Interbasin Groundwater Flow at the Benson Narrows, Arizona

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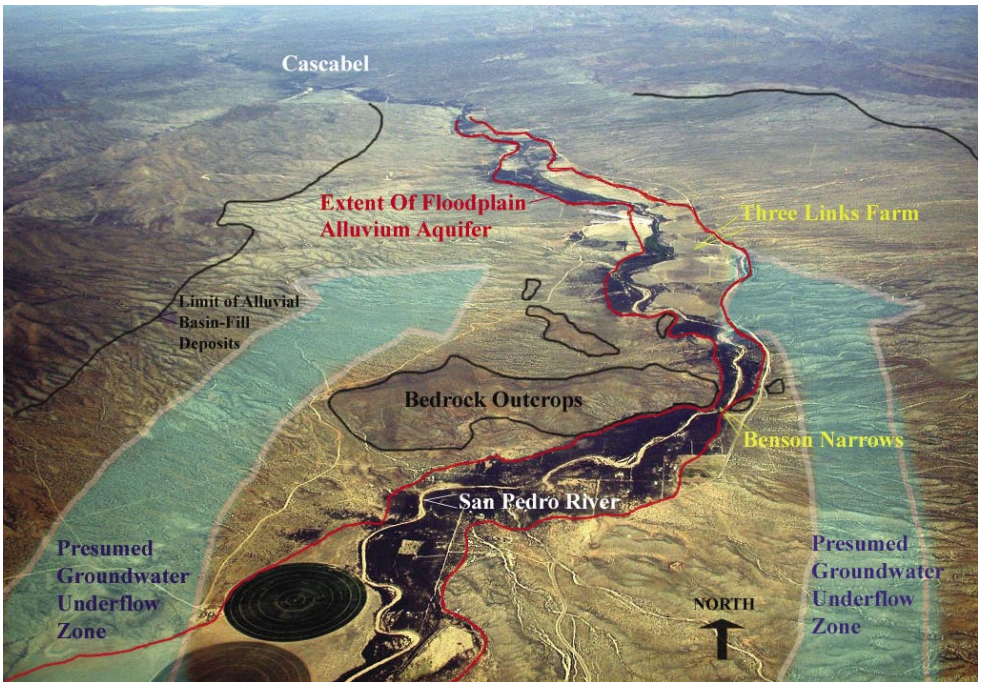
The Nature Conservancy's (TNC) Three Links Farm stretches six miles along the San Pedro River in southeastern Arizona and contains a perennial flow reach and a cottonwood-willow riparian forest with a large variety of birds and other wildlife. TNC is working to re-establish ecosystem and hydrologic function in appropriate reaches of the San Pedro River, with an emphasis on protecting and restoring perennial streamflow and associated riparian habitat.

Understanding the hydrogeologic relations along the San Pedro River and source of groundwater underflow that supports the perennial flow at Three Links Farm is critically important to TNC's conservation efforts. The farm is located immediately downstream of the Benson Narrows, which marks the boundary between the Upper and Lower San Pedro basins. Previously, just 120 acre-feet per year of interbasin groundwater underflow were estimated to move through this area, based on the assumption that groundwater could move solely through the San Pedro River floodplain alluvium aquifer at the restricted slot canyon of the Benson Narrows (Heindl, 1952).



Groundwater flow at the Benson Narrows (figure from The Nature Conservancy).

Subsequent work, however, identified the possibility of groundwater underflow through the 800- to 1,000-foot thick alluvial basin-fill deposits flanking the bedrock outcrops of the Narrows (Montgomery, 1963; Halvorson, 1984).

Recent hydrogeologic investigations show that during the 2003 water year, about 3,500 acre-feet of groundwater passed through the floodplain alluvium aquifer at Three Links Farm. TNC hypothesized that most of this water originates as groundwater underflow moving from the Upper San Pedro Basin through the alluvial basin-fill deposits at the Benson Narrows. Direct measurement of such underflow was not possible because wells of sufficient depth are lacking. Thus, new hydrogeologic work conducted at Three Links Farm included the following tasks:

- Fifteen existing wells at the farm were surveyed for location and altitude. Water level elevations were measured at each well during 2002-2003.

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- Groundwater altitude contour maps were constructed for different seasons, and groundwater gradients in the floodplain alluvium aquifer were calculated.

- Well records and new soils mapping by the USDA-NRCS Tucson Soil Survey Office were used to estimate the width and thickness of the floodplain alluvium.

- Aquifer testing was conducted using multiple observation wells. Based on analysis of results, a transmissivity of 40,000 square feet per day was estimated for the floodplain alluvium aquifer at one location on the farm.

From these new data, TNC researchers estimated that the average annual volume of groundwater underflow through the floodplain alluvium where aquifer testing was conducted was more than 3,500 acre-feet per year. Researchers then considered potential sources of water that could replenish the floodplain alluvium aquifer at that rate. Their analyses suggest that interbasin groundwater flow from the Upper San Pedro Basin is the primary replenishment source for the groundwater underflow observed at Three Links Farm, for the following reasons:

- No flood flows in the San Pedro River occurred at Three Links Farm during the monitoring period for which underflow estimates were made. Therefore, streambed recharge was ruled out as a source of groundwater.

- Irrigation at the farm had ceased more than a year before the monitoring period; therefore, irrigation return flow was not a source.

- Estimated average annual mountain front recharge is about 160 acre-feet for the small watersheds in the Little Rincon Mountains and the Johnny Lyon Hills flanking the southern end of the Lower San Pedro Basin (Goode and Maddock, 2000).

- Steady groundwater levels in the floodplain alluvium at the farm during the monitoring period eliminated drainage from previously stored groundwater in the floodplain alluvium as a source.

- Existing groundwater chemical analyses in the aquifers north and south of the Narrows indicate that groundwater types do not change there: the types found in the Upper San Pedro Basin are also found in and near Three Links Farm.

This research indicates that substantial groundwater is moving through the floodplain alluvial aquifer at Three Links Farm and that most of this water originates from the Upper San Pedro Basin. This finding has significant implications, for in the neighboring Benson sub-area of the Upper San Pedro groundwater basin, deficit groundwater pumping was estimated to be 1,300 acre-feet in 2002 (Arizona Department of Water Resources, personal communication). Increased groundwater pumping in the Benson sub-area could result in diminished interbasin groundwater flow to the Lower San Pedro Basin.

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