

Bosque/Leon River Watersheds

Perchlorate Study



United States Army Corps of Engineers



Texas Commission on Environmental Quality



Brazos River Authority



The Institute of Environmental and Human Health at Texas Tech University



MWH



United States Environmental Protection Agency



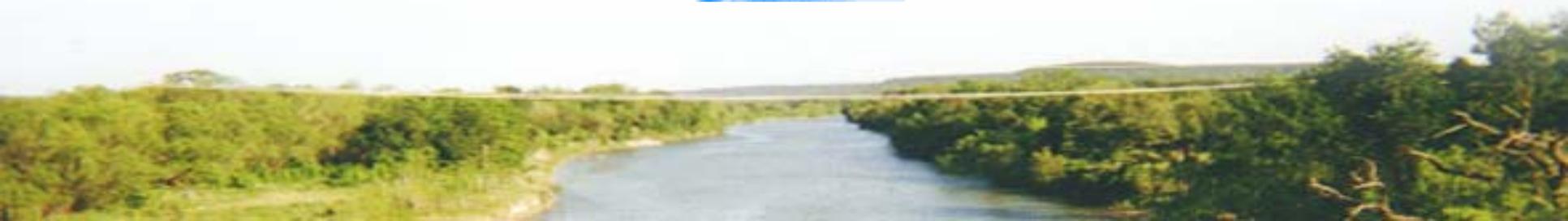
City of Waco

Public Meetings

***Waco , TX - April 6, 2004
Temple, TX - April 7, 2004***

Introduction

Kyle Headley
Regional Environmental Planner
(Central Basin)
Brazos River Authority



Agenda

- **Introduction** *Kyle Headley (BRA)*
- **Exposure Concepts and Human Exposure** *David Ebersold (MWH)*
- **Ecological Exposure** *Todd Anderson (TIEHH)*
- **Summary of Findings** *Wayne Elliott (USACE)*





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Project Team Members

- **U.S. Army Corps of Engineers** – project management and technical support
- **Texas Commission on Environmental Quality (TCEQ)** - advisory to study team, liaison with Interagency Perchlorate Steering Committee
- **Brazos River Authority (BRA)** – technical services and stakeholder coordination
- **The Institute of Environmental and Human Health (TIEHH) at Texas Tech University** – toxicological and ecological studies
- **MWH** – watershed hydrological studies, fate and transport, conceptual modeling, exposure assessment
- **U.S. Environmental Protection Agency** – advisory to study team, regulatory liason
- **Stakeholder Consortium** – advisory to study team, community interface





The Bosque/Leon River Watershed Stakeholders Alliance

- City of Belton
- City of Bruceville-Eddy
- City of Copperas Cove
- City of Gatesville
- City of Harker Heights
- City of Hewitt
- City of Killeen
- City of Lorena
- City of Moody
- Bluebonnett Water Supply Corporation
- Bell County and McLennon County Health Districts
- Central Texas American Water Works Association
- City of Morgan's Point
- City of Nolanville
- City of Robinson
- City of Temple
- City of Troy
- City of Waco
- City of Woodway
- Bell County WCID #1
- Bell County WCID #3





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Ammonium Perchlorate - A national technical asset integral to strategic defense systems





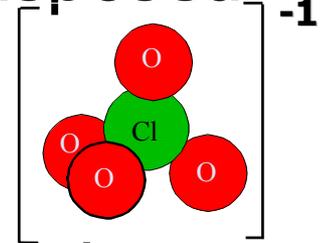
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High-Pressure Water Washout of Solid Propellant



What is Perchlorate?

