Human Health Risk Assessment – A Case Study

As Part of the PFAS Affected Property Assessment Investigation at Former Reese AFB, Lubbock, Texas

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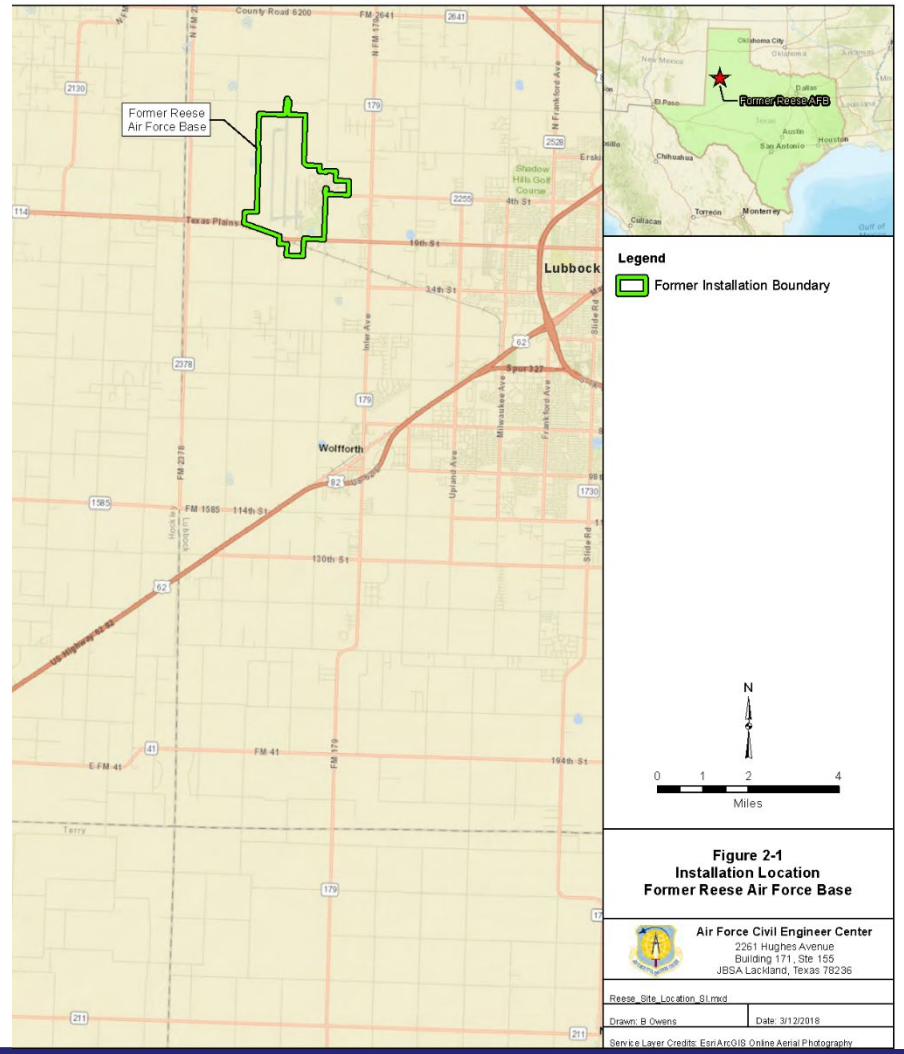
Agenda

- Introduction
- Overview
- Affected Property Assessment (APA)
- Human Health Risk Assessment
- Summary

Overview



- 1970 - 1997: Aqueous Film Forming Foam (AFFF) used at Reese AFB
- 1997: Reese AFB closed under BRAC
- 2016: Preliminary Assessment identified 11 AFFF Areas and 1 Fire Training Area (FTA)
- 2017: Site Inspection identified PFAS in soil and groundwater
- 2017 - Ongoing: Domestic Well Sampling and Treatment
- 2019 - 2023: TRRP Affected Property Assessment (APA) required under TCEQ RCRA Corrective Action Permit

