UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

OIL SHALE BRIEFING BOOK

REGION VIII
DENVER COLORADO

576

R8
321

Oil Shale Research Workgroup

Tour

October 21-23, 1980

Itinerary

October 20	Arrive in Grand Junction, Colorado

- Evening meeting (informal, optional, about 7:00pm) with Area Oil Shale Supervisor's Office.
- Stay at American Family Lodge (303/243-6050)

October 21

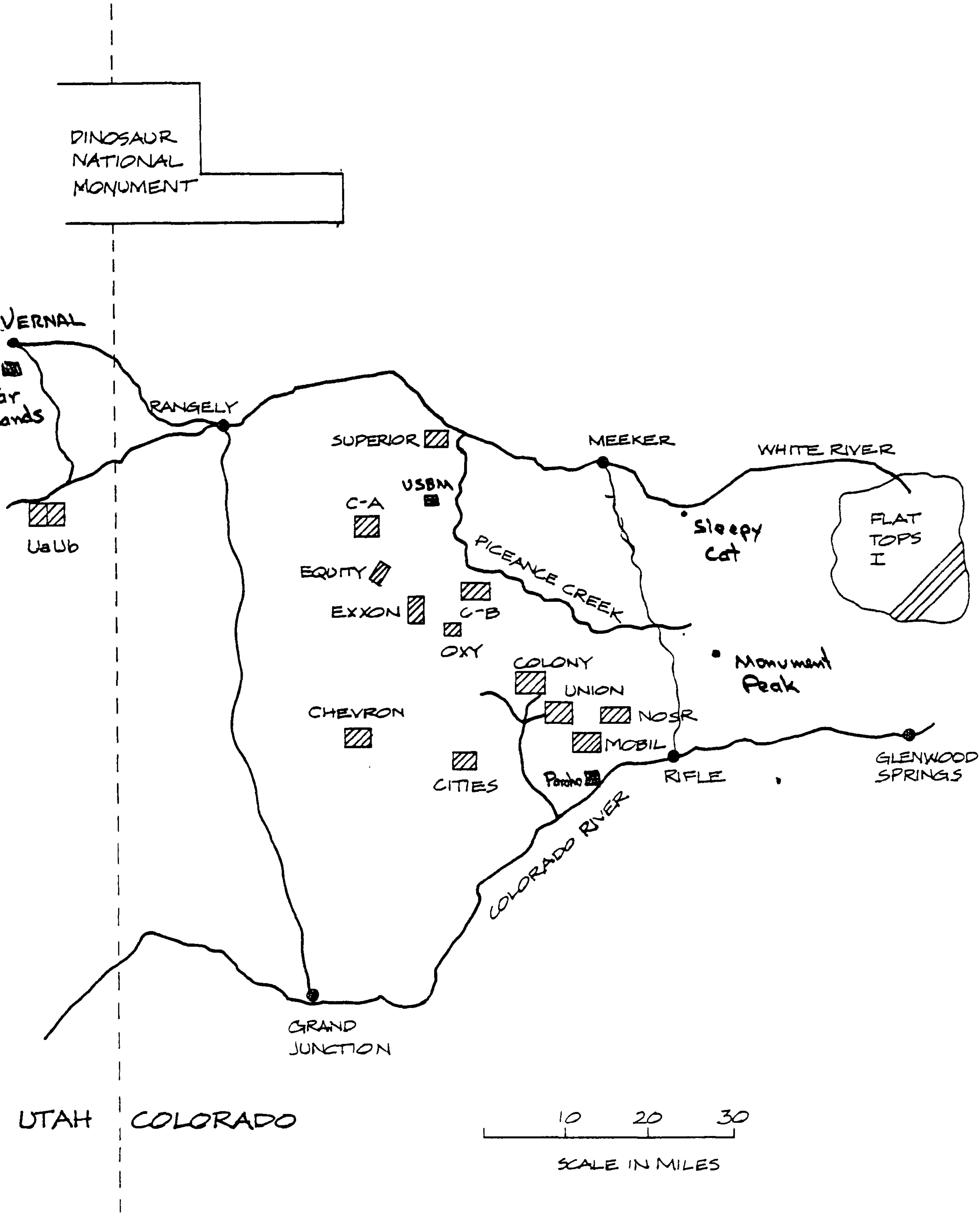
7:20 a.m.	Begin Boarding Bus at American Family Lodge
7:30am	Depart for Union
9:00 - 10:00	Briefing of Union's activities Field visit view of construction
10:00	Depart for Colony
10:30 - 11:30	Briefing of Colony's activities Field visit view of construction
11:30	Lunch
Noon	Depart for Paraho
1:00 - 2:30pm	Briefing and tour of Paraho facilities Split into three groups - mine, retort, revegetation
2:30	Depart for Visibility/Air Quality site
3:00 - 4:30	View EPA Region VIII Monitoring site (Weather permitting?)
4:30	Depart for Meeker
5:30	Arrive at Sleepy Cat Lodge (303/878-4413)

October 22

~~8:00am~~	~~Depart for Tract C-b~~ Cancelled
~~9:00 - 11:00~~	~~Briefing and Tour of C-b~~
9:00 ~~11:00~~	Depart for USBM shaft, Horse Draw view of C-b on the way
11:30	Lunch
11:30 - 1:00	Briefing and Tour (underground)
1:00	Depart for Tract C-a
1:30 - 3:30	Briefing and Tour of C-a
3:30	Depart Tract C-a for Vernal, Utah Drive by briefing of Superior
5:30	Arrive at Vernal Stay at Dinosaur Motel (801/789-2660) and Motel Utah (801/789-1131)

October 23

8:30am	Depart for DOE Tar Sands Project
9:00 - 10:30	Tour of Asphalt Ridge
10:30	Depart for lease tracts UaUb
11:30	Lunch
12:30 - 2:00pm	Depart for Grand Junction
4:30	Arrive in Grand Junction


DINOSAUR
NATIONAL
MONUMENT
VERNAL
Tar
Sands
RANGELY
UaUb
SUPERIOR
USBM
C-A
EQUITY
EXXON
C-B
OXY
CHEVRON
CITIES
COLONY
UNION
NOSR
MOBIL
Paraho
MEEKER
WHITE RIVER
Sleepy
Cat
FLAT
TOPS
I
PICEANCE CREEK
Monument
Peak
RIFLE
GLENWOOD
SPRINGS
COLORADO RIVER
GRAND
JUNCTION
UTAH
COLORADO
10
20
30
SCALE IN MILES

OIL SHALE INDUSTRY PROFILE

The development of oil shale has been "just around the corner" for at least 60 years. The heart of the problem facing a viable oil shale industry has been economics. While some companies talk about overly restrictive environmental requirements and of regulatory uncertainty as factors in the non-development of oil shale, close scrutiny of the situation brings one back to economics as the principal constraint. Other factors besides economics (environmental requirements and regulatory uncertainty to a much lesser degree) which have postponed the development of an oil shale industry include technical and legal uncertainties. Considerable work has been done over a number of years to remove many of the technical uncertainties surrounding oil shale processing. However, uncertainties regarding scale-up of technologies remain. The largest demonstration of retorting has been at a capacity of 1200 tons per day. Commercial size modules will be about six times larger. Two major legal constraints face a potential oil shale industry. The first consists of the contested ownership of 43,000 acres of unpatented mining claims filed on oil shale land under the mining law of 1872. The Mineral Leasing Act of 1920 made oil shale a leasable mineral. Recent court decisions have unheld the validity of the pre 1920 claims. The second legal uncertainty involves Federal vs State ownership of certain lands. Both Utah and Colorado have claimed Federal lands bearing oil shale under provisions of the Statehood Enabling Act of 1894.

Produced shale oil is entitled to the world free market price as a result ofactions by the President and DOE. Most companies were projecting a required price of about $25 per barrel in the 1978-79 time frame. Therefore, even with inflation, shale oil is becoming attractive at the present world market price of about $30 per barrel. Further adding to the attractiveness of shale oil is the certainty of a supply of oil, given recent events in the Middle East.

Shale oil is being produced in the USSR and in China. Commercial size projects are under construction in Brazil and Australia. The Federal Prototype Oil Shale Leasing Program was launched in the United States late in 1973 in order to demonstrate the viability of the technology and to define the environmental impacts of shale oil production. Operations via the modified in-site technique are proceeding on the two Colorado lease tracts. The two Utah lease tracts are involved in the land ownership legal battle. The two Wyoming tracts attracted no bidders. Development on private lands in Colorado appears to be destined to underground mining and surface retorting.

The President established a goal of production of 400,000 bpd of shale oil by 1990. Congress appears to be arriving at a similar production goal but to be accomplished by 1992. Due to the recent renewed interest in oil shale development DOI Secretary Andrus is evaluating the need for resumption of an oil shale leasing program prior to fulfillment of the Prototype Program objectives. A recent survey of oil shale company production goals by 1990 resulted in a total figure -f almost 700,000 bpd (see attached table). It should be strongly emphasized that these must be considered as posturing or planning figures and in no way represent firm commitments to proceed.

In conclusion, oil shale has had a great potential for years; it now appears that the 1980's will bring some development into being. The role, location, and mode of development will all bear upon the environmental acceptability of the industry.

T Thoem

Status of Oil Shale Projects

From Cameron

COMMERCIAL PROJECTS

1. CATHEDRAL BLUFFS SHALE OIL CO. - Occidental & Tenneco(T3S,R96W,6PM

   Bonus bid of $117.8 million paid to acquire rights to Tract C-b in 1974. Original partners, ARCO and TOSCO, withdrew in 1975. A third original partner, Shell, withdrew 11/76. Occidental joined(with Ashland as remaining partner)11/76. Ashland withdrew 2/14/79. On 9/4/79, Tenneco acquired half interest for $110 million. Modified DDP for 57,000 BPD modified in situ plant submitted March 1, 1977. DDP approved 8/30/77. EPA issued conditional PSD permit for first phase of development 12/16/77. Primary contractor is Ralph M. Parsons Company. Three headframes, two of concrete and one of steel, have been erected. As of mid-October 79 the shaft depths were: Ventilation/Escape - 910', Service - 725', Production - 726'.

   Project cost: $1 billion

2. COLONY DEVELOPMENT OPERATION - ~~ARCO~~ EXXON (60%) and TOSCO (40%)(T5S,R95W,6PM)

   Proposed 46,000 BPD project on Colony Dow West property near Grand Valley, Colorado. Underground room-and-pillar mining and TOSCO II retorting planned. Production would be 66,000 TPD of 35 GPT shale from a 60-ft. horizon in the Mahogany zone. Development suspended 10/4/74. Draft EIS covering plant, 196-mile pipeline to Lisbon, Utah, and minor land exchanges released 12/17/75. Final EIS has been approved. World price for shale oil and inclusion of shale oil in entitlements program increases likelihood that project will be reactivated. EPA issued conditional PSD permit 7/11/79. If a proposed $3/bbl tax credit indexed for inflation or equivalent incentive becomes law, Colony hopes the climate will improve to attract enough investment for reactivation of the project.

   Project cost: Estimated at $1.132 billion(1977 dollars) including $20 million for community development.

3. UNION LONG RIDGE PROJECT - Union Oil Company of California (T5S,R95W,6PM)

   In 1974, Union announced plans for a commercial project ranging in size from 50,000 BPD to as much as 150,000 BPD on some 22,000 acres of fee land near Grand Valley, Colorado. Land, shale and water resources are adequate. Underground room-and-pillar mining and Union "B" retorting would be employed. Union's "B" retort is a modification of their direct-heated,rock pump retort first tested in the late 1950's. Current plans are to proceed with a 9,000 BPD (10,000 TPD) prototype facility before expanding to commercial production. Environmental and engineering studies are substantially

COMMERCIAL PROJECTS (Contd.)

completed for prototype facility. Union has announced that it will proceed if a $3/bbl tax credit is enacted. EPA issued conditional PSD permit 7/31/79. Colorado Mined Land Reclamation Board issued permit 8/2/79.

Project cost: Approximately $100 million for 9,000 BPD module.