- Primary ingredient in solid rocket propellant
- Large supplies of perchlorate have been disposed of at ammunition facilities
- Negatively charged ion, ClO_4^-
- Dissolves easily in water, transported through groundwater and surface water
- Known to interfere with iodide uptake in the thyroid and may disrupt production of thyroid hormones

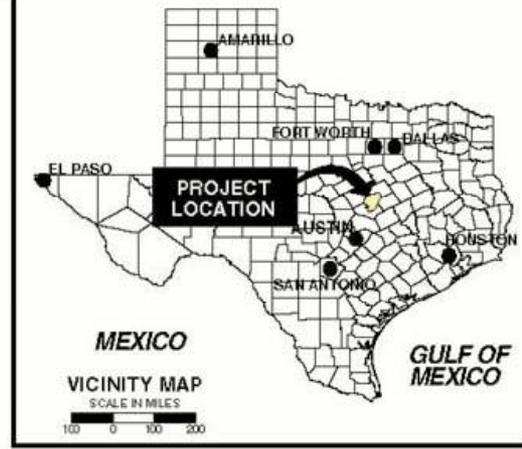
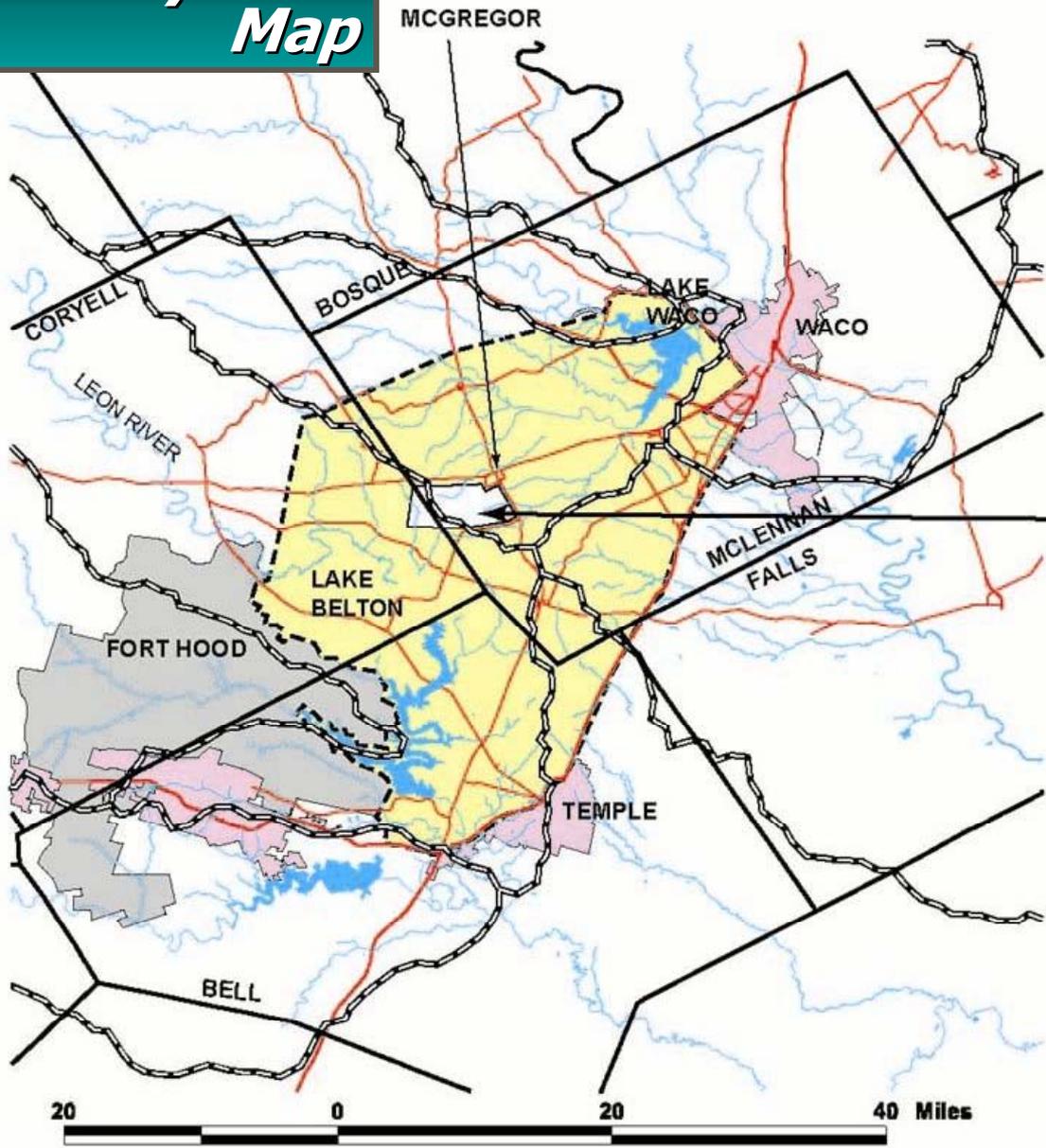


Why is Perchlorate a Concern in this Region?

