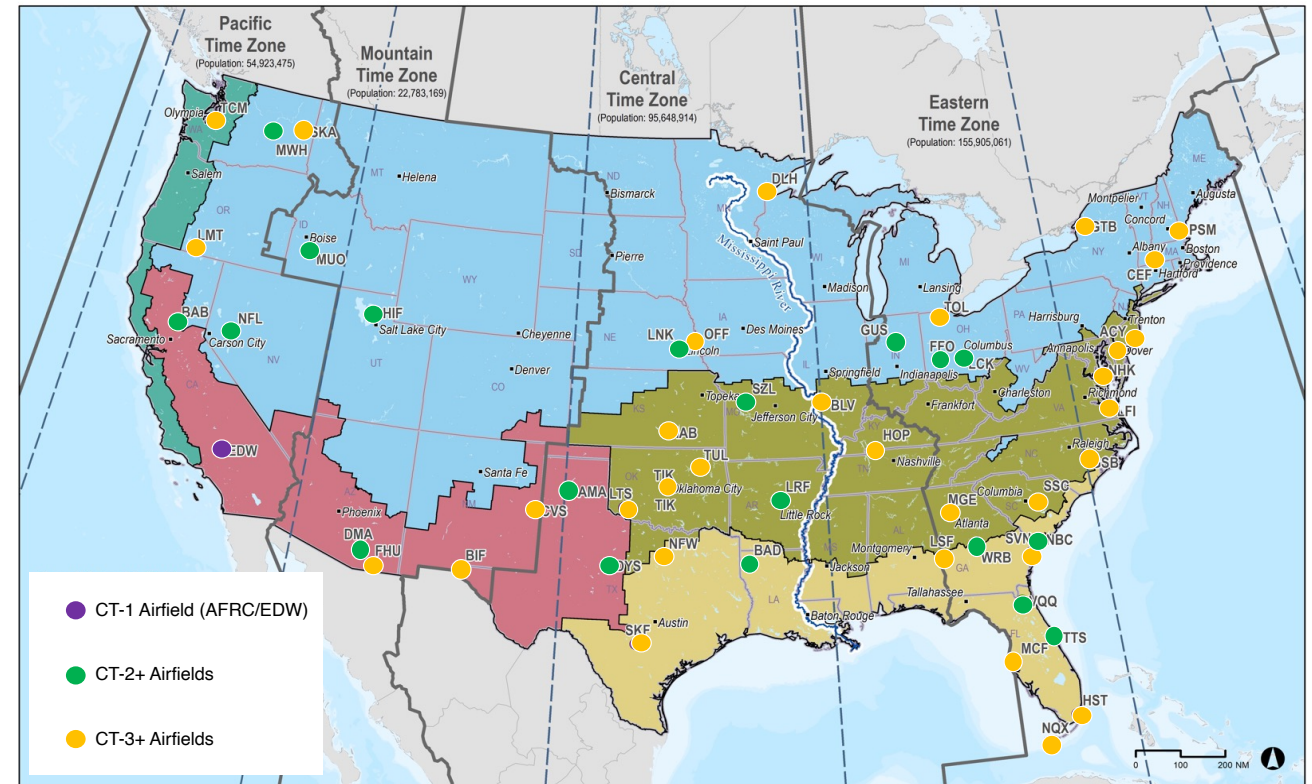
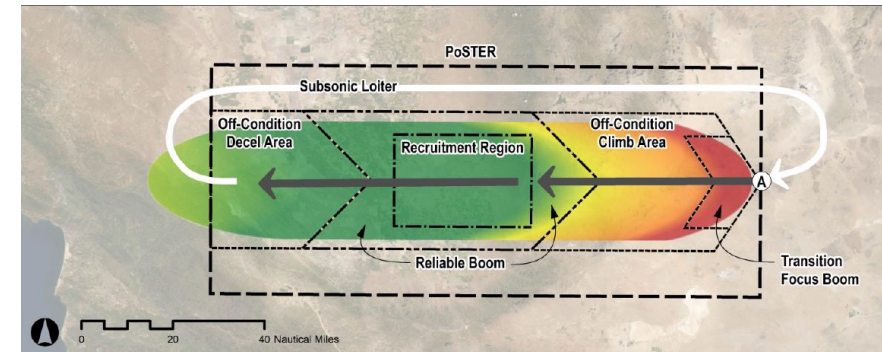
Subcontractors