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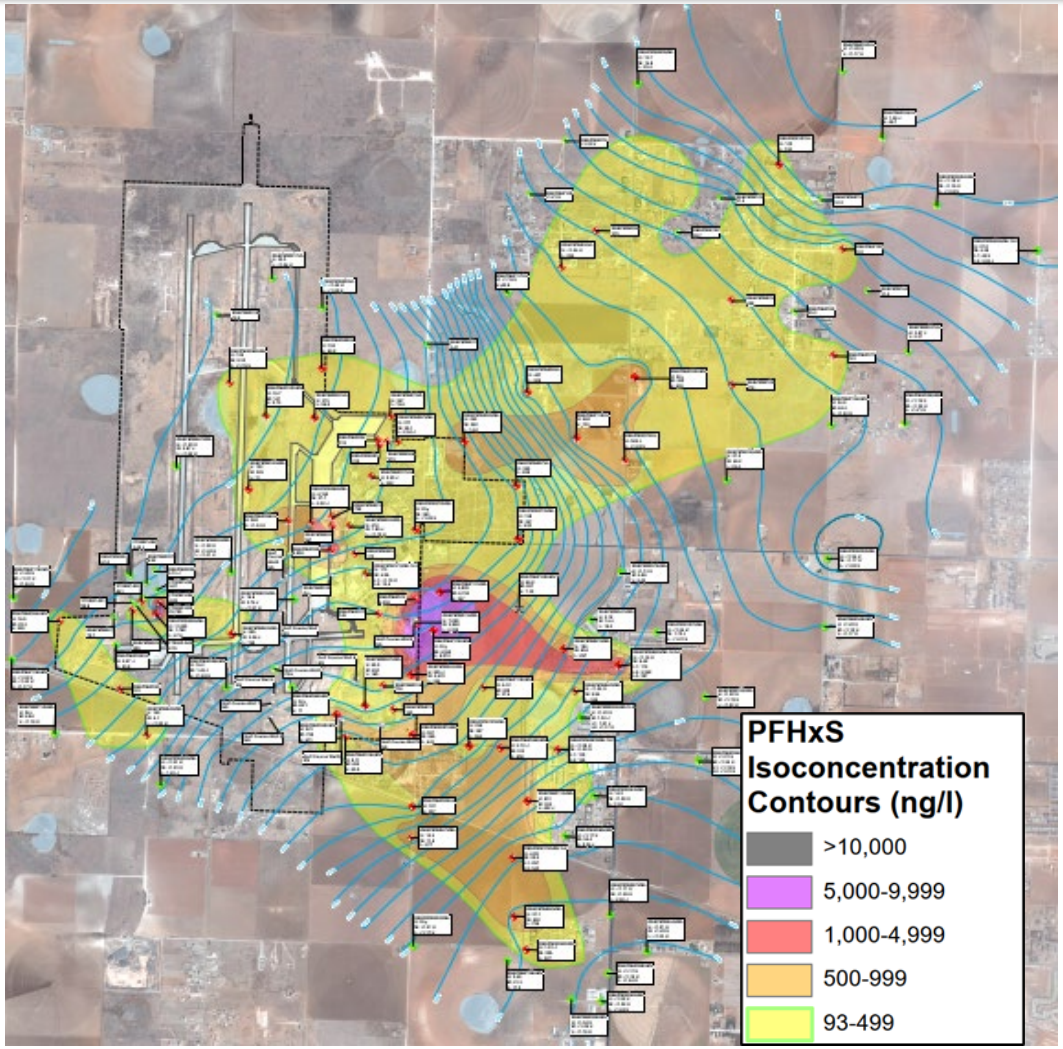