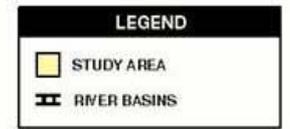
- Known source at NWIRP McGregor
- Documented migration beyond the NWIRP boundary; detected in streams and groundwater
- Streams and groundwater flow to Lakes Belton and Waco
- Lakes Belton and Waco serve as public water supply for 500,000 people



Study Area Map



NAVAL WEAPONS
INDUSTRIAL RESERVE
PLANT



BRAZOS RIVER BASIN, TEXAS
BOSQUE & LEON RIVER BASINS
1 JANUARY 2001
U.S. ARMY ENGINEER DISTRICT, FORT WORTH, TEXAS
SOUTHWESTERN DIVISION



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Project Goal

Evaluate potential human and environmental exposure to perchlorate in the Lakes Waco and Belton study area.

--- Project Team (February 2000)





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Exposure Concepts Human Exposure

David Ebersold, R.G., C.E.G.

Vice President

MWH



Four Exposure Pathway Elements

Potential Sources	Receiving or Transport Medium	Exposure Point	Possible Exposure Routes
<ul style="list-style-type: none"> - NWIRP McGregor 	<ul style="list-style-type: none"> - Water - Soil - Air - Sediment - Food 	<ul style="list-style-type: none"> - Point of contact between receptor and receiving or transport medium 	<ul style="list-style-type: none"> - Ingestion - Inhalation - Dermal Contact
<ul style="list-style-type: none"> - Ft. Hood (Limited surface water sampling) 	<ul style="list-style-type: none"> - Lake Belton 		

All Four Elements Required for Complete Exposure Pathway to a Receptor



Potential Exposure Pathways



Field Studies Designed to ID Exposure Pathways



<i>Study</i>	<i>Pathway Elements Addressed by Study</i>			
	Source	Medium	Exposure Point	Exposure Route
★ Stream Sampling	+	+	+	
★ Groundwater / Surface Water Levels		+		
ADCP Study		+	+	
Intake Sampling			+	
Delta Areas Study		+	+	
Sediment Pore Water Sampling		+	+	
Anoxic Study, Perchlorate Transformation		+		
Vegetation Sampling / Laboratory Studies		+	+	
Market Basket Study		+	+	
Animal Sampling (Fish, Amphibians, Birds, Mammals) / Laboratory Studies		+	+	+

Nearly 40 individual field, laboratory, and modeling studies completed





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Automated Stream Sampling and Water Level Monitoring



Over 2,800
samples
analyzed from
15 stream sites



Field Studies Designed to ID Exposure Pathways



<i>Study</i>	<i>Pathway Elements Addressed by Study</i>			
	<i>Source</i>	<i>Medium</i>	<i>Exposure Point</i>	<i>Exposure Route</i>
Stream Sampling	+	+	+	
Groundwater / Surface Water Levels		+		
★ ADCP Study		+	+	
Intake Sampling			+	
Delta Areas Study		+	+	
Sediment Pore Water Sampling		+	+	
Anoxic Study, Perchlorate Transformation		+		
Vegetation Sampling / Laboratory Studies		+	+	
Market Basket Study		+	+	
Animal Sampling (Fish, Amphibians, Birds, Mammals) / Laboratory Studies		+	+	+

Nearly 40 individual field, laboratory, and modeling studies completed





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Lake Belton Transects (ADCP)





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Lake Belton ADCP Study

(Survey across 23 transects in Lake Belton)