4. RIO BLANCO OIL SHALE COMPANY - Gulf & Standard(Indiana)(T2S,R99W,6PM)

Proposed project on federal Tract C-a in Piceance Creek basin, Colorado. Bonus bid of $210.3 million to acquire rights to tract; lease issued 3/1/74. Revised DDP calling for use of LLL Rubbilized In Situ Extraction(RISE) of shale oil submitted to Interior 5/77. Combination of modified in situ retorts and surface retorts(TOSCO II) will be used to produce 76,000 BPD. Five-year process development project will be conducted to prove in situ technology. Commercial facility scheduled to get underway in 1987. DDP approved 9/22/77. American Mine Services Inc. of Denver was awarded a $4 million contract 11/21/77 to sink a 15-foot wide, 971-foot deep shaft. EPA awarded PSD permit on 12/16/77. Primary contractor is Morrison-Knudsen Company with a $38.8 million contract. Tests are underway to determine underground water quantities. Agreement($6 million) reached 3/79 with Oxy for exchange of modified in situ technical data. On 8/31/79 approval was granted to modify in situ retorts using RBOSC design. On 7/16/79 announced 1-year design and cost study($4 million) that could lead to $100 million construction and operation of Lurgi-Ruhrgas surface retort demonstration plant. Shaft completed at 979' in 10/79, and outfitting is progressing. Surface processing facilities scheduled for completion 1st quarter of 1980. First burn is scheduled for ~~April~~ October 1980.

Project cost: Four-year process development phase budgeted at $93 million. No cost estimate available for commercial facility.

5. WHITE RIVER SHALE PROJECT - Phillips, Sohio & Sunedco(T10,R94E,SLM)

Proposed joint development of federal lease Tracts U-a and U-b in the Uinta Basin near Bonanza, Utah. Bonus bid for Tract U-a was $76.6 million by Sun(now Sunedco) and Phillips. Bonus bid for Tract U-b was $45.1 million by White River Shale Oil Corporation (jointly owned by Phillips, Sohio and Sunedco). Rights to Tract U-b subsequently assigned to Sohio. Both leases issued 6/1/74. Detailed Development Plan filed with Interior 6/76 proposes modular development with ultimate expansion to 100,000 BPD. Application for one-year suspension of lease terms granted 10/76 based on environmental considerations. This suspension was superseded by a court injunction suspending the lease terms based on property title questions. WRSP's leases U-a and U-b are in jeopardy due to the existence of unpatented pre-1920 oil shale placer mining claims and

COMMERCIAL PROJECTS (Contd.)

by an, as yet unresolved,application for a state lease to the same property by Peninsula Mining associated with Utah's in-lieu land selection procedure. The injunction order suspending the U-a and U-b federal lease terms is uncontested and is in full force and effect. The final Environmental Baseline Study report was issued on 11/15/77 by WRSP. Utah approved White River Dam and Reservoir funding 2/78. EIS for the Dam is proceeding.

Project cost: Estimated at $1.61 billion for 100,000 BPD project (1975 dollars)

6. NAVY OIL SHALE RESERVE DEVELOPMENT - TRW Inc.

Navy issued RFP 6/77, calling for preparation of Master Development Plan for Naval Oil Shale Reserves 1,2, and 3. Objective is to put NOSR in position for large scale development of resources within five years. Contract awarded 6/22/78 to team composed of TRW, CF Braun & Company, Gulf Research & Development Company, Williams Bros. Engineering Company, and Tosco Corporation. Comparative analysis of NOSR 1 and eight other Piceance Creek basin properties has been completed. A production range of 50,000 to 200,000 BPD is being evaluated. Baseline environmental data are being obtained.

Project cost: $2.16 million through 10/1/79
$60 million in 4 annual options

7. CHEVRON RESOURCES CO.

Project feasibility study is ongoing. Project would consist of open pit mining and surface retorting. Feasibility plans are directed toward a 100,000 BPD operation by 1990. Baseline environmental data are being collected. Although on private land an EIS would be prepared because of offsite right-of-way approvals.

8. EXXON COAL USA, INC.

A request for land exchange was sent to BLM on December 28, 1979. Project feasibility study is ongoing.

9. SUPERIOR OIL CO. (T1N,R97W,6PM)

Proposed project involving production of shale oil, nahcolite, alumina and soda ash from a 6,500-acre privately owned tract in Piceance Creek basin near Meeker, Colorado. Underground mining and aboveground processing to yield shale oil, nahcolite, aluminum trihydrate, and soda ash. Facilities proposed to be constructed in modules of 11,586 BOPD from 26,176 TPD shale feed. Co-products

COMMERCIAL PROJECTS (Contd.)

would be 4,878 TPD of 80 percent nahcolite, 580 TPD alumina,and 1,005 soda ash. Land exchange request to block up economically viable property filed with Interior 12/73. Draft EIS issued by BLM 7/17/79.

Project cost: $300 million for one multi-mineral module
$473,459 for EIS

10. TOSCO SAND WASH PROJECT - Tosco Corp.(T9S,R21E,SLM)

Proposed 50,000 BPD project on 14,688 acres of state leases in Sand Wash area of Uinta basin near Vernal, Utah. State-approved unitization of 29 non-contiguous leases requires $8 million tract evaluation by 1985. Minimum royalty of $5 per acre begins in 1984 and increases to $50 per acre in 1993. Preliminary feasibility study completed for TOSCO II surface retorting. Process and engineering work underway. Environmental assessment underway on site, but no other field work being conducted. Tosco has drilled a core hole on the Sand Wash site as a preliminary step to shaft sinking and establishment of a test mine. The test mine would confirm economics and mining feasibility plans for the commercial project. Permits for this new work have been received from the state.

Project cost: Approximately $1 billion

11. OCCIDENTAL OIL SHALE, INC.,LOGAN WASH(T75,R97W,6PM)

Oxy is developing its modified in situ retorting technology on its Logan Wash site near De Beque, Colorado. Field tests have been underway since 1972. Initial tests were conducted on three small retorts measuring 30 feet square by 70 feet high. Tests are now being conducted on commercial scale retorts measuring 120 feet by 280 feet high. Thirty thousand barrels of oil were produced from first commercial retort between December 75 and June 76. A $60.5 million cost-sharing contract was signed 9/30/77 with DOE. Production from retort 5 was 11,287 barrels. Retort number 6 was rubblized 3/25/78. In mid-September, two weeks after ignition, a sill pillar collapsed within Retort 6, but there was no interruption in operation. As of 10/15/79 gross oil production from Retort #6 was 47,733 barrels. PSD permit for Retorts 7 & 8 awarded 11/1/79.

Project cost: To date at least $45 million spent
$60.5 million DOE cost-sharing contract

COMMERCIAL PROJECTS(Cont.)

12. PETROSIX - Petrobras (Petroleo Brasileiro, S.A.)

A 2,200 TPD Petrosix demonstration retort located near Sao Mateus do Sul, Parana, Brazil. The plant has been operated successfully near design capacity in a series of tests since 1972. A U.S. patent has been obtained on the process. A 50,000 BPD plant is now being designed. Preliminary indications favor a scaled-up facility about five miles from existing site. A 36-ft. inside diameter vertical retort is being designed for construction at the San Mateus plant site for cold-testing of shale feed and discharge devices. This is a scale-up factor of four over the existing 18-foot inside diameter retort. Part of commercialization project is underway, viz. mine expansion, engineering of the retort, and equipment procurement. Partial operation will begin in 1984, and full capacity will be reached in 1987.

Project cost: Total expenditures in excess of $35 million
Projected cost of 50,000 BPD plant is $1.3 billion

13. RUNDLE PROJECT - Central Pacific Minerals & Southern Pacific Petroleum

Development of the Rundle deposit in Queensland, Australia. Construction will begin in 1980 on two commercial demonstration modules using Superior and Lurgi-Ruhrgas processes. Production projected to be 20,000 BPD by 1982. By 1986, production would grow to 250,000 BPD from 40 retorts.

Project cost: $316 million (US) for 20,000 BPD
$2.16 billion (US) for 250,000 BPD

R&D PROJECTS

14. DOW CHEMICAL CO.

DOW was awarded a four-year contract by ERDA in March 1977, for production of fuels from Antrim oil shale formation. Project includes characterization and mapping of Antrim shale resources in Michigan Basin, evaluation of three in situ fracturing techniques on an 80-acre site belonging to DOW, and two in situ production tests. Explosive fracturing activities for the hydraulic fracturing subtask were completed in the 100 series wells. Well cleanout was almost completed and permeability studies and fracture evaluation will proceed as soon as it is complete. Evidence that there is communication between these wells continues to accumulate. The third and fourth shots in the explosive underreaming series were detonated in well #301. The well cavity was increased by a factor of 2.4 compared to the original borehole volume for a 62-foot section

R&D PROJECTS(Contd.)

after the third shot. The fourth shot produced more damage to the bottom section of well casing. For the chemical underreaming subtask, well #201 was notched in a limestone stringer below the Antrim formation. The well was hydrofractured with water but no communication with nearby wells was observed. Further evaluation of this subtask is underway. The data from extraction trials on the front site have been collected and processed. Analysis of product gases from the final trial showed that they had a total energy content 4.9 times the total solid fuel and gaseous fuel put into the well for ignition, thus establishing that significant quantities of Antrim shale had been affected by the operation. Ignition in well #305 in 10/79 gave indicati
combustion occurred.

Project cost: $14 million

15. EQUITY OIL COMPANY

Equity received a $6.5 million contract from ERDA in June 1977, for development of in situ technology using superheated steam. The work is being conducted on a one-acre site in the Piceance Creek basin of Colorado. The first phase of the contract has been completed which involved drilling two core holes near a previous steam injection site. Site evaluation has been completed. Start-up of field project occurred 6/79. As of mid-October 1979, steam was being injected at 950^{o}F and 1,450 psi at a rate of 20,000 to 25,000 lb/hr(about 50% design rate). No shale oil had been produced.

Project cost: DOE cost-sharing contract for $6.5 million.

16. GEOKINETICS,INC.

Geokinetics has been conducting field tests to develop horizontal in situ retorting technology since 1973. Obtained ERDA contract 7/77 to develop technology in thin horizontal beds of oil shale in Uintah County, Utah. Porosity is established in formation by raising the shallow overburden during explosive fracturing of the shale formation. Total production to end of 1978 was 5,437 barrels.

Project cost: DOE cost-sharing contract valued at $9.2 million

R&D PROJECTS(Contd.)

17. LARAMIE ENERGY TECHNOLOGY CENTER

Laramie and Rocky Mountain Energy Co. have been conducting in situ shale oil production tests for several years near Rock Springs, Wyoming. Partial dismantling of Site 12 began 5/79, and post-operation water monitoring phase began 7/79.

Project cost: Undetermined

18. PARAHO OIL SHALE FULL SIZE MODULE PROGRAM - Paraho Development Corporation

Paraho is seeking six sponsors, each contributing $500,000, for Phase I of a 3-phase module program. Phase I consists of engineering and planning; Phase II is detailed design, procurement, and construction; and Phase III is operation. Paraho initiated Phase I at its own expense on 12/1/77.

Project cost: $4 million for 16-month Phase I
$75 million for 21-month Phase II
$14 million for 24-month Phase III

19. U.S. BUREAU OF MINES - Multi Minerals Corp.

USBM began drilling 10-foot diameter, 2,400-foot deep shaft 3/77. Objective is to mine samples of oil shale, nahcolite, and dawsonite from shale formation. Shaft may be used for ventilation in future experimental mine. Drilling operations were completed 10/2/77 at 2,371 feet. Shaft classified as gassy mine. Multi Mineral Corp. is performing experimental mining. EIS in preparation for "Integrated In Situ Process" testing.

Project cost: Over $8 million for shaft sinking.

