CURRENT AND FUTURE WATER DEMAND OF THE TEXAS OIL AND GAS AND MINING SECTORS AND POTENTIAL IMPACT ON AQUIFERS

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ABSTRACT

The Texas mining industry, in addition to oil and gas, produces mostly lignite coal and aggregates (sand and gravel and crushed rocks). Operations always involve water, either as an aid in extraction or as a byproduct. A recent study compiled current water use in the various sectors of the mining industry and made projections for the next 50 years. The study concerned the upstream segment of the oil and gas industry (drilling, hydraulic fracturing, waterfloods), the aggregate industry (washing included but no further processing), the coal industry (pit dewatering and aquifer depressurizing), and other substances mined in a fashion similar to that of aggregates (industrial sand, lime, etc.), as well as through solution mining. Overall, in 2008, the industry used ~160 thousand acre-ft (kAF), including 35 kAF for hydraulic fracturing and ~21 kAF for other purposes in the oil and gas industry. The coal and aggregate industries used 20 kAF and 71 kAF, respectively. Mining of industrial sand dominates the remainder. Approximately three-fourths of the water used is consumed, and approximately two-thirds of the water consumed is groundwater. Projection estimates call for a steady increase in water use in coal and aggregate production and a sharp increase, followed by a slow decrease, in the oil and gas industry. Operators favor surface water when it is plentiful, but groundwater is a more drought-proof source. Because the various segments of the energy industry are spread out across the state, they impact many different aquifers. Mining withdrawals represent only ~1% of total withdrawals at the state level but can be much higher locally and compete with other uses, such as municipal usage or irrigation.

INTRODUCTION

Mineral resources in Texas fall into four categories: (1) hydrocarbons (oil and gas), (2) lignite and coal, (3) crushed rock and sand and gravel (collectively known as aggregates), and (4) other substances. Oil and gas make up most of the dollar value and compose a significant fraction in terms of volume with the aggregate category (Table 1). Oil and gas are produced from almost every county in the state (Fig. 1a), whereas lignite mines are located in a narrow band in the middle of the state (Fig. 1c) and parallel to the coast (Kyle, 2008; Kyle and Clift, 2008). Sand and gravel are exploited mostly along rivers (Fig. 1d). Crushed-stone quarries are present mostly in the footprint of the Edwards Limestone. The objective of a recent study performed for the Texas Water Development Board (TWDB) was to determine county-level historical and projected mining water use in Texas, focusing on fresh water (total dissolved solid content [TDS] < 1000 mg/L). Disregarding oil and gas wells and other oil- and gas-related facilities, the U.S. Census Bureau (2005) listed a total of 11 lignite mines, 100+ crushed stone, and ~200 sand and gravel operations, many of them small, as well as ~70 facilities of a different type, neither lignite nor aggregate, in Texas in 2000. More details about mine count, as well as a more detailed account of water use, can be found in Nicot et al. (2011).

Oil and gas resources are generally sorted into conventional and unconventional categories (Figs. 1a and b). The former represents the archetypal reservoir traps in either sandstones or carbonates and is made up of interconnected pores that allow ‘easy’ communication with the well bore. The latter is generally characterized by the use of advanced technologies and consists of different types of formation and/or extreme environmental conditions (pressure and temperature). Characteristics of unconventional resources of interest relevant to this study include low permeability and a need to stimulate the reservoir through hydraulic