Field Studies Designed to ID Exposure Pathways



<i>Study</i>	<i>Pathway Elements Addressed by Study</i>			
	Source	Medium	Exposure Point	Exposure Route
Stream Sampling	+	+	+	
Groundwater / Surface Water Levels		+		
ADCP Study		+	+	
Intake Sampling			+	
Delta Areas Study		+	+	
Sediment Pore Water Sampling		+	+	
Anoxic Study, Perchlorate Transformation		+		
Vegetation Sampling / Laboratory Studies		+	+	
Market Basket Study		+	+	
Animal Sampling (Fish, Amphibians, Birds, Mammals) / Laboratory Studies		+	+	+

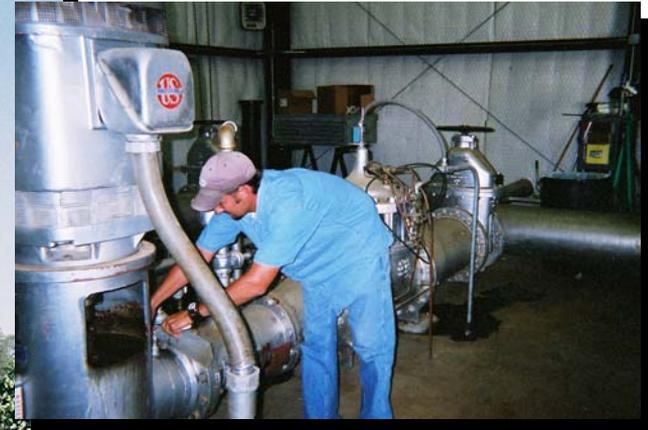
Nearly 40 individual field, laboratory, and modeling studies completed





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Intake Sampling



Field Studies Designed to ID Exposure Pathways

<i>Study</i>	<i>Pathway Elements Addressed by Study</i>			
	Source	Medium	Exposure Point	Exposure Route
Stream Sampling	+	+	+	
Groundwater / Surface Water Levels		+		
ADCP Study		+	+	
Intake Sampling			+	
★ Delta Areas Study		+	+	
★ Sediment Pore Water Sampling		+	+	
Anoxic Study, Perchlorate Transformation		+		
Vegetation Sampling / Laboratory Studies		+	+	
Market Basket Study		+	+	
Animal Sampling (Fish, Amphibians, Birds, Mammals) / Laboratory Studies		+	+	+