PREDICTED SHALE OIL PRODUCTION LEVELS FROM WESTERN OIL SHALE RESOURCES 1980 — 1996

(BARRELS PER CALENDAR DAY)

NOV 1979

	OIL SHALE PROJECTS		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
(1)	OCCIDENTAL OIL SHALE LEASE TRACT C-b	a	PILOT OPERATION, ENGR. PERMITTING, CONSTRUCTION →				6,250	30,000	50,000	50,000	87,500	140,000	200,000	COMMERCIAL OPERATION →					
(2)	PROJECT RIO BLANCO LEASE TRACT C-a	b	PILOT OPERATION, ENGR. PERMITTING, CONSTRUCTION →				19,000	45,600	76,000	COMMERCIAL OPERATION ENGR, PERMITTING, CONSTRUCTION →					90,800	111,600	135,000	COMMERCIAL OPERATION →	
(3)	GEOKINETICS, INC UINTA BASIN	c	SAME AS ABOVE →		5,000	5,000	10,000	15,000	25,000	40,000	50,000	→							
(4)	EQUITY OIL PICEANCE BASIN	d	PILOT OPERATION → PLANS DEPEND UPON OUTCOME OF PILOT OPERATIONS →																
(5)	NAVAL OIL SHALE RESERVE PICEANCE BASIN	e	FEASIBILITY STUDY →				DESIGN PERMITTING →		CONSTRUCTION →				28,000	41,500	50,000	COMMERCIAL OPERATION →			
(6)	DEMONSTRATION OF ABOVE GROUND RETORTING (DOE-PON)	f	MODULE DESIGN	MODULAR PLANT CONSTRUCTION		8,000	4,000	END PROJECT											
(7)	DEMONSTRATION OF ADVANCED RETORT TECHNOLOGY (DOE-PON)	g	RESEARCH →				PILOT TESTS, ENGINEERING, PERMITTING MODULE CONSTRUCTION →						8,000	8,000	END PROJECT				
(8)	UNION OIL LONG RIDGE, PICEANCE BASIN	h	CONSTRUCTION →		9,500	MODULE OPER. CONSTRUCTION		30,000	50,000	COMMERCIAL OPERATION SCALE UP →							75,000	100,000	→
(9)	COLONY/TOSCO PARACHUTE CREEK, PICEANCE BASIN	i	DESIGN, CONSTRUCTION →				25,900	38,400	46,200	COMMERCIAL OPERATION →									
(10)	TOSCO SAND WASH UINTA BASIN	j						PERMITTING, CONSTRUCTION →			23,100	46,200	→						
(11)	WHITE RIVER PROJECT LEASE TRACTS Ua, Ub, UINTA BASIN	k	EXACT SCHEDULE WILL DEPEND UPON OUTCOME OF LITIGATION →													45,000	90,000	→	
(12)	CHEVRON OIL PICEANCE BASIN	l	ENGR., PERMITTING, PILOT MODULE CONSTRUCTION →				7,000	15,600	24,200	32,800	41,400	50,000	66,600	83,200	100,000	→			
(13)	SUPERIOR OIL PICEANCE BASIN	m	PERMITTING, CONSTRUCTION →					6,700	10,000	12,000	COMMERCIAL OPERATION →								
(14)	MOBIL OIL PICEANCE BASIN	n	ENGINEERING, PERMITTING, CONSTRUCTION →						6,000	6,000	30,600	42,500	50,000	COMM. OPERATION SCALE UP →			78,000	91,500	100,000
(15)	CARTER OIL	o	ENGINEERING, PERMITTING, CONSTRUCTION →						16,800	24,900	30,000	45,000	60,000	COMMERCIAL OPERATION →					
(16)	CITIES SERVICES		NO DEFINITE PLANS AT THIS TIME																
	TOTAL PROJECTS		0	0	14,500	22,500	81,650	181,300	304,200	337,900	446,800	557,900	693,000	723,100	755,200	821,000	942,400	980,900	989,400

from TOSCO

II. OIL SHALE: READY, COMMERCIALLY COMPETITIVE, ENVIRONMENTALLY SOUND

The Resource

Mineral deposits called "oil shale" appear in many parts of the world, and have been produced on a commercial scale for over 150 years. Scottish shale oil was produced through the late 19th century into the 1920's; Sweden's deposits were worked to economic exhaustion in the period after World War II; Chinese and Estonian oil shale is now in production. A fledgling industry exists in Brazil, and studies are under way in Israel, Morocco and Australia.

Although all these deposits and the Devonian shales of the Eastern United States are all called "oil shale," they vary in their composition, richness, and mineability. Present United States oil shale plans focus on the oil shale of the Green River formation of Colorado, Utah and Wyoming. This deposit, the remains of an ancient, stagnant freshwater lake which gradually filled with organic matter and dust, is especially rich in an area in Northwest Colorado called the Piceance Basin and an area of Utah immediately to the West called the Uinta Basin.

Oil shale is a hard, sedimentary rock, characterized by thin layers resulting from annual patterns of deposition in the prehistoric lake. It does not contain liquid oil, but an organic matter called kerogen. When the oil shale is heated to about 900°F in a process known as pyrolysis, the organic kerogen vaporizes and the vapors may then be condensed into shale oil, except for a non-condensible gas fraction.

The gas fraction, which is small in the Tosco II retorting process, may be used as plant fuel. The remainder of the oil shale is the dust which was deposited in the lake and a small amount of residual carbon. In the Tosco II retorting process the dust is recovered in the form of a fine, black silt-like material called spent shale.

The composition and usability of shale oil is within the range of properties of conventional crude oils, its only unusual properties being a high "pour point" (which is not a problem) and a high nitrogen content. The nitrogen, which would interfere with conventional refinery processes, can be removed by standard hydrogenation processes.

The hydrogenation process produces a synthetic crude oil of premium quality which can be readily converted into transportation fuels in a typical Rocky Mountain refinery. Table I compares the yield from shale oil with that from a premium quality sweet Wyoming crude currently selling for $28.50 a barrel.

Shale oil is a source of transportation fuels comparable to premium quality domestic crudes. Since it fits easily and readily into the existing complex refining, distribution and consumption system for oil, it is the most straightforward substitute for imported oil.

The available quanitites of oil from shale are very large. The entire Green River formation contains an estimated 600 billion recoverable barrels of shale oil in deposits of a richness of 25 gallons per ton of shale

Table I

Percentages of Products from a Typical Rocky Mountain Refinery[1]

	From Wyoming Sweet	From Hydrotreated Shale Oil
Gasoline	52.4%	55.3%
Diesel/Jet	33.5	39.1
High Sulfur Fuel Oil	3.8	-
Low Sulfur Fuel Oil	8.7	3.5
LPG	1.7	2.5
Processing (Loss) Gain	(0.1)	(0.4)
	100.0%	100.0%

[1]Based on Tosco in-house analysis.

or higher. While recovery of all of this oil will require further refinement of the technology, 130 billion barrels in deposits averaging at least 30 gallons per ton in mining horizons of 30 feet or more can be recovered using existing technology.[1] The currently recoverable oil from shale exceeds by more than four times the current United States proven reserves of crude oil.

Clearly, limits exist on the rate at which these very large reserves may be produced. Using present technology within the bounds of sound environmental practices and water availability without reduction in use by other water users, the maximum production rate is generally thought to be in the neighborhood of one million B/D. While some industry sources think twice that level of production is feasible, most agree that technological advances in the course of a decade following initial commercial production are likely to permit substantially greater future production rates than those now projected.

While one million B/D or even two will not replace all imported oil, currently between eight and nine million B/D, it can make a major difference as part of an effective program of conservation, solar, and increased traditional and new fossil energy production. Oil shale production at the level of one million B/D would represent a new domestic source of premium quality oil equivalent to half of that from Alaska on a continuing basis well into the next century.

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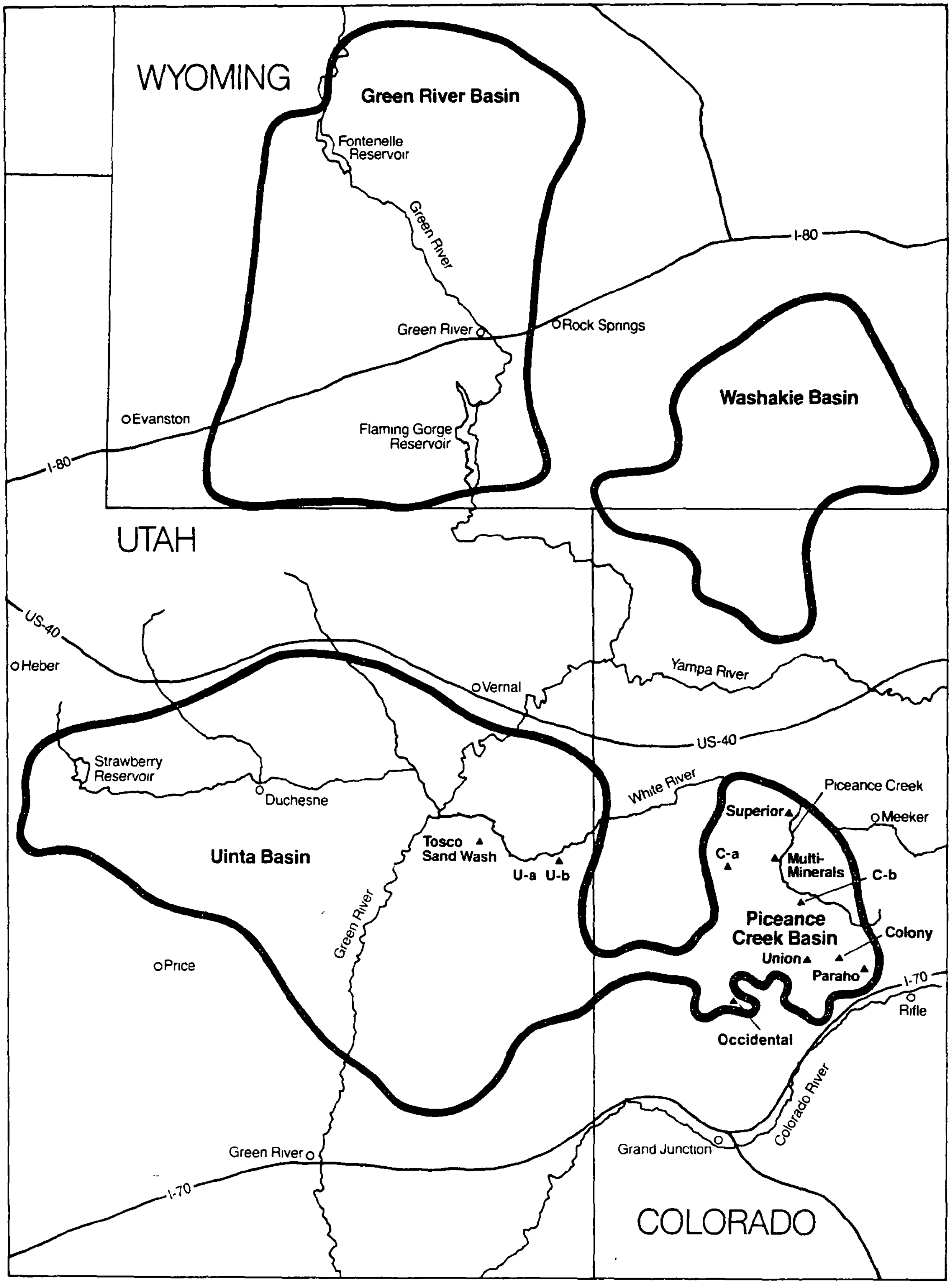
[1]National Petroleum Council estimate.



