of the aquifer, and multiple extraction wells would likely be necessary to meet municipal needs. It may be possible, however, to maintain sustained withdrawals from the Neogene aquifer with minimal effect on water levels in the surficial aquifer. Withdrawals from the upper Neogene aquifer may affect water levels in the surficial aquifer less directly than withdrawals in the surficial aquifer itself and may possibly be sustained by regional sources of recharge. These withdrawals in the upper Neogene aquifer may not directly capture river water but would likely still cause groundwater declines in the surficial aquifer and induce inflows from nearby rivers and other surface-water sources. Withdrawals from the Neogene aquifer, however, may require treatment for high salinity or dissolved solids. The age, or residence time, of groundwater in the Neogene aquifer (thousands of years old) is likely to be one or two orders of magnitude greater than that of groundwater in the surficial aquifer and to differ among subbasin areas. This variability may have implications for the quality and sustainability of this resource. The sustainability of groundwater in the Neogene aquifer in subbasin areas like the western part of the Central Kabul subbasin, which is bounded by interbasin ridges, may be much less than that of the groundwater in the Neogene aquifer in the northern and western areas of the Kabul Basin, which are bounded by large mountains.

In addition to an increasing demand for water, future climate change is a concern for the residents of the Kabul Basin. Although considerable uncertainty is associated with climate-change projections, the climate-change forecast for 2057 may include a 10-percent reduction in total annual precipitation; as simulated in this study, this reduction would reduce all inflows and exacerbate currently stressed water resources. Increasing temperatures would likely shift peak spring runoff to an earlier period during the year. Currently, most annual recharge occurs in the spring and late winter; however, an earlier peak recharge period would shift water resources ahead of the summer period, when water is most needed, and thus extend the summer dry period. The larger rivers flowing into the basins may still supply considerable recharge to the Kabul Basin; however, if irrigation is reduced because of low flows, the decline in direct recharge from rainfall and stream leakage may be compounded by reduced irrigation recharge. Reductions in recharge may be slight in areas near the larger rivers, such as areas adjacent to the Panjsher and Ghorband Rivers to the north and the Kabul and Logar Rivers to the south. In other areas that receive a large component of recharge from local uplands, such as areas in the Paghman River watershed and the Shomali subbasin (which includes the Barik Ab River watershed), the effect of climate change on water resources may be more critical. The Deh Sabz subbasin currently receives very little direct recharge and no recharge from irrigation; as a result, reductions in precipitation may affect this subbasin less than other subbasins. The Central Kabul subbasin, particularly the northwestern part, also receives very little recharge; however, with an increased demand for water, the effects of climate change on the hydrologic system in this area would likely be pronounced. Simulated groundwater-level declines indicate about one-quarter of all shallow supply wells may become inoperable. Simulated declines are predicted to be greatest near the base of the Paghman Mountains (in the Western Front Source Area). In the headwater areas of the Paghman and Upper Kabul and Shomali subbasins, simulations indicate that more than 50 percent of shallow supply wells may become inoperable.

In conclusion, the Kabul Basin has an immediate and growing need for water, yet available supplies may be adversely affected by future climate change. In some areas of the basin, water supplies are adequate, but the water quality has deteriorated because of poor sanitation and poor well-construction practices. The basin likely has considerable groundwater reserves in deep, currently unused aquifers that may be sustainable for municipal and domestic use but not for agricultural use. The hydraulic feasibility of groundwater extractions and the quality of groundwater in the deep aquifer, however, are unknown. This investigation was intended to provide data, analysis, and tools needed for planning for the future water resources of the Kabul Basin. Additional investigations would be needed, however, to assess the utility of water resources in the deep aquifer for future supply, to monitor water-level and quality conditions over time, and to assess for changes in water availability over time.

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