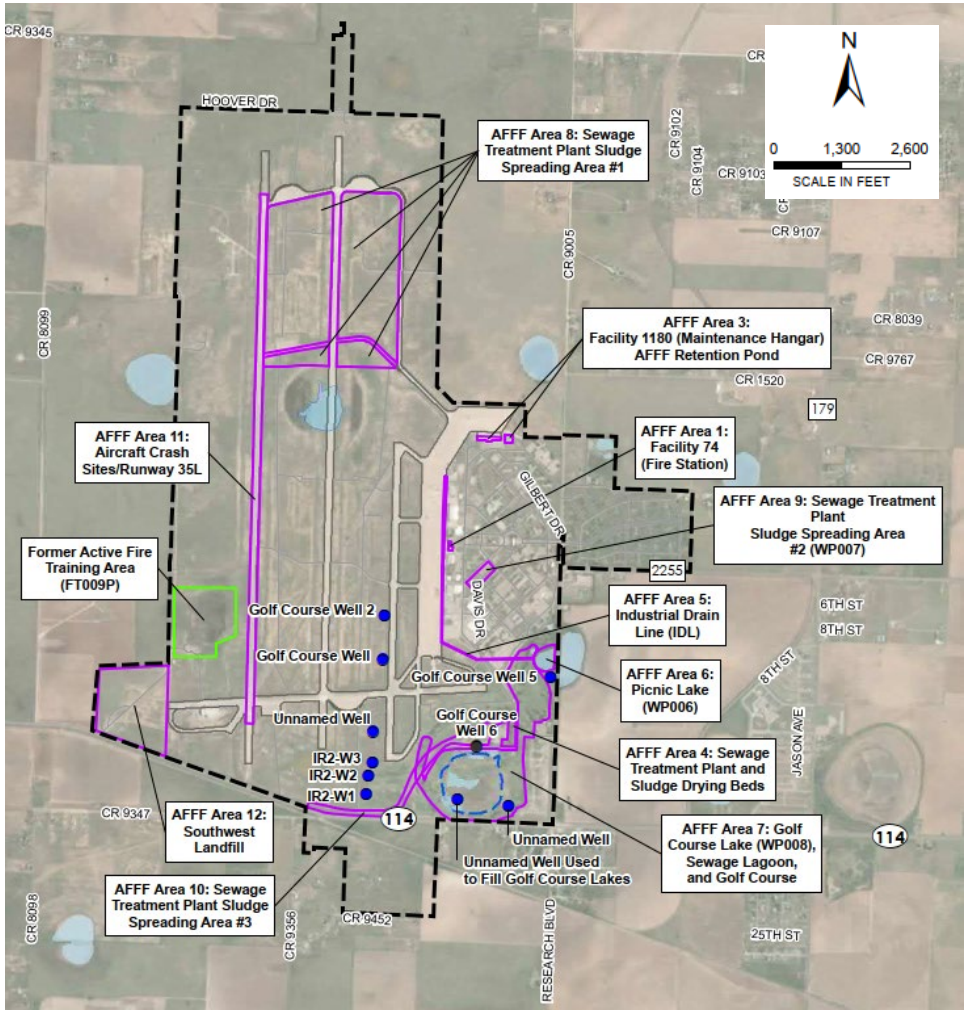
Overview