Proposed Oil Shale Projects

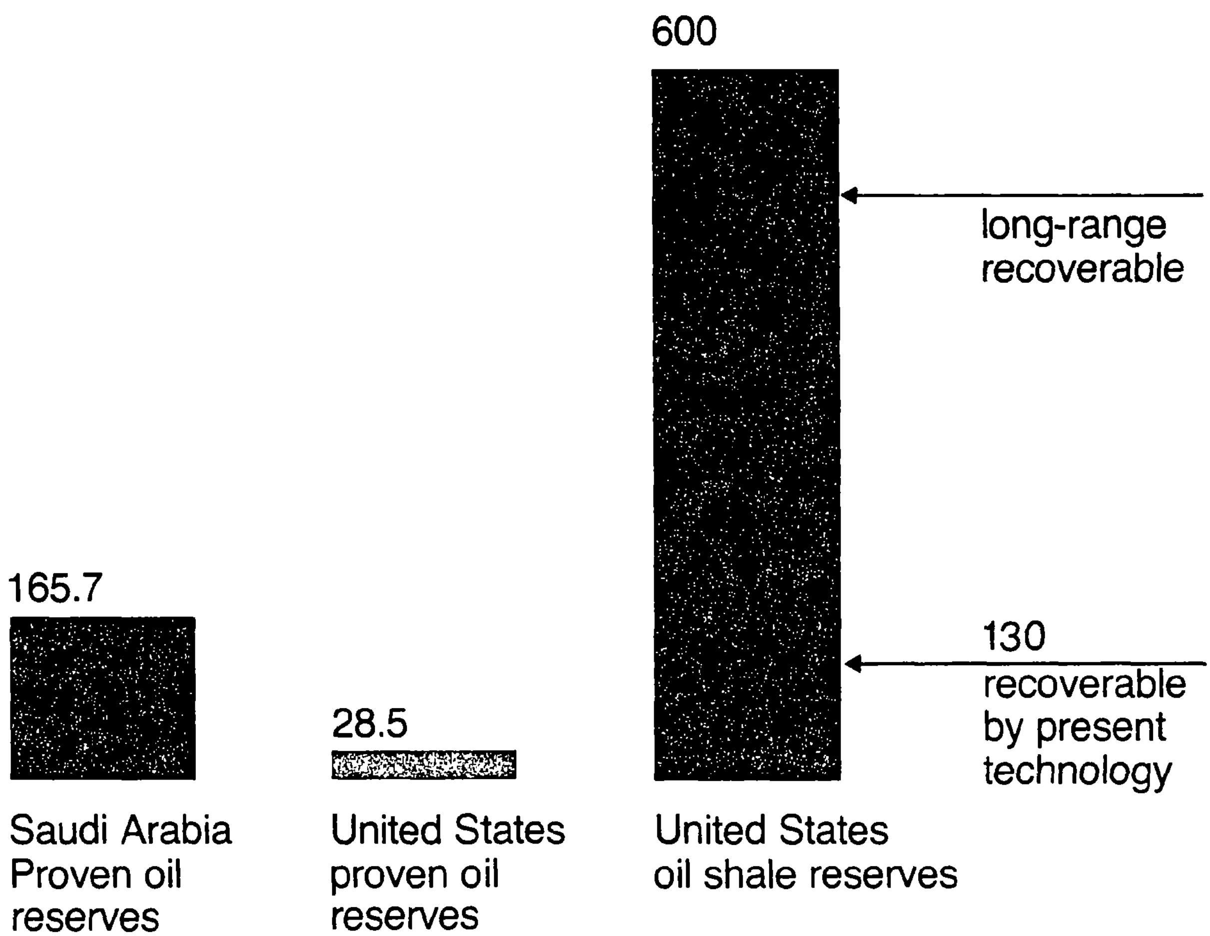
C-a — Gulf and Standard of Indiana

C-b — Occidental and Tenneco

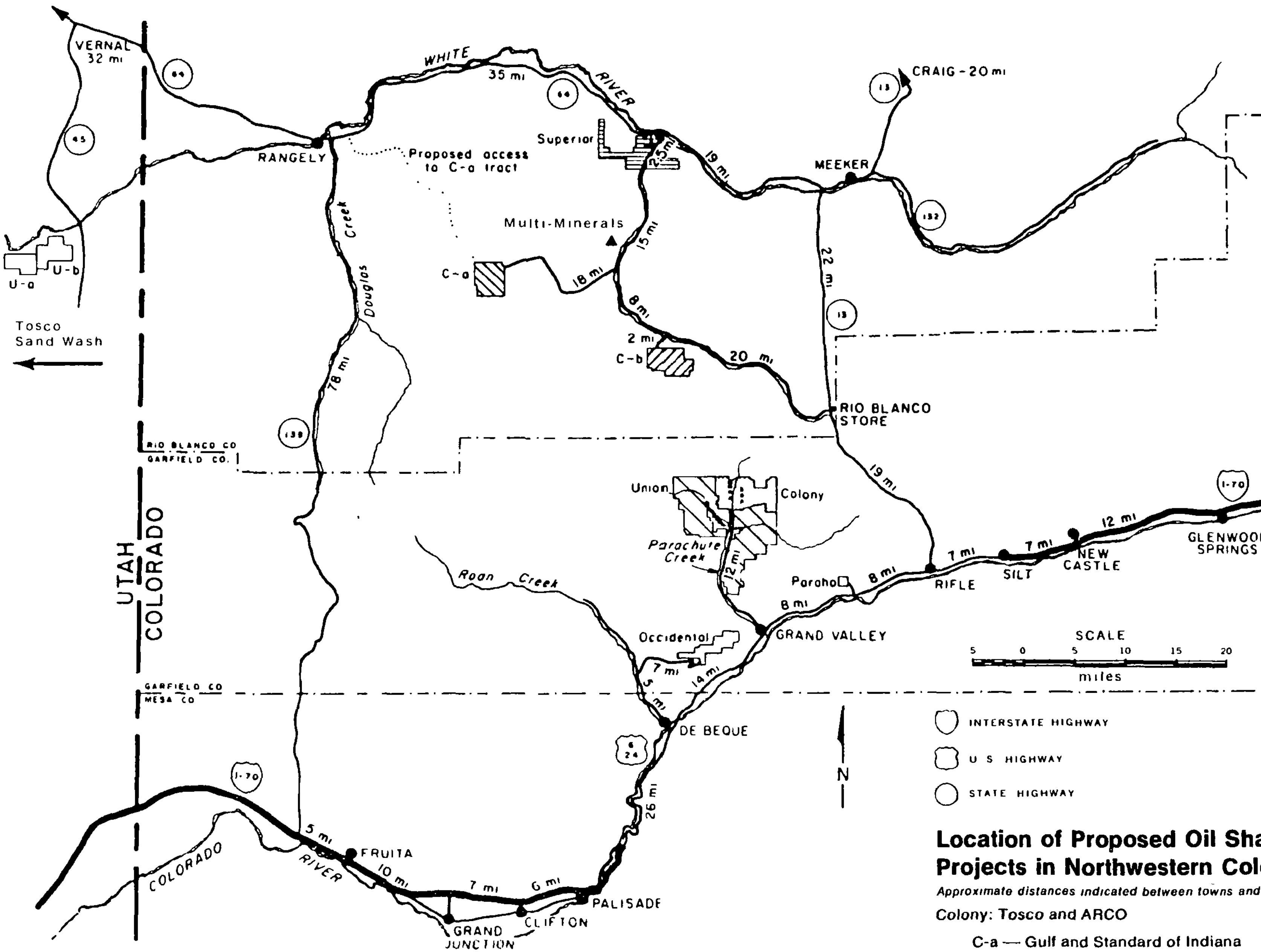
U-a U-b — Sohio, Phillips and Sun

U.S. Oil reserves and potentially recoverable shale oil compared with Saudi Arabian reserves

(In billions of barrels)



Source: Energy Information Administration, Cameron Engineers



Location of Proposed Oil Shale Projects in Northwestern Colorado

Approximate distances indicated between towns and projects

Colony: Tosco and ARCO

C-a — Gulf and Standard of Indiana

C-b — Occidental and Tenneco

U-a U-b — Sohio, Phillips and Sun

Shale oil would directly replace declining domestic production of crude oil, or if that decline is slowed enough, displace imports. In addition, it would provide a national security "credibility" factor far in excess of actual production rates, because of its stable production cost and very large production potential. Saudi Arabia now exercises an influence in OPEC pricing disproportionate to its production rate because it alone has large unused marginal production capacity. Oil shale can play a similar role for the United States.

Status of the Technology

Unlike any other source of unconventional liquid fuels, shale oil production by the TOSCO II process is economically competitive today, field-ready now, and able to move into viable commercial production with no further research and development.

The TOSCO II retorting process entered the pilot stage more than twenty years ago and was scaled up to "semi-works" (semi-commercial) scale nearly fifteen years ago. The TOSCO II process will be used in the commercial development of the Colony Project, a joint venture between Atlantic Richfield (60%) and Tosco (40%).

The Colony Project has its own privately owned shale reserve, detailed engineering plans, and a definitive cost estimate based on these plans, an approved Environmental Impact Statement, and all but one remaining significant permit granted for a commercial scale (47,000 B/D) shale oil project.

Commercial development of oil shale is being pursued by a number of companies. The major technologies for retorting shale oil fall into two categories; surface retorting and modified *in situ*. The surface retorting process involves three major steps: first, conventional underground mining; second, crushing of the shale rock after it has been mined and brought to the surface; and third, heating of the crushed rock to 900° F. in surface retorts to vaporize and release the hydrocarbons. The vaporized hydrocarbons are then upgraded at the site and, upon completion of the process, are ready for the conventional refining process.

There are several different surface retorting technologies in active development. These differ primarily in terms of the method of feeding the crushed rock into the retorting chamber, the type of retorting chamber used, and the mechanisms for achieving even, rapid distribution of the heat to maximize the efficiency of recovery. The major surface retorting technologies are the TOSCO II process, the Union B process, the Paraho process, and the Superior multi-mineral recovery technology. (see diagrams 1-2 and the diagram in the back pocket).

The pure *in situ* method, which involves no mining, has been extensively studied and is considered impractical. In the modified *in situ* process, a working space is mined out in the shale bearing formation and large columns of the rock are rubblized in place by explosion. The rubblized zones are then ignited and the burning shale operates as an underground retort, vaporizing the trapped hydrocarbons. The shale oil vapors are then gathered at the surface where they are further retorted and upgraded. Occidental's process is the best known modified *in situ* process and the one being most actively developed (see diagram 3).

There are presently a number of oil shale projects in various stages of development in Colorado and Utah using either surface retorting technology, _in situ_, or a combination of the two, depending on the nature of the resource. The _in situ_ technology is regarded as a promising secondary recovery technique in combination with surface retorting technology.

Roughly 90% of the resource is owned by the federal government. Two federal tracts in Colorado and two in Utah were put up for bid and leased for development under the Federal Prototype Oil Shale Leasing Program. Although two tracts were also offered for bid in Wyoming, due to the leanness of the oil shale there, there were no bidders. In addition to the two federal test lease tracts in Colorado and Utah, there are also a number of developments in progress on privately owned land or state leases.

In Colorado, test lease Tract Cb is being developed by Occidental Petroleum and Tenneco. The lease was by a direct venture of Ashland, Arco, Shell, and Tosco for a bonus bid of $117.8 million. The original participants withdrew for a variety of reasons after considerable resource analysis and environmental monitoring work. Occidental is now at work on a pilot project on tract Cb using its own proprietary modified _in situ_ technology. Tract Cb is located northwest of Rifle toward the center of the Piceance Basin. The closest town is Meeker (see map). Occidental is also developing a second project on its own privately owned land south of tract Cb.

Tract Ca is being developed by Rio Blanco Oil Shale Company, a joint venture of Gulf Oil and Standard Oil of Indiana. Rio Blanco plans to use both a surface retorting and an _in situ_ recovery technology in combination. Rio

Blanco is under license to use the TOSCO II surface retorting process and is working on the development of its own version of modified in situ technology. Rio Blanco acquired the lease in 1974 for a bonus bid of $210.3 million. The project is in the resource analysis, environmental monitoring and analysis, and development planning phase. Tract Ca is located northwest of Tract Cb, near the town of Rangeley (see map).

The Colony Project, a joint venture of ARCO and Tosco, is located on a privately owned tract north of Grand Valley and south of both federal test lease tracts (see map). The Colony Project has completed its pilot operation and plans to proceed to a commercial scale 47,000 B/D facility using the TOSCO II process, if effective legislation is enacted by the Congress. The TOSCO II process utilizes hot ceramic balls to heat the crushed shale in a rotating kiln (see diagram in pocket of back cover).