Nearly 40 individual field, laboratory, and modeling studies completed



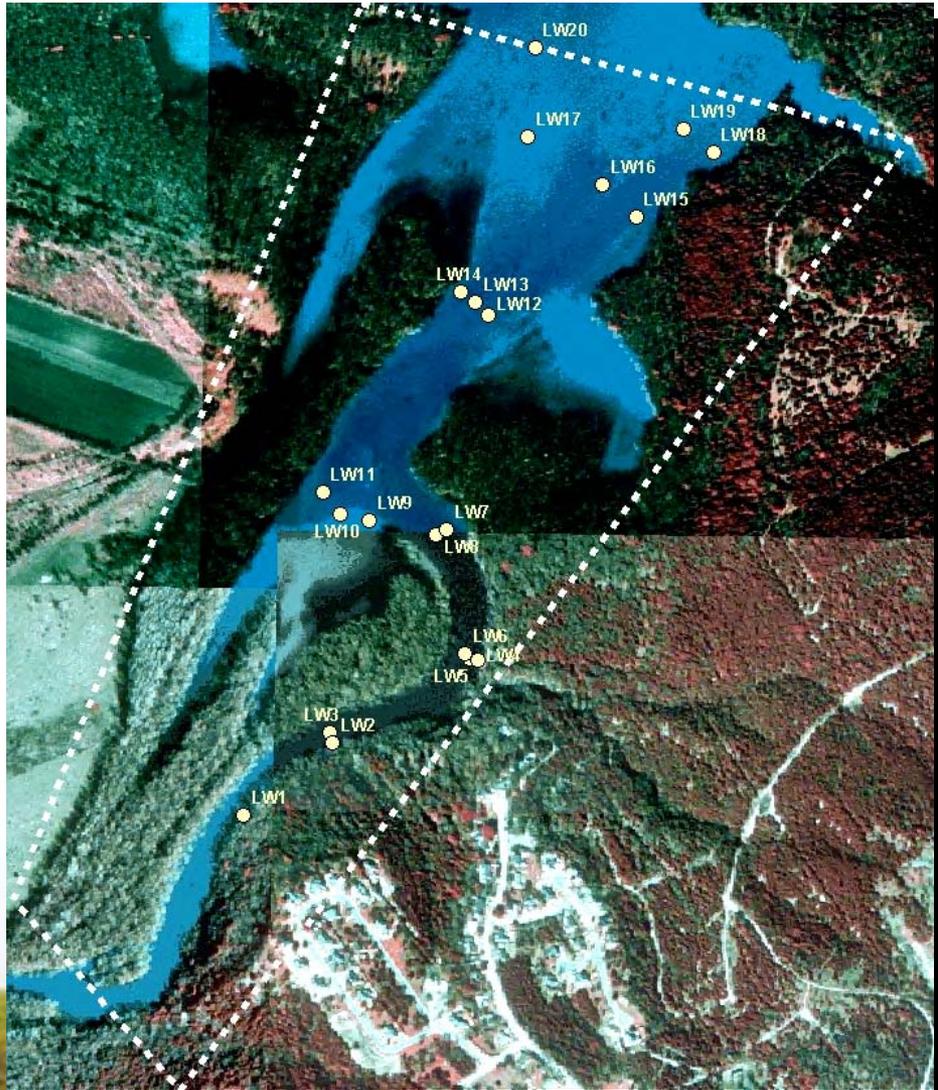


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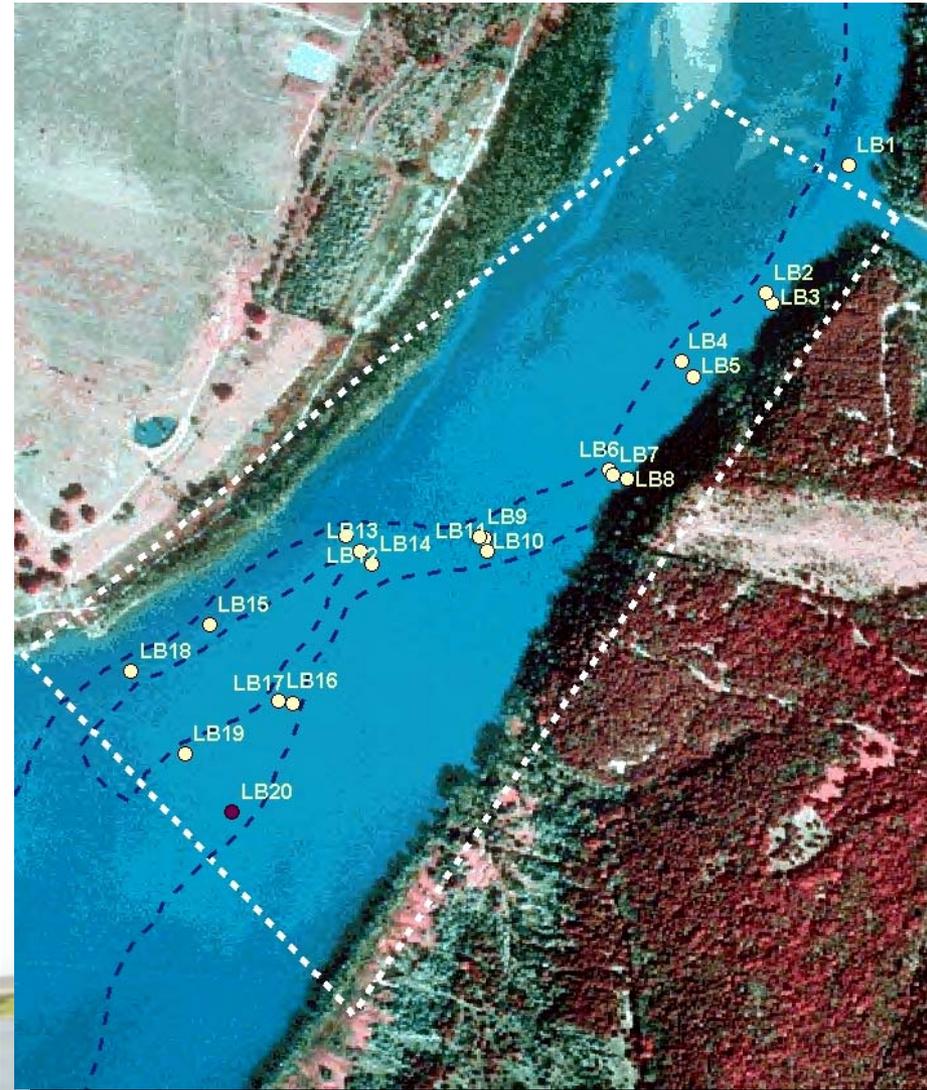
Delta Areas Sampling