Airfield and Community Test Site Selection



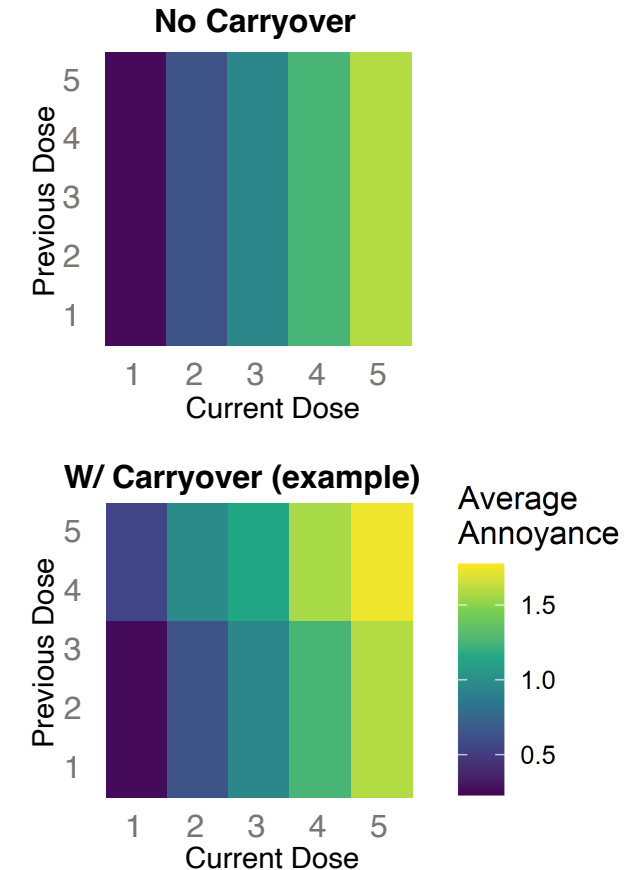
- **4-6 Tests planned for 2025-2026**
 - Test #1 from NASA Armstrong
 - Subsequent test locations TBD
- **Technical and aircraft-related constraints**
 - Runway, airfield infrastructure
 - Emergency/alternate landing sites
 - Available population centers
- **Ensuring representativeness**
 - Sampling approaches and statistical validity
 - Geographic and climate zone variation
 - Survey participant demographic diversity
 - Variation in urbanization level



Survey Design and Analysis – Recent Progress



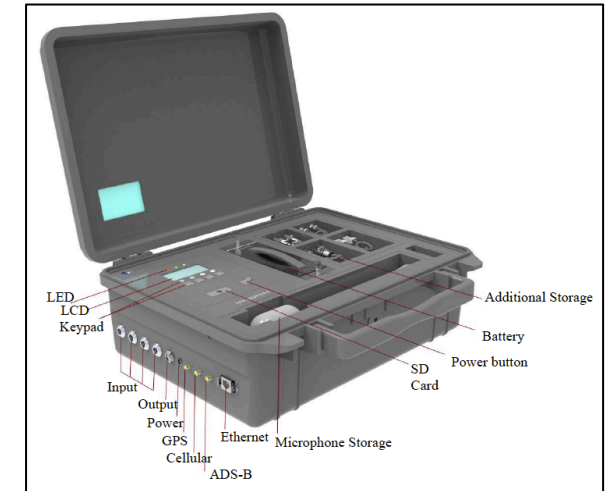
- **Development of dose-response simulation dataset**
- **Survey Methods and Analysis Plans**
 - Proposed methods are generally robust with high likelihood of success
 - Addressing / Refining specific aspects
 - Sparse data / data sufficiency; Dose error mitigation
 - Combining data from multiple communities
- **Research on Effect of Dose Error on Dose-Response Curve**
 - Dose error creates a bias in dose-response curve (upper plot)
 - Bias not alleviated by increasing number of survey participants
 - Accuracy requires emphasis on quantifying, minimizing, and mitigating error
- **Study of potential for carryover effects in survey results**
- **Feedback from Independent Expert Panel on survey plans**



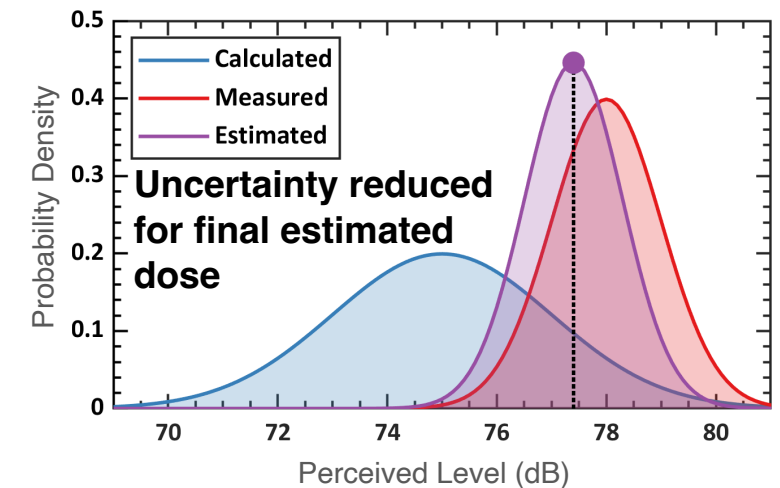
Exposure Design, Estimation, and Analysis – Recent Progress



