Source Characteristics

The form of the perchlorate waste and nature of the disposal activities affect contaminant release:
- High pressure washout or burning of ammonium perchlorate propellant produces soluble or aqueas phase perchlorate.
- Disposal of solid forms of perchlorate–based propellants result in bulk salts.
- Perchlorate disposal at NWIRP McGregor included both aqueas forms and solid salts.
- Perchloric acid and perchlorate salts are highly water–soluble.
- However, solid propellants may contain tacky inert binders that reduce short–term dissolution and mobilization, but pose a long–term source of contaminant.
- Dense brines of perchlorate salts have a tendency to sink.

Soil Characteristics

Physical, chemical and biological properties of the receiving soil affect the potential for perchlorate transformation, mobilization and migration at near–source areas.
- The presence of oxygen (i.e., aerobic conditions) in surficial soils limit the microbial degradation of perchlorate, which is a reductive process.
- The nitrogen component of ammonium perchlorate is subject to metabolism by aerobic nitrifying microbes. However, the presence of nitrifying bacteria in soil can deplete oxygen and produce locally anaerobic conditions.
- Anaerobic conditions are required for microbial degradation of perchlorate, but this process is limited to a few specific genera of reductive microbes.
- High cation exchange capacity of soils (e.g., high potassium content) reduces perchlorate ion mobility.
- Soils within the study area generally consist of a thin clay vertisol layer that is porous and tends towards being aerobic. Such conditions would tend to minimize microbial degradation of perchlorate and promote leaching to the subsurface.

Shallow Groundwater Characteristics

Subsurface characteristics potentially affecting perchlorate migration include porosity and degree of subsurface fracturing, hydraulic conductivity, depth to groundwater, and groundwater flow direction.
- The shallow subsurface is generally comprised of weathered, highly fractured and jointed limestone, and supports high groundwater velocities.
- Vertical fractures in the limestone within the shallow subsurface produce locally high vertical hydraulic conductivities; numerous seeps and springs are present.
- Shallow groundwater level occurs from near–surface to approximately 14 feet bgs.
- However, groundwater depth is seasonally dependent. During the wet season, groundwater heads are higher than stream heads and contribute to stream flows. During the dry season, groundwater heads are lower than stream heads and streams contribute to the groundwater system.
- Shallow groundwater tends to parallel topography and flows from the hills to the valleys. Consequently, groundwater generally flows in the same direction as surface water.
- Consistent with the above, perchlorate is highly mobile within the shallow subsurface and readily transfers between groundwater and surface water compartments.