(Surface Water and Sediment Pore Water)

Lake Waco



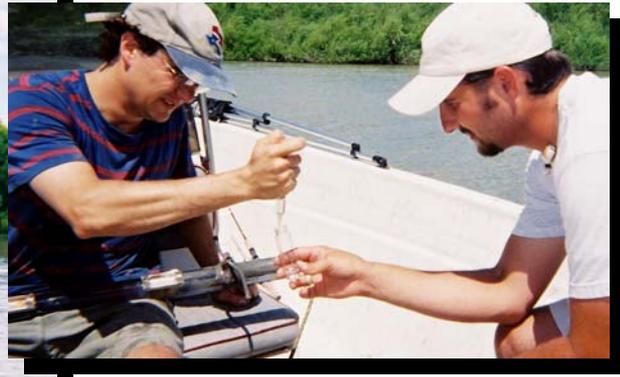
Lake Belton





Sediment Pore Water, Streams and Delta Areas

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Field Studies Designed to ID Exposure Pathways

<i>Study</i>	<i>Pathway Elements Addressed by Study</i>			
	Source	Medium	Exposure Point	Exposure Route
Stream Sampling	+	+	+	
Groundwater / Surface Water Levels		+		
ADCP Study		+	+	
Intake Sampling			+	
Delta Areas Study		+	+	
Sediment Pore Water Sampling		+	+	
★ Anoxic Study, Perchlorate Transformation		+		
Vegetation Sampling / Laboratory Studies		+	+	
Market Basket Study		+	+	
Animal Sampling (Fish, Amphibians, Birds, Mammals) / Laboratory Studies		+	+	+

