FACT SHEET - OIL SHALE AND WATER

NATIONAL OIL SHALE ASSOCIATION

Revision 1—June 2012

WHY IS WATER USE IN OIL SHALE IMPORTANT?

Water is a precious commodity in the west where a bulk of the U.S. oil shale deposits are found. There are many demands upon the water in the oil shale region - principally the Colorado River and its tributaries. But there can be enough for all users with proper management of resources and employment of new technologies.

HOW IS WATER USED IN PRODUCING SHALE OIL?

Water is necessary for producing shale oil. The amount and quality varies with technology. Typical uses include process cooling, reclamation, dust control and the municipal needs resulting from any population increase due to oil shale workers and supporting businesses.

HOW MUCH WATER IS NEEDED?

Direct consumptive water requirements range from 1 to 3 barrels of water per barrel of shale oil produced (B/B) depending upon the shale oil recovery technology being employed. Current R,D&D programs will confirm water needs, but the range of uncertainty is small. A recent study by NOSA determined the average usage at 1.7 B/B (see addendum to this fact sheet). The quality of the required water also varies, and much can come from non-potable sources.

Estimates for a range of commercial shale oil production rates follows based upon 1.7 B/B:

Shale Oil Production Barrels/day	Shale Oil Production Barrels/year	Water Required acre-ft/day	Water Required acre-ft/year
5,000	1,800,000	1.1	400
50,000	18,000,000	11	4,000
500,000	180,000,000	110	40,000

In addition to the direct requirements for water, there may be additional requirements resulting from the increased population and associated businesses that will develop as a result of an oil shale industry. It will depend upon the level of infrastructure that will already exist to accommodate a new industry and the labor intensity of the oil shale technology employed. Estimates range from 0 to 10% of the direct requirements given above.

WHERE WILL THE WATER COME FROM?

Water for oil shale projects may come from a variety of sources: ground water wells, surface streams and rivers, water produced from oil shale processing, waste waters from other industries or municipalities, reservoir storage, and/or trans-basin diversion projects.

Water is produced during the processing (retorting) of oil shale that is not indigenous or tributary to local ground water or streams. It amounts to between 4 and 14% of the shale oil produced. Therefore an average of 10% of the required indigenous water may be saved by treating this water and using it within the project.

The use of waste water from other sources is potentially viable for commercial oil shale projects. For instance the water currently produced from the oil and gas and coal bed methane wells may be treated and used for various uses within an oil shale complex.

HOW DOES OIL SHALE WATER USAGE COMPARE TO OTHER USES?

Water usage by oil shale projects compares favorably with other industrial, agricultural and municipal uses. Below are water usage comparisons for a 50,000 barrel per day oil shale plant to ethanol produced from irrigated corn, electric power generated from coal, irrigated alfalfa, and the typical household in the western U.S (also see chart in the Addendum to this fact sheet).

Oil Shale Plant	Ethanol Project	Electric Power	Agriculture	Domestic
50,000 bbl/day	21,000 bbl/day	400 MW	2,200 acres	14,000 people
4,000 acft/yr	4,000 acft/yr	4,000 acft/yr	4,000 acft/yr	5,000 acft/yr

Note: some of the water usages given above are 100% consumptive and others are less than 100%

HOW IS WATER MADE AVAILABLE TO USERS?

The right to use water from surface streams and rivers is controlled legally within each state. Laws in western and eastern states vary. In the east a riparian doctrine is followed which permits anyone whose land has frontage on a body of water to use that water. Most western states follow a prior appropriation doctrine. Colorado water law is generally looked upon in the west as the water authority, and follows the first in time first in right philosophy. This approach placed many senior water rights in the hands of the original pioneer ranchers.

In Colorado the right to use water can be acquired though acquisition from previous owners. And rights to use water have also been obtained by participation in projects such as the Ruedi reservoir. Groundwater from wells is also controlled by state regulation and applies to all ground water that is tributary to surface waters. It does not apply to non-tributary ground water, sources of saline water produced from most oil and gas wells, or the water produced from retorting of oil shale.

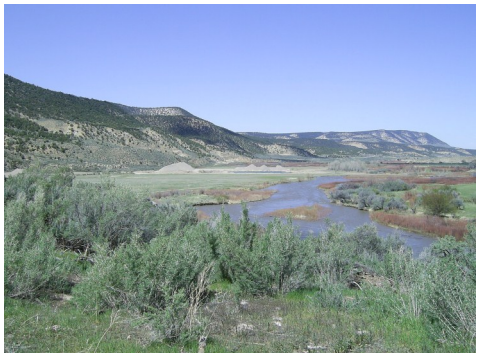
HOW WILL WATER BE DELIVERED TO OIL SHALE FACILITIES?

Water pipelines, storage and treatment facilities will be required to provide uninterrupted and reliable sources of water to commercial oil shale projects. Due to the arid nature of the west, storage of water during the snow melt period is required to assure a supply during the dry period of the year. These storage facilities will be on and/or off the site of the oil shale project.

WILL THERE BE ENOUGH WATER AVAILABLE FOR ALL USERS?

Research is being performed to reduce water usage, conserve water supplies, and use alternate sources of water. While this research is being conducted plans for the optimum manner for supplying water to commercial oil shale development are being developed.

THE BOTTOM LINE



Water is not the issue that will make or break oil shale development, but misleading information from some groups is leading the public to think it is.

Water will be used sparingly, and alternate supplies can be used to reduce the amount even further.

Water used for oil shale development is a beneficial use that will create jobs, spur economic development, and enhance our energy security.

ADDENDUM TO FACT SHEET—OIL SHALE AND WATER

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NOSA EVALUATES OIL SHALE WATER USAGE

The National Oil Shale Association (NOSA) has conducted an evaluation of the estimated water usage for current oil shale projects. NOSA requested input from developers and received confidential input from several. The input was summarized by insitu and surface technologies and averaged in each of the two categories.

This is a very complicated subject because there are so many variables to consider. The future is uncertain as to which technologies that will be employed as most are in the R,D&D phases and do not have data from commercial demonstration scale facilities. The water estimated to be used by the technologies being developed varies widely. Uncertainties such as the following complicate the evaluation: will shale oil upgrading will be conducted on-site or remote from the production facility; will flushing be conducted for insitu retorts (or will retorting be conducted in a non-aquifer zone); does spent shale from surface retorts require significant amounts of water for stabilization (or does the technology produce spent shale of a more stable character without significant addition of water); is electric heating the dominant insitu source of heat or will shale gas or other fuels be used; and what degree of hydro-treatment is anticipated to produce either a syncrude or transportation fuels on the site?

Therefore the results of this analysis are preliminary, but considered better than rules of thumb that have come down from past estimates, and are considered appropriate for water planning purposes.

Surface Retorting 2.0 Bbls water/Bbl of shale oil (B/B), or 14 gallons of water/MMBTU of energy produced*

Insitu Retorting 1.7 Bbls water /Bbl of shale oil (B/B), or 12 gallons of water/MMBTU of energy produced*

*Figures based upon Shale Oil upgrading off site. If upgrading is included on-site add 0.6 to 1.6 B/B (average of 1.1 B/B).

Based upon the above estimates by NOSA an oil shale industry producing 1.55 million barrels per day of raw shale oil would require 2.6 million barrels of water per day or 124,000 acre feet per year which compares well with the 120,000 acre feet per year estimated by AMEC for the Colorado, White and Yampa River Roundtables.

The following chart is another comparison of water usage by oil shale and other energy producing technologies using DOE data and prepared by Dr. Jeremy Boak of the Colorado School of Mines in 2012.