Union Oil Company, which has been involved in the oil shale industry for more than 50 years, is developing its own privately owned tract adjacent to the Colony Project (see map). The Union "B" surface retort uses externally heated gas to heat the shale. A reciprocating rock pump forces crushed shale in from the bottom. Gas and oil leave the bottom of the retort; retorted shale overflows the top. The Union process is widely regarded as practical and commercially ready (see diagram 1).

Paraho Development Corporation is a joint venture participated in by seventeen oil companies for the purpose of further developing a surface retorting technology originally pioneered by the School of Mines. Paraho has operated three retorts on lands leased from the U.S. Naval Oil Shale Reserves near Rifle, Colorado (see map). The Paraho retort is a continuous vertical kiln. It can be operated by direct combustion within the retort (direct mode) or by external heating of the recycled gases (indirect mode) (see diagram 2).

The Superior Oil Company owns 6,500 acres of oil shale land located on the northern edge of Colorado's Piceance Creek basin (see map). Superior's technology, an indirect hot gas process, is designed for multiple recovery of shale oil, nahcolite, and dawsonite, two minerals which are unusually plentiful on the Superior reserves. Superior believes that its process, which produces four products, is practical and financially flexible.

In Utah, Federal Lease Tracts Ua and Ub are being jointly developed by the White River Shale Project. The lease to Tract Ua was originally awarded to Phillips Petroleum Company and Sun Oil Company (now Sunoco Energy Development Company) in 1974 for a bonus bid of $76.6 million. The White River Shale Corporation was formed when Sohio Petroleum Company joined the venture and the group was awarded the lease as Tract Ub in 1974 for a bonus bid of $45.1 million.

White River's two-year Environmental Baseline Monitoring Program included monitoring and analysis of surface water, groundwater, geology and soils, air quality, biological resources, and other studies.

After completing extensive conceptual engineering studies White River filed a Detailed Development Plan with the federal government in 1976 outlining plans for development of the tracts. The lease is currently in suspension at the request of White River pending resolution of problems related to the

Union B Retort

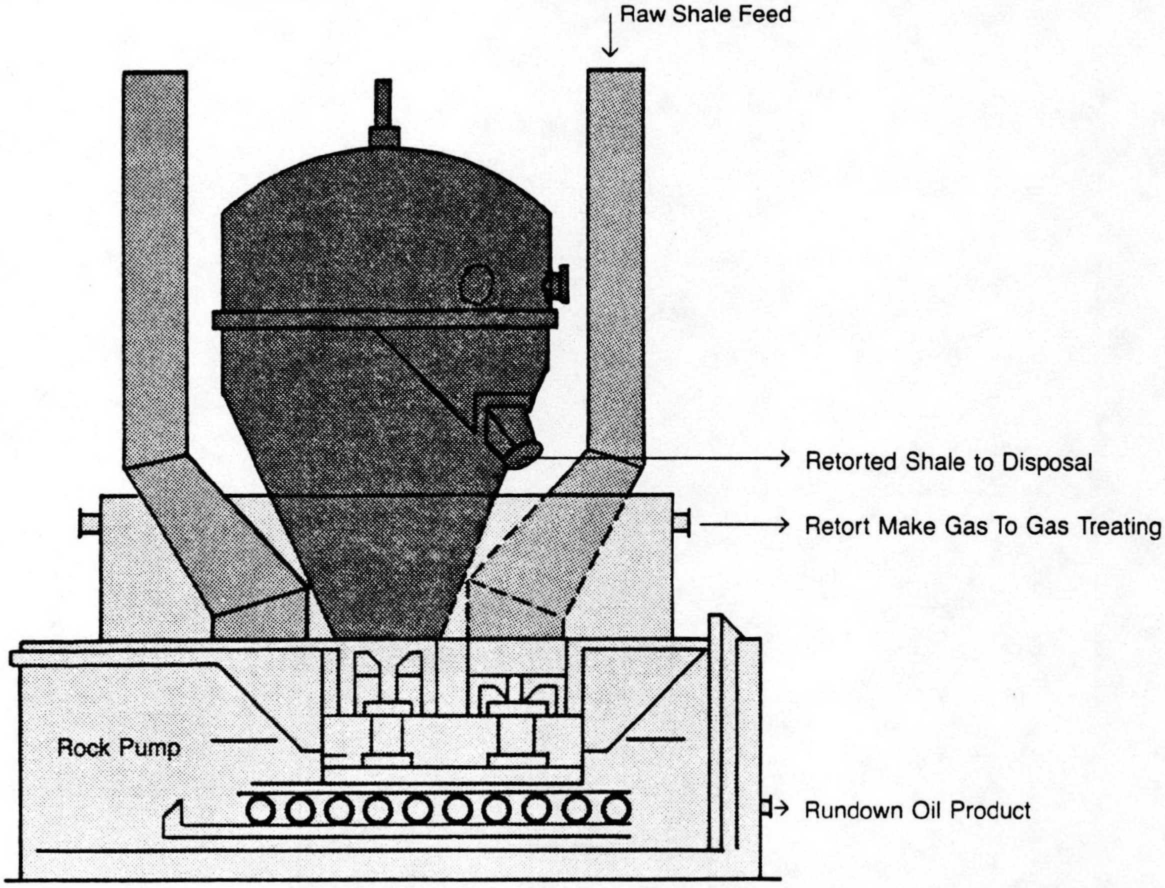


Diagram 1

Paraho Reactor

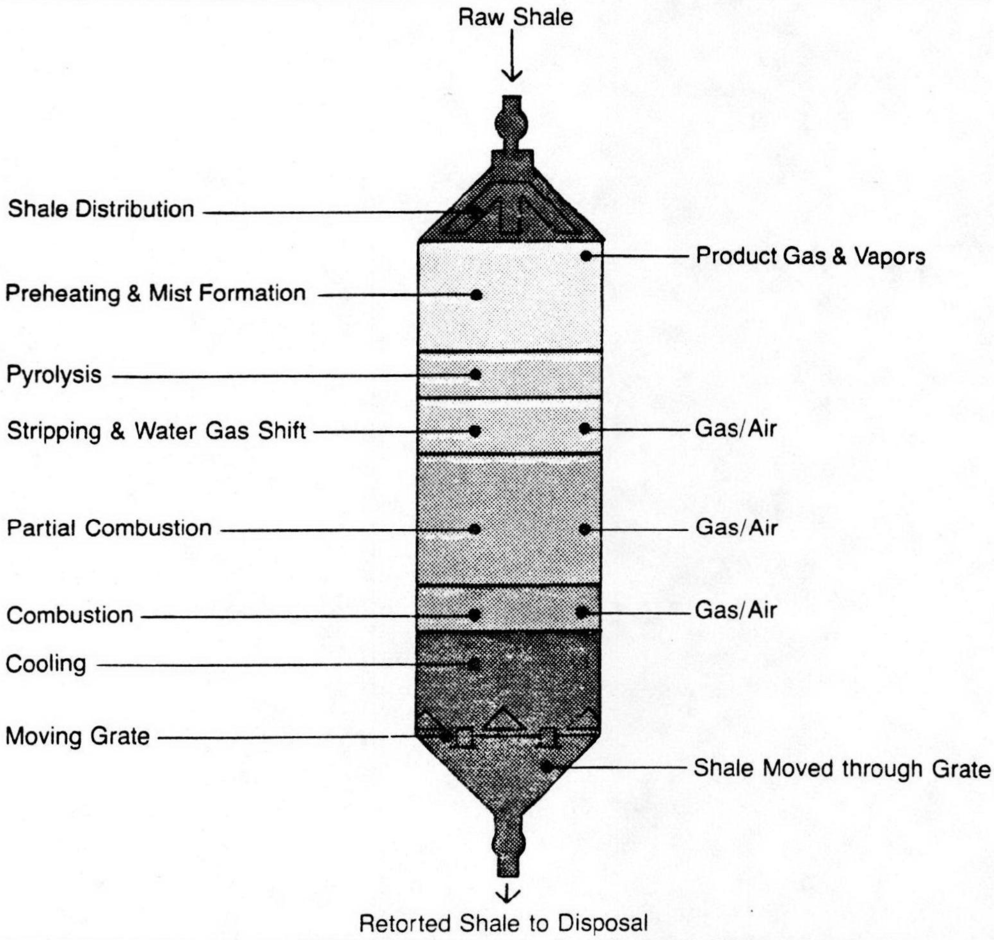


Diagram 2

Occidental Modified In Situ Process

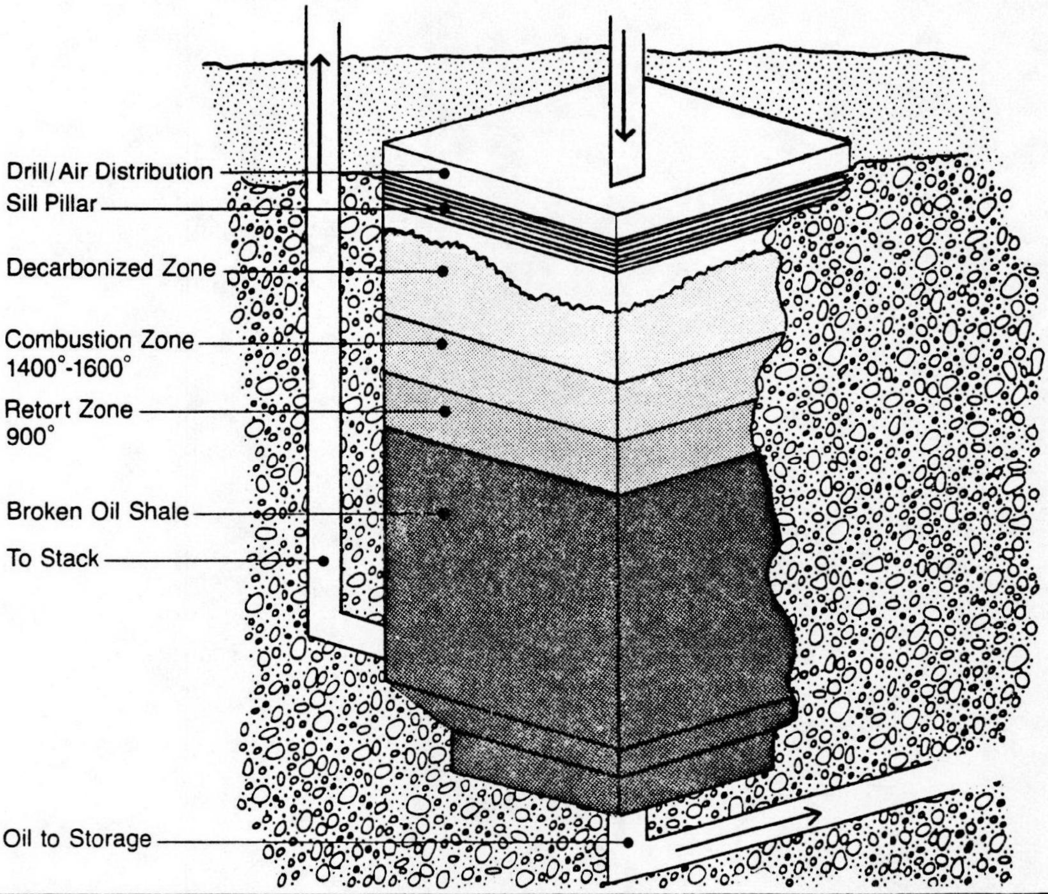


Diagram 3

ultimate disposition of the title to the tracts and other complications.[1]

A state lease, the Sand Wash Project, in northeastern Utah, is being developed by Tosco Corporation. The Sand Wash project is currently completing the resource analysis and environmental monitoring phase and will begin preparation of the EIS and permit applications in 1980. The project will use the TOSCO II technology and much of the plant design, environmental and socioeconomic work carried out for the Colony project.

The first step in the development of an oil shale project is the analysis of the resource to determine the thickness of the shale, the depth and location of the deposit, the extent and location of underground water and other factors. The choice of a technology is based in large part on the characteristics of the reserve. Extensive environmental monitoring is often carried out. After detailed plant design and cost projections for a commercial plant have been carried out, the environmental impact statement (EIS) can be prepared. During the preparation and approval of the EIS, the dozens of other state and federal permit applications can be made for a commercial plant.