Deeper Groundwater Characteristics

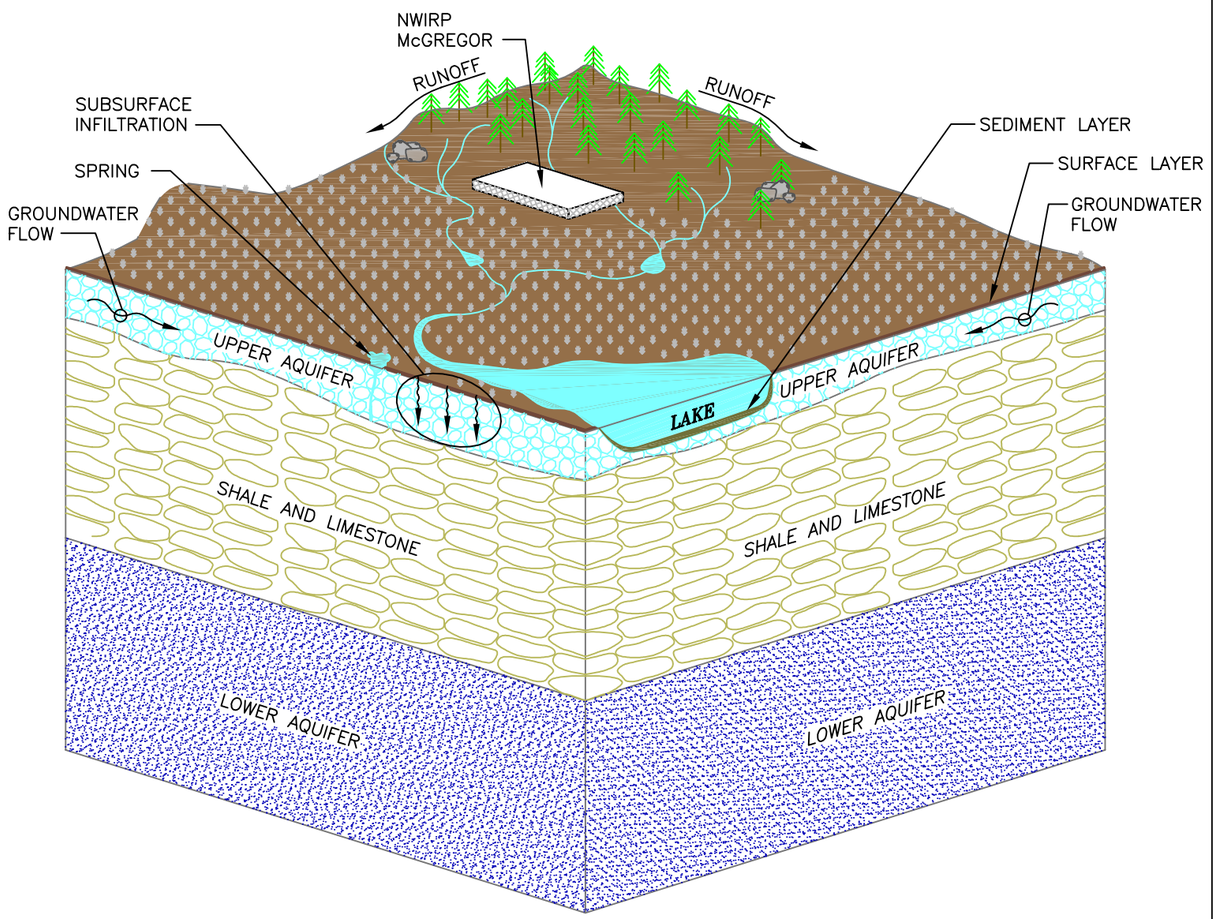
Characteristics of the lower aquifers suggest that deeper groundwater is unlikely to become contaminated by perchlorate.
- Approximately 900 feet of shales and limestones separate the shallow water–bearing zone from the sands of the deeper Trinity Aquifers.
- The recharge zone for the deeper aquifers is located approximately 70 miles northwest of former NWIRP McGregor.
- There are no known local faults that would provide conduits for shallow water recharge to the deep aquifer.
- Perchlorate has not been detected in water samples from deep production wells, suggesting that the shallow and deep aquifers are not in communication.

Surface Water Characteristics

Surface water characteristics potentially affecting the migration and fate of perchlorate within the watersheds include surface water budgets, chemistry, turbidity, trophic state, stratification, and sedimentation rates.
- Numerous streams and tributaries intersecting former NWIRP McGregor provide a conduit for highly soluble perchlorate to contaminate areas distant from the source.
- Stream volumes and flow rates affect the degree of hydrodynamic dispersion of perchlorate.
- Surface water pH, oxygen content, cation exchange capacity, and organic carbon content may affect perchlorate solubility and bioavailability.
- Clay and silt particles contain charged surfaces capable of adsorbing perchlorate ion. Wind–wave action and the presence of a diffuser produce high clay turbidity in Lake Waco. Low turbidity in portions of Lake Belton result from deeper water, less wave action, and density stratification.
- Trophic state affects organic carbon content as well metabolic capacity of surface water. Lake Waco is moderately eutrophic and supports seasonal algal blooms. Lake Belton is variously classified due to its length and depth.
- Density stratification relates to surface water mixing and nutrient turnover rates. Lake Waco is subject to regular top–to–bottom mixing, which results in more uniform water temperatures, chemistry, and metabolism. Lake Belton supports more limited, annual mixing and is subject to complex redox patterns that vary with depth.
- Anoxic conditions in Lake Waco are probably limited to plunge pools below the old dam, while the deeper Lake Belton supports more complex patterns due to density stratification and, possibly, nutrient loading patterns.

Sediment Characteristics

Sediment characteristics that may affect perchlorate fate in surface waters include the following:
- Sediment may serve as either a sink or source of perchlorate to surface water and biological receptors.
- High clay and silt contents of Lakes Waco and Belton provide a potential sorption surface for dissolved perchlorate ions.
- Litter from decaying algae and phytoplankton in eutrophic waters contributes to sedimentation.
- Anaerobic sediments may support microbial degradation of perchlorate.



U.S. ARMY CORPS OF ENGINEERS

PROJECT:
BOSQUE AND LEON RIVERS
WATERSHED STUDY

DRAWING TITLE:

GENERALIZED WATERSHED
CROSS–SECTION

MWH
MONTGOMERY WATSON HARZA

Sheet 1 of 1

SCALE: N.T.S.

FIGURE: 5–47

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