- **2023 – Ongoing: Interim Corrective Measures for the Picnic Lake Area Plume**
- **2023 – Ongoing: Feasibility Study process towards TCEQ Response Action Plan (RAP)**

Affected Property Assessment

- TCEQ Concurrence January 2024
- Conceptual Site Model (CSM)
- Media sampled: groundwater, soil, surface water, sediment, fish, benthic invertebrates, plant tissue, vegetable tissue
- Human Health Risk Assessment
- Tier 3 Human Health Risk Assessment for fish ingestion
- Screening Level Ecological Risk Assessment
- Site-Specific Ecological Risk Assessment
- Residential Vegetable Garden Evaluation
- Lysimeter Study



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Human Health Risk Assessment

Human Health Risk Assessment

- **Former Reese AFB (TX), PFAS APAR Phase II HHRA**
- **Performed in accordance with TRRP regulations and guidance & TCEQ-approved HHRA Work Plan**
- **Objectives:**
  - **Identify potentially complete human exposure scenarios to PFAS in environmental media, attributable to historical use of AFFF at the former Reese AFB**
    - soil, groundwater, sediment, surface water, plant tissue (e.g., garden vegetables), fish tissue
  - **Estimate potential carcinogenic risk and noncarcinogenic hazard (as applicable)**
  - **Develop Tier 3 PCLs**
    - for PFAS and human exposure scenarios for which an unacceptable potential hazard is identified for consideration in the Phase II APAR
  - **Provide information for use in remedial decision-making**

Acronyms:

- **APAR – Affected Property Assessment Report**
- **TRRP – Texas Risk Reduction Program**
- **TCEQ – Texas Commission on Environmental Quality**
- **PCL – Protective Concentration Level**

TCEQ TRRP HHRA Process

- **Prescribed in TRRP rule and guidance [30 TAC 350.75 (a)-(h)]**
  - **Tier 1: Comparison to default/generic PCLs**
    - **Performed in APAR for complete or reasonably anticipated to be complete exposure pathways**
    - **TCEQ Tier 1 PCLs in published look-up tables (soil and groundwater only)**
  - **Tier 2: Development of site-specific PCLs**
    - **Performed in APAR**
    - **Allows for use of limited site-specific information**
  - **Tier 3:**
    - **Site-specific HHRA**
      - Included individual PFAS retained as potential chemicals of concern (COCs) following the Tier 1/Tier 2 PCL evaluation
      - Included receptors/exposure scenarios for which Tier 1 PCLs are not available
    - **Comparison to site-specific PCLs**
      - Performed in APAR
      - Allows for use of additional site-specific information/alternate equations
      - Informs remedial decision-making

CERCLA vs TRRP – PFAS List

- **TCEQ TRRP**
  - **16 PFAS**
  - **May 2023 Protective Concentration Level (PCL) Tables**
- **U.S. EPA**
  - **14 PFAS**
  - **May 2024 Regional Screening Level (RSL) Tables**
- **DoD (Assistant Secretary of Defense, March 2024) – CERCLA sites**
  - **8 PFAS**
  - https://www.acq.osd.mil/eie/eer/ecc/pfas/pfas101/rsl.html

TRRP (May 2023 PCL Tables) – 16 PFAS	U.S. EPA (May 2024 RSL Table) - 14 PFAS
Perfluorooctanesulfonic acid (PFOS)	**Perfluorooctanesulfonic acid (PFOS)**
Perfluoroundecanoic acid (PFUnA)	Perfluoroundecanoic acid (PFUDA)
Perfluoropentanoic acid (PFPeA)	
Perfluorohexanoic acid (PFHxA)	**Perfluorohexanoic acid (PFHxA)**
Perfluorododecanoic acid (PFDoA)	Perfluorododecanoic acid (PFDoDA)
Perfluorooctanoic acid (PFOA)	**Perfluorooctanoic acid (PFOA)**
Perfluorodecanoic acid (PFDA)	
Perfluorodecanesulfonic acid (PFDSA)	
Perfluorohexanesulfonic acid (PFHxS)	**Perfluorohexanesulfonic acid (PFHxS)**
Perfluorobutanoic acid (PFBA)	**Perfluorobutanoic acid (PFBA)**
Perfluorobutanesulfonic acid (PFBS)	**Perfluorobutanesulfonic acid (PFBS)**
Perfluoroheptanoic acid (PFHpA)	
Perfluorononanoic acid (PFNA)	**Perfluorononanoic acid (PFNA)**
Perfluorotetradecanoic acid (PFTeA)	Perfluorotetradecanoic acid (PFTetDA)
Perfluorotridecanoic acid (PFTrDA)	
Perfluorooctane sulfonamide (PFOSA)	
	Bis(trifluoromethylsulfonyl)amine (TFSI)
	Hexafluoropropylene oxide dimer acid (HFPO-DA)
	Perfluorooctadecanoic acid (PFODA)
	Perfluoropropanoic acid (PFPrA)