All the projects in Colorado and Utah are in various stages of this development process. The test lease tracts are generally in the resource analysis and environmental monitoring phase. Tract Cb is in the pilot plant phase as are several other projects. No projects is in commercial production.

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[1]Cameron Enginners, Inc. Oil Shale Status Report, August, 1979.

The Colony Project is the only project which has completed its pilot plant operation and testing, and has a completed and approved EIS, all but one of its major permits in hand, and its community development and socioeconomic impact mitigation planning completed for a commercial plant. If effective legislation were to pass, the project could move forward to commercial production immediately. Roughly four years would be required for construction of a commercial plant.

The length of time required to prepare for commercial development including resource analysis, environmental monitoring, design work, pilot operations, commercial plant design, permit applications, EIS preparation and approval, and development of the financing package is sufficiently extensive, and the program sufficiently complex and costly that only a few projects are ready for commercialization.

A so-called "crash program" would not occur regardless of the magnitude of the federal incentives enacted. Under a practical and effective incentive program, it is likely that several of the most advanced projects would be able to move forward to commercial production. To the extent that it did not occur naturally, construction of these could be phased to minimize the peaks and valleys of population influx and other impacts.

Cost

The detailed plans and definitive estimates for the Colony Project are not rough preliminary estimates, but careful and thorough engineering estimates performed at a cost of $12 million by two world-scale contractors.

This estimate is used in the recent Rand Corporation study of cost estimate escalation in "synfuel" projects as an example of a mature and reliable estimate, in contrast with less reliable and probably understated numbers for untried and less developed processes. The estimate was completed in 1974 and is now in the process of being updated to take normal inflation into account.

Using the currently projected, updated costs, the investment cost for the Colony Project is about $25,000 per "daily barrel" of shale oil production capacity. Based on published oil industry statistics, the 1978 cost of finding and developing conventional oil and gas was about $27,000 per daily barrel, significantly more than the current estimated cost of oil shale production from the Colony Project.[1]

Subject to the updating now in progress, it appears that upgraded shale oil from this proposed plant can sell at around $25/B, returning all capital, operating and financial costs, and yielding about a 15% discounted cash flow rate of return on an all equity basis. This is well within current prices, since comparable quality Wyoming sweet crudes are now selling at $28.50/B.

While conventional oil and gas exploration should continue to be affected by general inflation, it is likely that such inflation will be offset or more than offset in second-generation shale oil plants by efficiencies resulting from technological advance. Thus shale oil can play a stabilizing role in energy pricing.

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[1]Tosco in-house analysis based on industry and Department of Energy data published in Oil Daily, June 11, 1979.

Other sources of liquid fuels, such as coal liquefaction, should also be pursued. Gasoline and other fuels from coal are now being produced in South Africa's SASOL plant. Expanded production levels are projected both from SASOL II, now under construction, and the proposed SASOL III. While there is no doubt of the workability of the process, costs are high. The U.S. contractor now building SASOL II estimates that gasoline from a comparable plant in the U.S. West would require a price of over $60/B. Nevertheless, even this cost may well seem cheap by the time such a plant is built. Other coal liquefaction processes are in pilot or pre-prototype stages, and work on these should be pursued.

These facts demonstrate that we cannot afford not to pursue commercial-scale development of shale oil. It is commercially ready and competitive with conventional sources, and highly competitive with other unconventional sources. It is a secure domestic supply. It is a source of urgently needed transportation fuels which are the least amenable to conservation or replacement by solar, and it is the most direct replacement for imported foreign oil.

Estimated cost of shale oil compared with estimated cost of coal liquefaction and coal gasification.

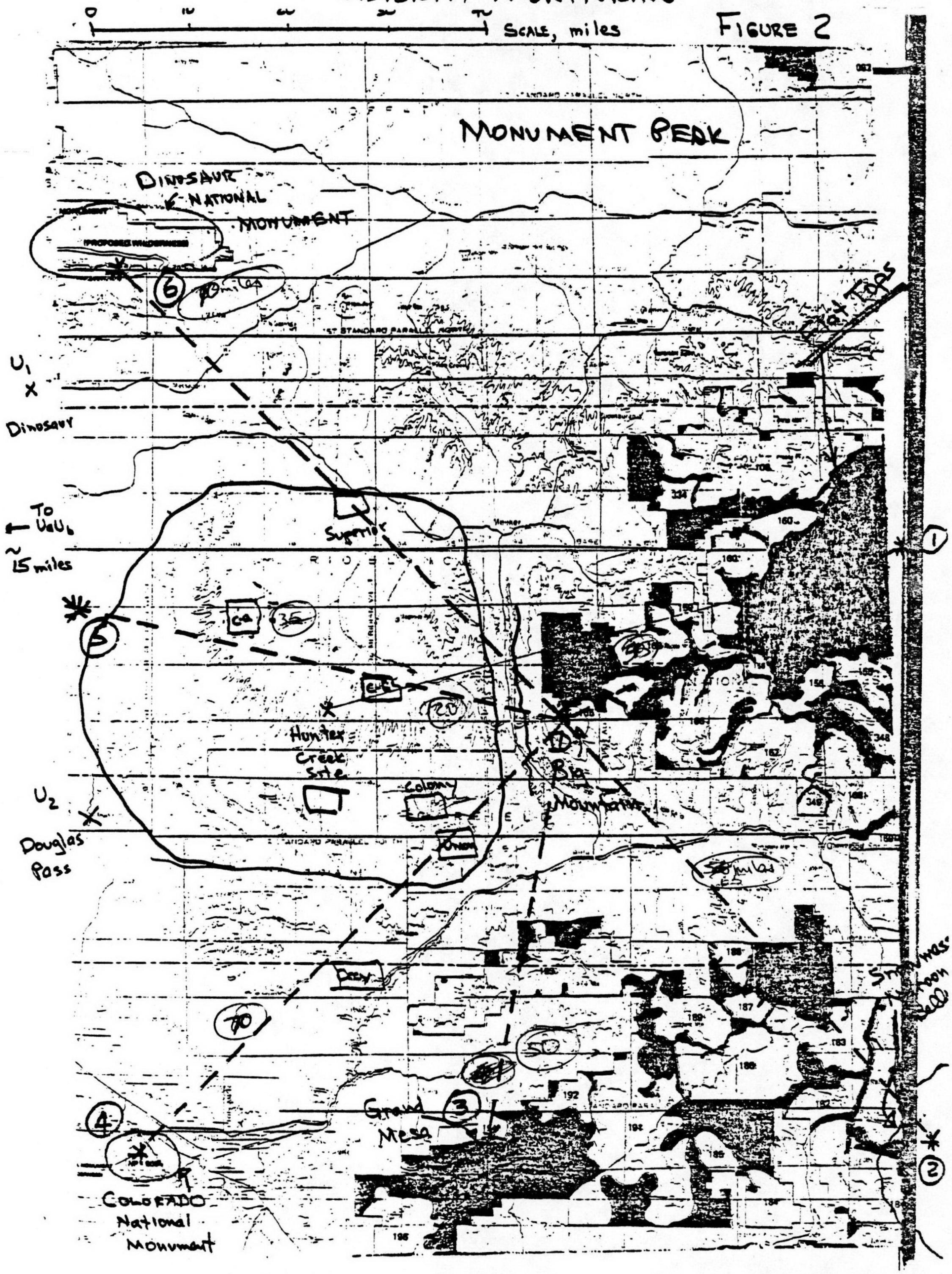
SHALE OIL[1]	$25 per barrel
COAL LIQUIDS (DIRECT)[2]	$36 per barrel
COAL LIQUIDS (INDIRECT)[2]	$37 per barrel
OIL SANDS[2]	$31 per barrel
COAL GAS[2]	$40 per barrel

[1] TOSCO estimate.

[2] Cameron Engineers, Testimony to the Senate Budget Committee Task Force on Synthetic Fuels, September 5, 1979.

VISIBILITY MONITORING

FIGURE 2



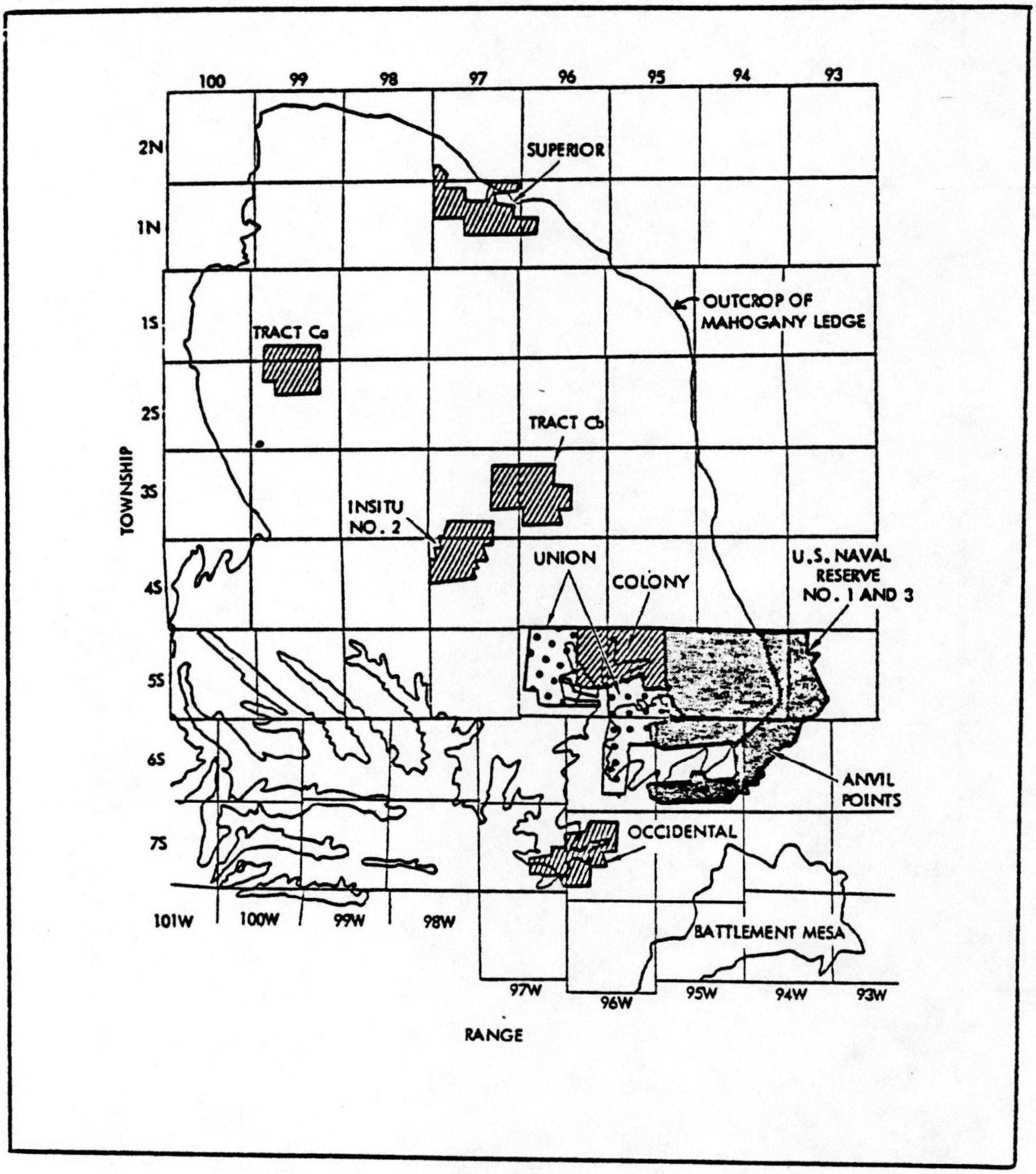
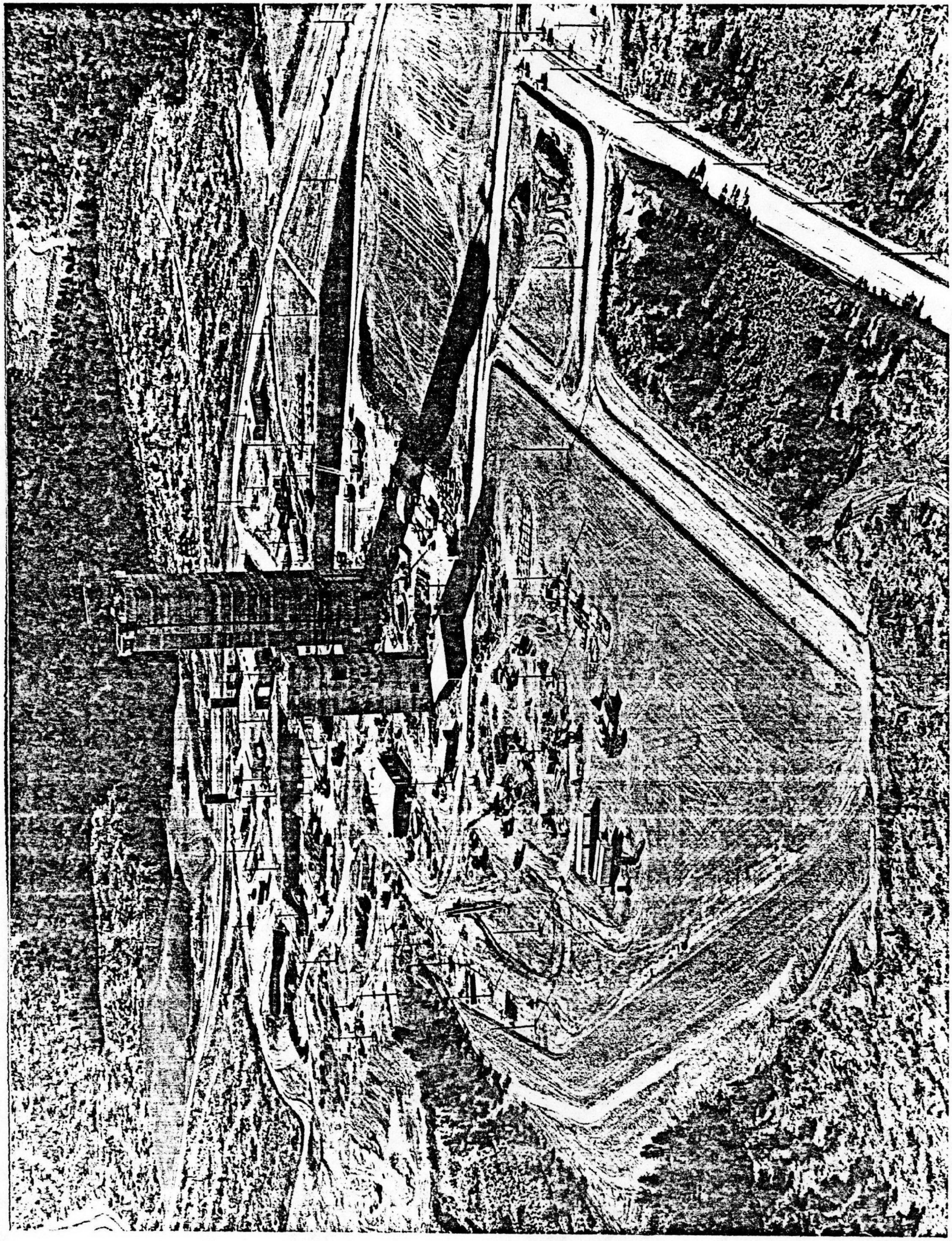