Nearly 40 individual field, laboratory, and modeling studies completed

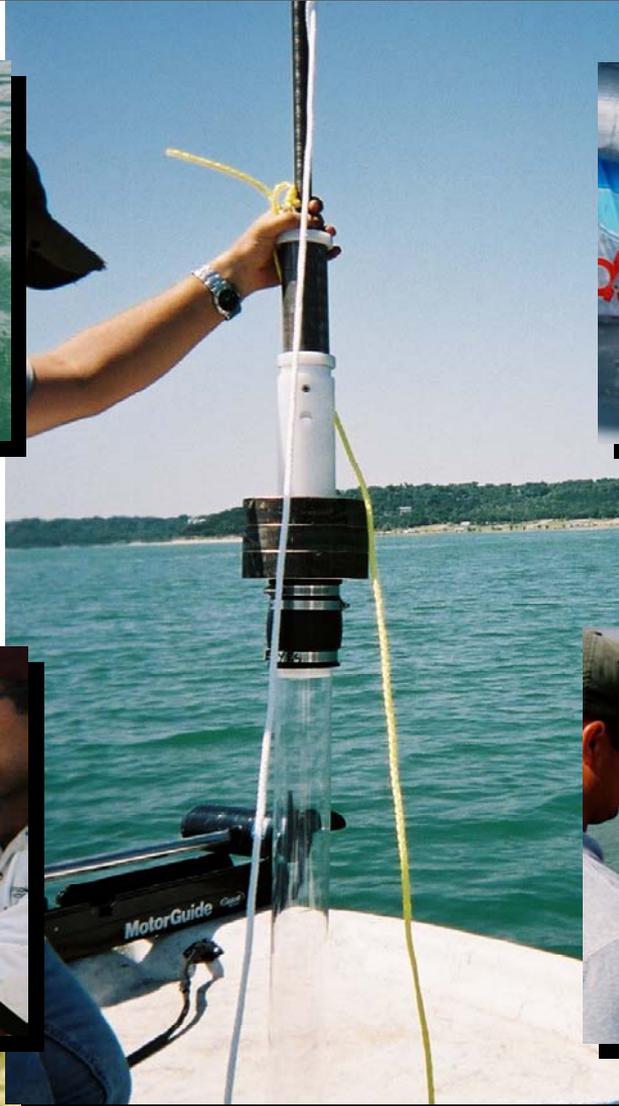




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Lake Belton Anoxic Study

(Retrieval of Sediment and Surface Water samples from Lake Belton)



Field Studies Designed to ID Exposure Pathways

<i>Study</i>	<i>Pathway Elements Addressed by Study</i>			
	<i>Source</i>	<i>Medium</i>	<i>Exposure Point</i>	<i>Exposure Route</i>
Stream Sampling	+	+	+	
Groundwater / Surface Water Levels		+		
ADCP Study		+	+	
Intake Sampling			+	
Delta Areas Study		+	+	
Sediment Pore Water Sampling		+	+	
Anoxic Study, Perchlorate Transformation		+		
★ Vegetation Sampling / Laboratory Studies		+	+	
★ Market Basket Study		+	+	
★ Animal Sampling (Fish, Amphibians, Birds, Mammals) / Laboratory Studies		+	+	+

Nearly 40 individual field, laboratory, and modeling studies completed





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Field Sampling of Plants and Animals



General Exposure Pathway Findings

- NWIRP McGregor considered source in study area; No evidence that Fort Hood is a source of perchlorate to Lake Belton based on limited sampling
- Studies used to determine if exposure pathways were complete for receptor groups
- Two general groups of receptors: human and ecological
- Ingestion appears to be the only viable exposure route for humans
- Complete exposure pathways exist to both human and ecological receptors



Potential Human Receptor Groups

Six groups of potential human receptors:

Potential Human Receptor	Description
1. Public Water Supply Users	Users of publicly provided water
2. Residential Users of Local Surface Water and/or Shallow Groundwater	Individuals in impacted areas not connected to public water system
3. Commercial/Industrial Workers	Workers in the study area - Does not include NWIRP site workers
4. Agricultural Workers	Agricultural workers in the study area
5. Recreational Users	Fishers, hunters, swimmers, etc. in the study area
6. NWIRP Vicinity Residents	Individuals living near NWIRP, particularly along streams draining from the NWIRP area





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Exposure Pathway Evaluation by Receptor Group

**Only realistic exposure route through ingestion*

Receptor	Pathway Elements*			Complete Pathway?
	Source	Medium	Exposure Point	
1. Public Water Supply Users	+	+	-	No
2. Users of Local Surface Water/Shallow GW	+	+	+	Yes
3. Commercial/Industrial Workers	+	+	-	No
4. Agricultural Workers	+	+	+	Yes
5. Recreational Users	+	+	+	Yes
6. NWIRP Vicinity Residents	+	+	+	Yes

Summary of Human Receptor Findings

No Exposure:

- Through public water supply
- Through consumption of beef

Potential Exposure:

- Through consumption of garden produce irrigated with stream water
- Through consumption of wild vegetation along streams
- Through consumption of fish caught in area
- Through ingestion of stream water while swimming





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Ecological Exposure

Todd Anderson

**The Institute of Environmental and
Human Health**

Texas Tech University



Ecological Exposure

- Aquatic and terrestrial receptor groups were examined in both the laboratory and field
- Assessment Context
 - Perchlorate may adversely affect plants and animals
 - Potential transfer to human food chain



Ecological Receptor Groups: Plants

Plants near perchlorate-contaminated streams take up perchlorate

Aquatic Plants

- Perchlorate in aquatic plant species appears to exist in pseudo-equilibrium with perchlorate concentrations in the water
- Plant concentrations lag changes in water concentrations and represent a better indicator of long-term exposure than water