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CERCLA vs TRRP - HHRA Process

	TCEQ	U.S. EPA
COPC Selection	Comparison of Tier 1 PCLs, where available (done in the APAR)	Comparison to U.S. EPA Regional Screening Levels (RSLs)
Exposure Assessment	Calculation of pathway-specific Risk-Based Exposure Limits (RBELs)	Calculation of pathway-specific Average daily dose (ADD)
	Differences in default exposure inputs	
Risk Characterization	Target cancer risk level (individual COCs) = 10^{-5}; Target HQ (individual COCs) = 1; Target HI (multiple COCs) = 10	Target cumulative cancer risk range = 10^{-6} to 10^{-4}; noncancer HI = 1 (per target organ)

CERCLA vs TRRP - Toxicity Values

- **TCEQ**
  - Noncancer endpoints only
  - Oral reference doses (RfDs)
  - Inhalation reference concentrations (RfCs); extrapolated for most PFAS
- **EPA**
  - Oral cancer slope factors (CSFs): PFOS* and PFOA
    - U.S. EPA Office of Water
  - Noncancer oral RfDs
    - Tier 1: U.S. EPA IRIS
    - Tier 2: PPRTV
    - Tier 3: ATSDR, U.S. EPA OW, ORD*, State of WI DHS*
  - No inhalation toxicity values
  - HHRA included sensitivity analysis using U.S. EPA toxicity values

*Indicates a change following the HHRA for the Reese AFB

Acronyms:

- ATSDR – Agency for Toxic Substances and Disease Registry
- WI DHS – Wisconsin Department of Health Services
- IRIS – Integrated Risk Information System
- ORD – Office of Research and Development
- OW – Office of Water
- PPRTV – Provisional Peer-Reviewed Toxicity Values

Human Exposure Pathways

Source Medium	Area	Receptor	Exposure Pathways
Surface Soil	On site/ Off site	Resident (adult/child)	Incidental ingestion, dermal contact, inhalation of volatiles and particulates, and ingestion of aboveground and below-ground vegetables
		Commercial/Industrial Worker	Incidental ingestion, dermal contact, inhalation of volatiles and particulates
		Site Visitors/Recreational Users	Incidental ingestion, dermal contact, inhalation of volatiles and particulates
Subsurface Soil	On site/ Off site	Resident (adult/child)	Inhalation of volatiles
		Commercial/Industrial Worker	
		Site Visitors/Recreational Users	Inhalation of volatiles
Groundwater	Off site	Agricultural Users	Incidental ingestion, dermal contact, and inhalation of volatiles in groundwater used for irrigation
			Ingestion of meat/eggs from animals fed water containing PFAS
			Ingestion of agricultural crops irrigated with water containing PFAS
Sediment	On site/ Off site	Recreational User (adult/child)	Incidental ingestion and dermal contact
			Ingestion of fish from on site water bodies
Surface Water	On site/ Off site	Recreational User (adult/child)	Incidental ingestion and dermal contact
			Ingestion of fish from on site water bodies

Quantitative evaluation performed in the HHRA (if potential COCs were identified)

Qualitative evaluation performed in the HHRA

Media/Pathways Not Included in HHRA

- **Pathways for which the HHRA conclusions would not change APAR conclusions or PCLs used**
  - **Adjustment of human exposure factors is not applicable**
- **Groundwater pathways**
  - **Ingestion of groundwater (as drinking water) (Class I)**
    - Per TRRP rule, points of exposure for Class I groundwater (drinking water) are individual wells
  - **Inhalation of volatiles in groundwater**
  - **Leaching of PFAS from soil to groundwater**
  - **These pathways were evaluated in the APAR via tiered PCL evaluation**
    - U.S. EPA MCLs for PFAS released following APAR submittal & have been applied as required by RCRA permit