Figure 1. Locations of Potential Oil Shale Developments - Piceance Basin, Colorado

TRACT C-6



** FACT SHEET **

C-B History and Today's Project

- April 1, 1974 Colorado B Tract (C-b) was leased for $117,778,000.36
- original participating companies were Atlantic Richfield, Ashland Oil, Shell Oil and The Oil Shale Corporation
- November 2, 1976 Shell Oil Company, following Atlantic Richfield and the Oil Shale Corporation, withdrew from the C-b lease, ARCO and TOSCO having withdrawn in 1975
- November 3, 1976 Ashland Colorado, Inc., lessee, and Occidental Oil Shale, Inc., operator, entered into an agreement using Oxy's Modified In Situ process
- Occidental acquired a 100% interest when Ashland withdrew effective February 14, 1979
- the Green River formation of Northern Colorado, Northwestern Utah and Southwest Wyoming are estimated to contain close to 2 trillion barrels of oil
- the C-b Tract contains approximately 5,100 acres
- an estimated 3.7 billion barrels of oil are contained in this Tract
- Occidental Oil Shale, Inc. plans a recovery of about 1.2 billion barrels of oil from the shale to be initially mined
- over 50 years production life expected
- current C-b project schedule is estimated to be:

  Sept. 1977 - mobilization and start of site preparation

  Jan. 1979 - began shaft sinking

  Mar. 1983 - began construction of initial retorts

  May 1984 - ignition of initial retorts

** FACT SHEET **

Description of Modified In Situ (In Place) Retorting

- modified in situ method of retorting is completely underground
- retorts are created by initially mining out enough shale to provide a suitable void into which the remaining rock is blasted
- remaining shale is rubblized by blasting
- provides permeability for gas flow during operation
- in situ retorts consist of groups or "clusters"
- eight 155' x 310' x 390' retorts make one cluster (subject to design change)
- processing of a cluster of retorts consists of several steps
    - a retort within a cluster is ignited from the top by externally fueled burners
    - when the temperature at the top of the retort is sufficient to sustain combustion, burners are shut off
    - a regulated mixture of air and steam is drawn into the top and then down through the retort
    - hot combustion gases flow down through the retort
    - these supply heat to the unretorted shale below
    - at 900^{o}F organic material or kerogen decomposes into oil vapor and gas
    - other gases are carried along with the combustion gases
    - steam in the air fed to the retort acts as a dilutant to the oxygen in the air to control the reaction temperature

Description of Modified In Situ (In Place) Retorting (cont)

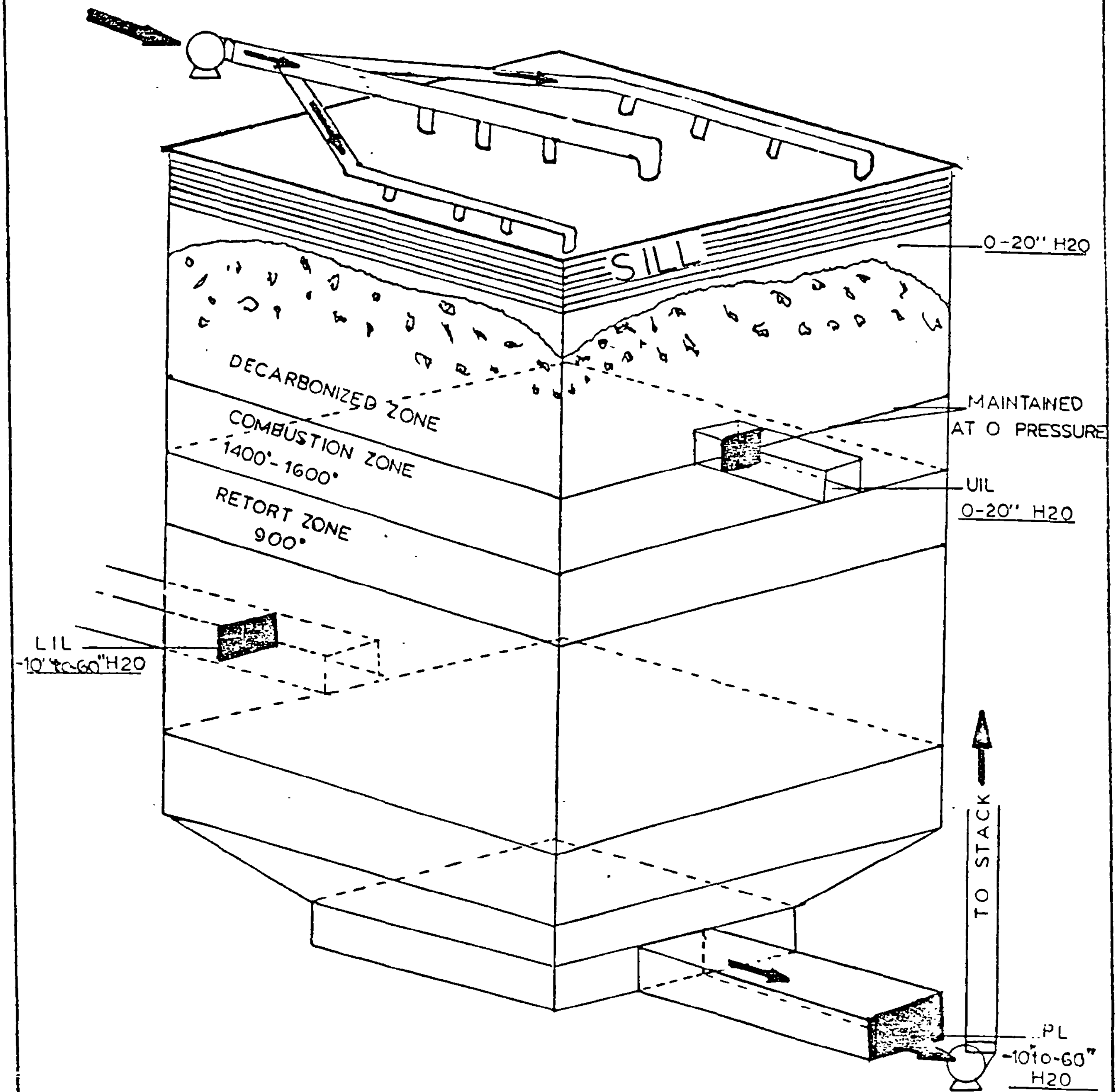
- in the combustion process, steam reacts to form carbon monoxide and hydrogen to improve the heating value of the product gas
- some mineral carbonates in the shale are also decomposed to carbon dioxide gas and mineral oxides
- the hot gas mixture flowing down through the retort preheats the raw shale
- at the same time, the oil and some of the water vapor are condensed
- product liquids and gases are collected in the bottom of the retort
- pumped to surface for separation and storage
- becoming product oil, produced fuel gas and water

Oxy's Modified In Situ experience began at the Logan Wash operation in 1972

- some 50,000 barrels of oil have been produced at Logan Wash
- private investment of 50 million dollars has been made in Logan Wash Operation

RETORT 6

SIMPLE RETORTING PRINCIPLES



RR-78

EPA R.VIII

ENVIRONMENTAL CONCERNS REGARDING OIL SHALE DEVELOPMENT

Mining and conversion of oil shale will degrade air quality, will consume precious water resources, may degrade surface and/or groundwater quality, will create solid and hazardous wastes to be disposed of properly, and will create significant population growth in a predominantly rural setting which translates into potential social and economic problems. That these things will occur is a given...the question is the magnitude and the significance of the occurrence. Key questions such as the following exist:

1. How much groundwater will be intercepted during mining?
2. What will the quality of potential discharges be?
3. Can groundwater quality be protected during and after in-situ retorting?
4. Can processed shale be disposed of properly without degrading ground or surface water quality?
5. Will revegetation of processed shale be successful over the long term?
6. What are the concentrations of various sulfur species in retort off gas streams?
7. What will be the air quality and visibility impacts on the Flat Tops Wilderness Area (nearest Class I area)?
8. What are the expected trace element concentrations in air, water, and solid waste residual streams?
9. Is conventional pollution control technology directly applicable to oil shale residuals? Is it as effective?
10. What is the expected population growth associated with the development of an oil shale industry?

Answers to the above questions (and perhaps other questions not yet posed) will in part determine the ability of individual plants and of an oil shale industry to be compatible with the desired environment for oil shale country.

Answers to some of the above questions may be partially answered by theoretical research work and limited-scope field investigations in the absence of <u>any</u> oil shale facilities. Answers to the remaining questions will necessarily be developed through rigorous testing programs and data analyses performed on facilities representative of commercial size.