- **Estimation and refinement of attainable range of boom levels**
- **Noise Exposure Scheduling Tool Developed**
 - Automated, adaptable dose scheduling for Phase 3
 - Inputs for dose range, operational constraints (X-59, crew rest, etc.)
- **Meteorological data needs identified**
 - Finalized hardware selection with data-based assessment of resolution
 - Validation cases finalized for regional forecast model under development
 - Devised method to extract turbulence parameters from atmospheric models
- **Progress of Ground Recording System towards Phase 3 use**
 - Prototype units evaluated
 - Initial operations procedures for community test usage developed
- **Key components of dose and uncertainty calculation assembled**
 - Algorithms to identify measured boom, mitigate ambient noise, compute metrics
 - Combine measurements with calculated doses at participant locations



Ground Recording System Unit

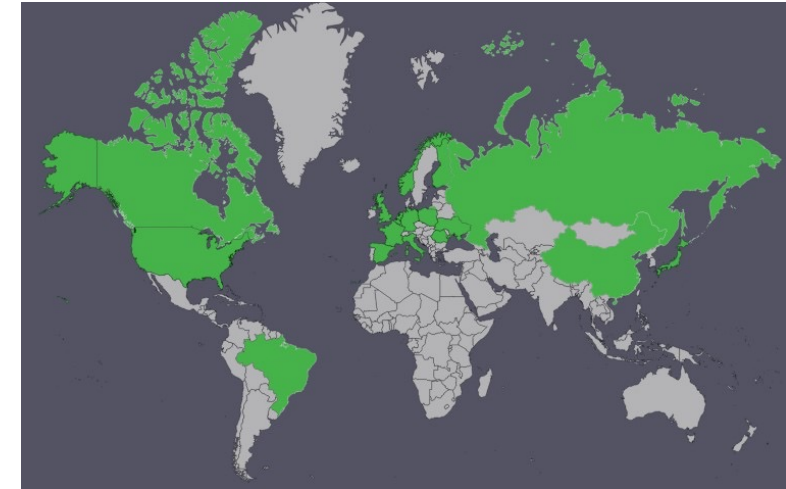


**Combining calculated and measured levels
(Notional Example)**

International Community Test Workshop 2 - Dec 2021



- **First major dissemination of scope of NASA plans**
 - Quesst mission overview and timeline
 - Technical approaches for site selection, survey, exposure estimation
- **Workshop Goals**
 - Communicate current status and overall plans for community testing
 - Obtain feedback; Identify any significant concerns on suitability of the proposed approaches and dataset as basis for international standards
- **Robust interchanges and discussions**
 - General concurrence with overall technical approach
 - Concerns expressed and discussed during workshop included:
 - Applicability of dataset; methods to expand representativeness
 - Characterization of annoyance relationship to rattle/vibration
 - Incorporating inputs to survey and exposure design/analysis plans as appropriate
 - Ongoing follow-up/engagement with key SME's via WG1 and other technical forums
- **NASA plans and workshop findings presented at Internoise Conference, Glasgow – Aug 2022**



Broad International Participation

- 18 Countries
 - 120+ attendees
 - 50+ organizations
- | | |
|--------------|------------------------|
| - Research | - Academia |
| - Regulatory | - Industry – technical |
| - Government | - Industry - OEM |

Quesst Mission Phase 3 Overall Timeline



2019 - 2024	2025 - 2026	2027
<i>Planning Stage</i>	<i>Execution Stage</i>	
• Develop overall Community Testing plans ○ Survey design ○ Exposure estimation ○ Operations ○ Public outreach and communication • Risk reduction activities ○ Survey test ○ Acoustic monitor and infrastructure checkout ○ Automated data processing validation • Obtain feedback on survey methods and exposure estimation approaches ○ ICAO CAEP Working Group 1 participation ○ Virtual and in-person international workshops ○ Independent review panel	• Community Test 1 near AFRC • Additional community tests ○ Various regions ○ Participant demographics • Survey and exposure data analysis • Develop dose-response relationship • Aggregate analyses and extend to nationally-representative database	Database delivery for CAEP14



Questions?

Thank you!