Closer Look at Site-specific Scenarios

Off site Residential Properties Vegetable Ingestion Pathway

- Off site residential properties with vegetable gardens
  - Whole-home treatment systems installed beginning in 2018
  - Potential residual PFAS concentrations in garden soil
- Surface soil and vegetable samples collected for HHRA
- Extensive coordination & communication with residents to develop sampling plan
  - Letters & follow up phone calls to set up interviews
  - Telephone interviews
  - Collected garden-specific information
    - Source of garden soil
    - irrigation practices
    - types of produce grown
    - consumption behaviors of home-grown produce
    - willingness to allow sampling from their garden

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Off site Residential Properties Vegetable Ingestion Pathway

- **Co-located surface soil and vegetable samples**
  - Collected from 5 off site residential gardens
  - 2 sampling events in 2021 - summer (Jul/Aug), fall (Nov/Dec)
- **Above-ground and belowground vegetables**
  - zucchini squash, tomatoes, okra, carrots, lettuce, mustard greens, radishes, turnips, turnip greens, other greens
- **Multiple challenges to overcome**
  - Some residents not currently gardening due to TCEQ recommendations
  - Provided seeds/seedlings
  - Timing of planting/sampling
  - Background/reference samples grown in containers using bagged potting/garden soil
  - Avoided items that may contain PFAS
  - Written instructions & periodic check-in calls needed
    - Plant care, no PFAS-containing products used, check status of plants, maximize yield for sampling

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Off site Residential Properties Vegetable Ingestion Pathway

- Detected PFAS identified as potential COCs for quantitative evaluation in the HHRA
- Each residential property evaluated as a separate exposure area
- Site-specific soil-to-plant uptake factors calculated & assessed in uncertainty analysis

Conclusions:

- No unacceptable risk to off site residents via exposure to PFAS in garden surface soil and vegetables
- No PFAS retained as COCs in off site gardens

Fish Ingestion Pathway

- **Potential uptake of PFAS from sediment/surface water to fish in on site water bodies (lake, ponds)**
- **Interviews with Reese Golf Center Superintendent**
  - **Ponds not formally stocked**
  - **Fishing occurs on catch & release basis; fish are not consumed**
  - **Hypothetical future recreational fishing scenario conservatively evaluated**
- **Tier 1 assessment**
  - **Modeled PFAS concentrations in fish tissue from abiotic media (sediment & surface water) using literature-based uptake factors**
  - **Recommended further evaluation of 5 on site water bodies**

Tier 3 Fish Ingestion HHRA

- Collected fish tissue samples, electroshocking via boat
  - Targeted pelagic & bottom-dwelling species that humans may consume
  - Fish identified and sampled from 3 ponds; no fish observed in 2 ponds
- Biological survey - 2 ponds not suitable to sustain fish
- Analysis
  - Scaled fish (i.e., largemouth bass) - skin-on fillets after removing scales; Scaleless fish (i.e., sunfish and channel catfish) - skinless fillets
  - 7 PFAS (PFOS, PFPeA, PFHxA, PFOA, PFDSA, PFHxS, & PFOSA); LC/MS/MS method compliant with Table B-15 of DoD QSM 5.3
- Ponds evaluated as separate & combined exposure areas

Conclusions:

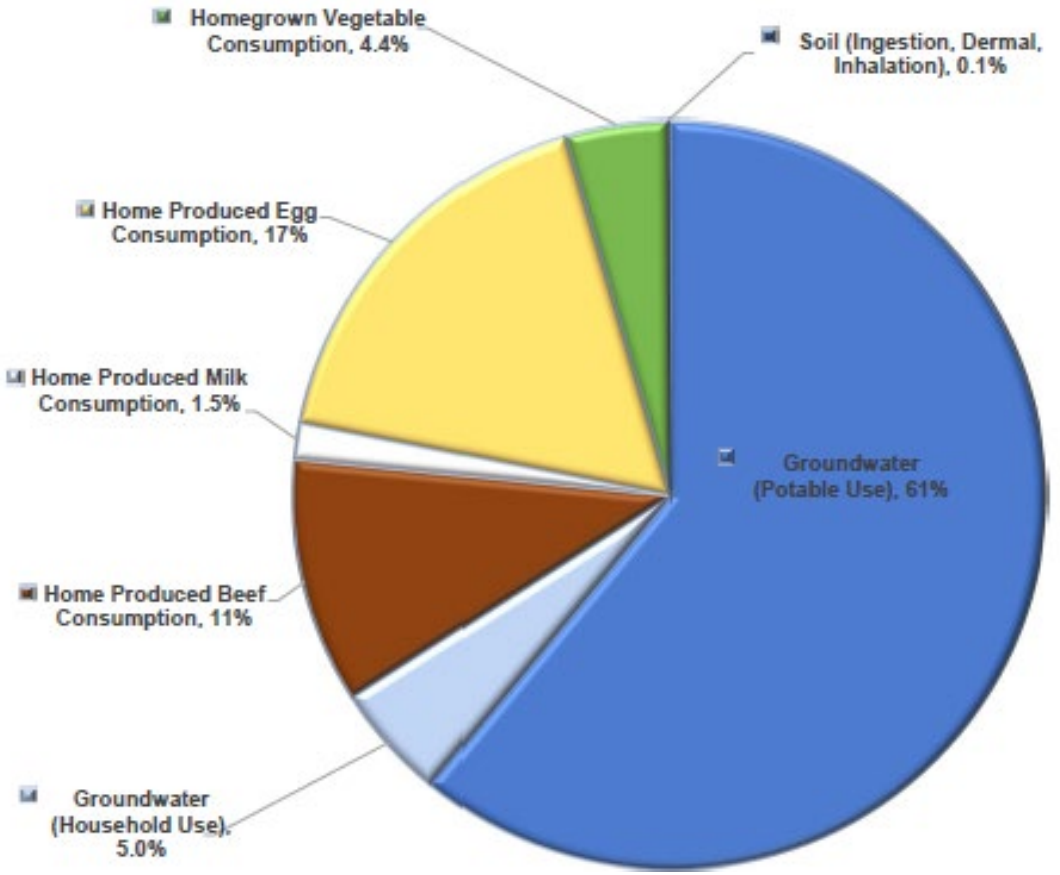
- No unacceptable risk to on site recreational users via exposure to PFAS in fish tissue
- No PFAS retained as COCs in fish tissue from the on site water bodies

Off Site Agricultural User

- Potential PFAS exposure via irrigation water from livestock (meat, milk, eggs) or cotton/sorgum products
- No established TRRP or EPA methods
- Qualitative evaluation performed
  - Conducted literature review; few available studies
  - Compared relative risks from potable use of groundwater to irrigation pathways based on Australia risk assessment (AECOM, 2017)

Conclusions:

- Potable use pathway protective of agricultural pathways
- Where potable use unacceptable, agricultural may be as well



Graph presented for Residential Child. In adults, 84% of PFAS exposure is due to potable use of groundwater.

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Conclusions

- **HHRA Conclusions**
  - **No unacceptable risk:**
    - Exposure to soil by current on site residents, off site residents, & future off site commercial/industrial workers
    - Ingestion of garden vegetables by current off site resident/gardeners
    - Exposure to sediment, surface water, & ingestion of fish tissue by on site & off site recreational users
  - **Potential noncancer hazard exceeds TCEQ's target level(s):**
    - Ingestion of groundwater as drinking water & inhalation of volatiles in groundwater (Based on results of PCL comparisons in APAR)
    - Exposure to soil by future on site residents & commercial/industrial workers
- **Detailed uncertainty analysis performed**
- **Importance of frequent communication**
  - **Off site residents, Air Force project team, regulatory agencies (TCEQ as lead agency; EPA in support role)**
- **Evolving PFAS Regulations**
  - **Have adopted U.S. EPA MCLs at Reese AFB based on RCRA permit**
  - **HHRA update anticipated based on revisions to TCEQ toxicity values and PCLs (expected within 1 year)**

Questions

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