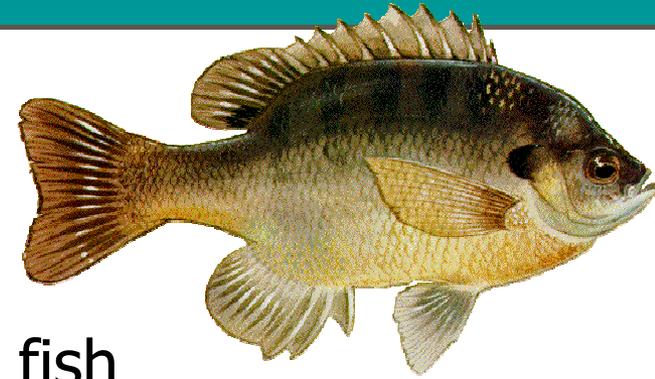
Terrestrial Plants

- Perchlorate concentrations in terrestrial plants were more variable than in aquatic plants
- Perchlorate can be released once plant leaves drop and decay



Ecological Receptor Groups: Aquatic Animals

Fish



- Perchlorate was detected sporadically in fish
 - Most of the perchlorate detections were in fish less than the legal catchable size
- When detected, perchlorate concentrations in fish were higher than those in water
- Fish collected from perchlorate-contaminated streams had alterations in thyroid histology
 - The relationship between changes in thyroid histology and population-level effects in fish is unclear



Exposure Receptor Groups: Aquatic Animals

Frogs

- Native frogs were affected by perchlorate
 - Increase thyroid follicle cell height but no colloid (area where thyroid hormones are stored) depletion
- Surface water from the study area did not affect thyroid function in frogs
- Perchlorate did not affect gonadal phenotype (sexual organs) in native and laboratory frogs
- Water from S Creek affected the ratio of male and female frogs
 - More females



Exposure Receptor Groups: Terrestrial Animals

Small Mammals and Birds



- Perchlorate was detected
 - Mice and songbirds near contaminated streams
 - Kidneys and livers
 - Perchlorate concentrations were high enough to alter thyroid histology and thyroid hormones
 - Ecological relevance is unclear
- No perchlorate in doves



Exposure Receptor Groups: Terrestrial Animals

Medium Mammals

- No perchlorate in raccoons or opossum trapped near contaminated streams
- No alterations in thyroid histology
- Thyroid hormone levels were normal



Exposure Receptor Groups: Terrestrial Animals

Large Mammals

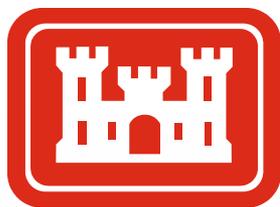
- No perchlorate in blood from cattle drinking only perchlorate-contaminated water
- No perchlorate in edible tissues
- Thyroid hormones were normal





Summary of Findings

Wayne Elliott
Project Manager
US Army Corps of Engineers
Fort Worth District



All Study Objectives Completed

Completed

- Develop effective community relations plan. ✓
- Compile existing study area information. ✓
- Identify data gaps in existing information. ✓
- Define and Develop the Conceptual Study Model (CSM). ✓
- Based on data gaps, develop Field Sampling Plans. ✓
- Field Investigation to fill the key data gaps. ✓
- Evaluate fate and transport pathways. ✓



All Study Objectives Completed (Cont'd)

Completed

- Evaluate potential environmental exposure to perchlorate in the study area. ✓
- Evaluate potential human exposure to perchlorate in the study area. ✓
- Assess exposure pathways to vegetation, fish, birds, mammals. ✓
- Assess impact on amphibians, fish, and large and small mammals. ✓
- Integrate data and assess ecological exposure ✓



Summary of Findings

Key exposure findings:

- No exposure to perchlorate through public water supply
- Potential for human exposure through fish, vegetation along streams, or swimming in streams, but unlikely. Impacted areas have been mapped.
- Plants in impacted areas do take up perchlorate
- Small animals and fish are exposed, but medium and large mammals show no evidence of being exposed



Other Team Accomplishments

- Project completed on time
- Completed \$2.5 million under budget (30% savings to taxpayers)
- Results may be useful to other agencies, resulting in more taxpayer savings





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Questions & Answers

Project Website:

<http://www.swf.usace.army.mil/ppmd/Perchlorate/index.html>

