

WATER FOR OIL SHALE DEVELOPMENT

Water has long been identified as a critical component of oil shale development. A 2006 report produced by Argonne National Laboratory compared previous estimates of water requirements, focusing only on direct requirements and not assuming local refining of the oil.³¹ These estimates are reproduced in *Table 1*.

Table 1.
Estimates of Water Requirements for Development of Oil Shale

Source	Oil Production (bpd)	Water Required (af/year)	Water Requirement Scaled to 100,000-bpd Oil Production (af/year)
Prien (1954)	1,000,000	227,000 diverted 82,500 consumed	22,700 diverted 8,250 consumed
Cameron and Jones (1959)	1,250,000	252,000 diverted 159,000 consumed	20,000 diverted 8,250 consumed
Ely (1968)	2,000,000	500,000	25,000
U.S. Department of the Interior (1968)	1,000,000	145,000 diverted 61,000-96,000 consumed	14,500 diverted 6,100-9,600 consumed
U.S. Department of the Interior (1973a)	50,000 underground mine	8,700	17,400
	100,000 surface mine	16,800	16,800
	50,000 in-situ methods	4,400	8,800
	400,000 technology mix	65,000	16,300
	1,000,000 technology mix	155,000	15,500
McDonald (1980)	1,500,000	200,000	13,300
RAND (2005)	No specific value given; assume 3 barrels of water per 1 barrel of oil		14,125

Source: J.A. Veil and M.G. Puder, *Potential Ground Water and Surface Water Impacts from Oil Shale and Tar Sands Energy-Production Operations*, Argonne National Laboratory.

Clearly, the estimates vary somewhat. The early studies did not consider an in-situ production process. Some studies only consider amounts of water diverted, not consumed. In general, though, the assumptions respecting quantities of water required for mining and retorting are in the same range.

The most recent government estimates are contained in the September 2008 *Final Oil Shale and Tar Sands Programmatic Environmental Impact Statement (PEIS)*. The U.S. Department of the Interior's Bureau of Land Management (BLM) assumes 1 to 3 barrels of water would be needed for every barrel of oil produced using an in-situ method and 2.6 to 4 barrels of water would be needed for every barrel of oil produced using the mining and surface retort

method.³² Based on these water-to-oil ratios, the BLM estimates annual water consumption for a 200,000-bpd in-situ project would be 18,600 to 34,600 af per year. For production of 50,000 bpd using underground mining with surface retort, the BLM estimates water consumption of 4,900 to 7,400 af per year. Scaling this production up to 200,000 bpd, water consumption would be 19,600 to 29,600 af per year — somewhat less than would be required for the same production level using in-situ methods.

In a study recently prepared for the Colorado and Yampa/White River Roundtable Committees by URS, Inc., *Energy Development Water Needs Assessment*, analysts determined the annual water demand (not consumption) for a 50,000-bpd mine and retort to be 6,920 af annually, while a 50,000-bpd in-situ facility would require 3,576 af annually (not including water for electric power).³³ Assuming a long-term production mix of 1.5 million bpd from in-situ methods and 50,000 bpd using a surface retort, the report estimates direct water demands of 112,675 af per year. The report then goes on to estimate indirect water demands. Assuming a population increase of about 94,000 associated with production of 1.55 million bpd, the report estimates human water demands of 21,100 af annually.³⁴ The largest single demand for water would come from the electric power production needed primarily in support of in-situ processing, an estimated 242,535 af of water annually.

Table 2.
Summary of Estimated Oil Shale Water Demands

Source of Water Demand	Annual Quantity (af)
Direct demand (1.55 million bpd)	112,675
Electric power	244,535
Increased population	21,100
Total	378,310

Source: URS, Inc., *Energy Development Water Needs Assessment*

Thus, an oil shale industry in Colorado that produces 1.5 million bpd by in-situ means and another 50,000 bpd using the mine/retort method would require 378,310 af of water annually for direct and indirect uses.³⁵ Using a factor of 0.76 to convert demand for process water into consumption and 0.35 to convert other uses,³⁶ total annual consumption of water in support of oil shale development would be 280,439 af.

CONDITIONAL WATER RIGHTS

Under Colorado law, an appropriation of water is established at the time the appropriator's intent to divert and use water is made clear through overt actions that place others on notice of the intent. The date the intent is manifested is the appropriation date. The right is regarded as conditional, however, until water is physically controlled and placed to beneficial use. Holders of conditional water rights must file an application with the water court to obtain a decree determining that a conditional right has been established and fixing its priority date. Holders are obligated to pursue development of the appropriation with reasonable diligence and must demonstrate that diligence to the water court every six years until water is actually placed to beneficial use.

Every appropriation is given a name for the structure proposed to be built to control and divert water. The location of the structure is identified, including the source from which water will be diverted. For appropriations intended to directly divert water, a maximum rate of flow described in cubic feet per second is identified. For appropriations to store water, the expected capacity of the facility is stated as a volume of water, described in acre-feet (an acre-foot of water is approximately 326,000 gallons of water). The intended general purpose (or purposes) of use (e.g., municipal or industrial) also is identified.