Much has been said and written about the environmental advantages and disadvantages of in-situ development vs. surface retorting technology. Without hard data from operating facilities it is difficult to reach firm conclusions. However, surface retorting appears to have slightly greater air emissions and has more of a solid waste-processed shale disposal problem compared to in-situ. On the other hand in-situ development poses greater risks to groundwater movement and quality than does surface retorting. Firm data are desirable prior to the launching of a large industry.

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EPA Regulatory Actions Affecting Oil Shale

Environmental regulatory actions which we have taken include -

EIS Reviews

- Prototype Oil Shale Leasing Program (D and F)
- Colony (D and F)
- Superior (D)

PSD Permits Issued

o	C-a	1000 BPD	12-15-77
o	C-b	5000 BPD	12-15-77
o	Colony	50,000 BPD	7-11-78
o	Union	9000 BPD	7-31-79
o	Occidental	1000 BPD	11-1-79

NPDES Permits Issued

o	C-a	dewatering phase
o	C-b	dewatering phase
o	Occidental	experimental facility

Future regulatory involvement will include -

RCRA Permits

Final regulations scheduled for April 1980 may impose requirements applicable to processed shale.

UIC Permits

Reinjection of produced water will be subject to the requirements as a Class III well. Final regulations are scheduled for April 1980.

In the absence of air NSPS, water effluent guidelines, and solid waste disposal performance standards the Region has been using test engineering judgment. The Agency through the lead of ORD is preparing a series of oil shale documents which will provide "early guidance" on control technology expectations, monitoring methodologies, and impact assessment. The EMB Task Force - Alternative Fuels Group is responsible for the development and implementation of a regulatory and research strategy.

HIGHLIGHTS OF THE REGION VIII ENERGY POLICY

STATEMENT AFFECTING OIL SHALE DEVELOPMENT

The Region VIII Draft Energy Policy Statement was developed in response to the President's Energy Message. The statement conveys the Region's intent to practice responsive government by providing priority expedited reviews of energy facilities. The statement also reiterates the region's commitment to the protection of its exceeding high quality environment. We believe that energy resource development and environmental protection can be compatible in most situations.

The Energy Policy Statement affects the development of oil shale in the following ways . . .

1. Expedited permit processing

   The Region has committed to the processing of oil shale permit applications within six months of receipt of a completed application.

2. Grandfathering

   The Region hopes that it will not be necessary to grandfather oil shale facilities from future substantive requirements. However, it is recognized that the EMB will probably have authority on a case-by-case basis to waive future requirements for existing facilities. EPA is pledging its full support to work with EMB on these case-by-base determinations.

3. Role of Development

   The Region favors "orderly phased development" rather than "crash commercialization of an industry". Some technologies may be in a position to be scaled to commercial size; others must be further developed at the modular scale. Minimization of technological failures, economic white elephants, environmental disastors, and socio-economic disruptions are benefits of this approach. Most of the industry plan to proceed in this manner. RMOGA endorses this approach. The chances of meeting the President's shale oil production goal improve with this approach.

4. Better than BACT

   Since it appears that the PSD air quality increments may serve as the limiting constraint to the size of an oil shale industry, we encourage initial oil shale developers to go beyond BACT in their air pollution controls. It may be worth the incremental cost to individual developers for the nation to realize the maximum amount of oil production from the Piceance Basin given Class I and Class II increments.

5. Federal Government Coordination

EPA is pledged to work with DOE on oil shale research efforts and with DOI on future leasing needs. EPA also actively participates on the Oil Shale Environmental Advisory Panel.

6. Information/Communication

- Through the FRC, we are assisting potential oil shale "impact" communities with planning and financial (through sewage treatment plant funding) support.

- Through the Energy Office, we are routinely communicating and interpreting EPA policies, regulations and research results to the oil shale industry.

- The Region will conduct an Energy Industry Seminar to help explain EPA's permit policies, procedures and requirements.

Items 2, 3, and 4 have received considerable attention from the oil shale industry, Congressman Dingell and OMB via comments on the Energy Policy Statement. The proposed Dingell and Cutler responses are attached.

Barbara Blum

Press Conference

Anticipated Questions and Answers

1. What is EPA's viewpoint on oil shale development?

   We recognize that a tremendous energy resource potential exists in shale. The oil shale areas of Colorado, Utah, and Wyoming contain an estimated 700 billion barrels of oil - more than proven Middle East reserves. With the escalation world price of oil and the growing uncertainty of a reliable supply of oil it appears that oil shale companies are about ready to proceed with development. The President has established a production goal for shale oil of 400,000 BPD by 1990. EPA has fully supported the goals of the Federal Prototype Program. It now appears that development on private lands may occur in parallel with the Federal program. Our hope is that development will proceed at such a pace to allow knowledgeable decisions to be made regarding future leasing for "second generation" facilities.

2. Does EPA endorse additional Federal leasing?

   The Prototype Program administered by DOI envisioned fulfillment of the objectives of the Program prior to any additional leasing. There appears to be mounting pressure to deviate from that stance. We no not believe that additional leasing is required to meet the President's 400,000 BPD goal. Therefore, any additional leasing in the near future should be aimed toward specific mining or processing technology development which is not being developed privately, through DOE, or through DOI. Knowledgeable decisions on the "best" ways to maximize resource recovery and to minimize environmental degradation from future projects could then be made.

3. What are EPA's primary environmental concerns regarding oil shale development?

   o Surface retorting of oil shale produces vast amounts--up to 20 million tons per year for a 50,000 BPD facility--of processed shale. This material must be disposed of in a manner which will not allow migration of water through the pile, leaching various inorganics and organics, and subsequent entry into the ground water system. Processed shale must also be covered with soil like material and successfully revegetated in order to prevent surface runoff containing high concentrations of total dissolved solids.

   o In situ retorting poses some questions yet unanswered about the ability to prevent groundwater quality degradation.

3. (continued)

   - Air emissions from any oil shale facility will contribute toward consumption of the PSD increments. It appears that the Class I increments at Flat Tops Wilderness Area may prove to be the limiting constraint to the size of an oil shale industry. Class II increments will govern how closely facilities may be spaced but do not appear to be a constraint for any individual facility. EPA issued a PSD permit to Colony for its 50,000 BPD operation.

4. The oil shale industry is concerned with the accuracy of air quality models applied to the complex terrain of oil shale country. What is EPA doing to refine existing models?

   We recognize the need for an accurate regional complex terrain model which can assess the impacts of several oil shale facilities in combination with impacts from the associated population growth. EPA plans an initial modest field effort in 1980 and hopes to conduct an intensive effort in 1981. Data obtained from these efforts will serve to refine(if necessary) and validate models which can accurately assess impacts on Flat Tops Wilderness Area. This effort should be a joint effort among the industry, DOE, DOI, and the States of Colorado and Utah. Preliminary planning is underway. Additional funding will be necessary.

5. Is there enough water available for oil shale development?

   A recent intensive study performed by the Colorado Department of Natural Resources for the U.S. Water Resources Council concluded that there were sufficient surface water resources available to support the consumptive demands of a 1.3 million BPD oil shale industry and its associated growth. Several assumptions and conditions affect this conclusion. First. while water may be physically available, reservoirs and conveyance facilities would have to be built in order to provide year round needs. Second, instream needs for recreational and aquatic uses may be compromised. Additional study on this issue is necessary. Finally, additional consumption in the Upper Colorado Basin while legal will impact on downstream - Lower Basin - present users who may have very junior water rights.

6. What impact will the UIC program have on the development of in situ oil shale projects?

   In situ oil shale retorts are classified as special process wells (Class III). There is concern about the potential for movement of contaminants out of the burned retorts as mining is completed and water is allowed to return to the site. There is, also, concern about potential quality modifications in the aquifer outside of the mined area from reinjection of water removed from the mine area. The main thrust of the

6. (continued)

UIC permit program is for monitoring and reporting to insure that toxic materials do not migrate off site via the ground water.

The Agency feels that the UIC regulations will be flexible enough to allow development of in situ oil shale while providing adequate protection of the ground water.

7. What is the status of the proposed UIC regulations?

The Agency anticipates finalizing both the consolidated permit regulations (which contain UIC permit regulations) and the technical UIC program requirements (CFR 146) this coming spring.

8. Will EPA be issuing UIC permits for in situ oil shale projects in Colorado?

The UIC program is intended to be a State run program. The State must establish a program for control of all underground injection activities which meet the minimum requirements established by the UIC regulations. The States of Colorado and Utah have already indicated their intention to assume primacy for the UIC program and have accepted EPA grants to enable them to develop their programs. It is anticipated that both states will be in a position to achieve primacy within the required time frame. EPA will only be involved in an oversight and assistance role. A point of fact is that the State of Colorado Health Department Water Quality Control Commission is presently issuing permits for in situ oil shale projects under their existing Subsurface Disposal Regulations.

9. What is the potential impact of the proposed UIC regulations on the existing production of oil and gas in this area?

There may be limited impact depending on the age of existing fields and the extent of the state regulations at the time many of the wells were drilled. Reworking of some wells may be required before they could be repermitted.

10. Will the UIC program slow down development of new oil and gas fields?

It is not anticipated that new oil and gas field development will be slowed by the need for a permit to inject produced water. The necessary information and resulting permits could be developed concurrent with development of the fields. In addition, the existing drilling and completion technology are such that the permitting agency will not have to require additional data collection.

11. Will EPA's sole source aquifer program impact the program for syn fuel development?

There is a potential for impact on the syn fuel program if there is federal financial assistance to a particular project. At this time there have been no designations of sole source aquifers in Region VIII. The Region does designate such aquifers. A memorandum of understanding would be developed with DOE outlining the procedure for review of assisted energy projects. If a project was reviewed and was found to pose a threat, mitigation measures would be required before federal assistance would be approved.

12. What is EPA's view of the adequacy of the Prototype Program?

The Program has established a sound mechanism which may provide answers to (1) the technological and economic feasibility of extraction and conversion of the oil shale resource, and (2) the environmental impacts from a commercial operation. The program needs to be carried out as outlined in the EIS and as further described in the DDPs.

13. Are local communities ready for oil shale development?

The potentially impacted communities have voiced support of the C-a and C-b development at the public hearingg held in Rangely and Meeker. The feeling is that the companies have worked closely with town and county officials to insure that adequate schools, medical facilities, recreational facilities, etc., are provided in a timely fashion.

14. What are the EPA responsibilities in water?, in air? , and other?

Water: EPA administers the NPDES program. Colorado issues permits; EPA issues permits in Utah. EPA also issues effluent guidelines and NSPS for effluents from processing and mining activities.

Air: EPA grants permits to construct and operate under the prevention of significant deterioration regulations. EPA promulgates NSPS and NESHAPS.

15. What ancillary facilities are required for oil shale development?

Power Plants: Power generating capacity is needed for the TOSCO type plants. 150 to 200 MW are needed for 50,000 BPD.
Water: If ground water is not used, a dam and reservoir may be the source for storage water.
Loading: By-products distribution via rail or pipeline will require terminals. Products pipelines will be necessary.
Other Off-site: Transmission lines and roads.
Communities: Services for an expanded community must be provided.

16. Is technology adequate to develop the oil shale resource?

This is what the Prototype Program is all about. Only pilot scale operations have been conducted in the U.S. Larger applications are existent in other countries but different shales exist.

17. Is reclamation of spent shale possible?

Again, the Prototype Program is designed to provide the answers. However, even with that Program the success of processed shale revegetation will not be proven for many years. Key concerns are amount of soil cover, species variety, and prevention of upward salt migration.

18. What impact will regulations under RCRA have on the oil shale industry especially regarding the disposal of processed shale?

Final regulations will be out this Spring. EPA has not yet made a final determination on how to categorize processed shale. It may be similar to some other high volume special wastes. Data on representative processed shale for all processes are necessary to determine the "degree of hazard" of the waste.

19. What is the total cost of environmental controls as applied to an oil shale facility?

Since there is limited environmental data available upon which to prescribe applicable control technology standards this cost estimate is difficult to make. This is one of the objectives of EPA in our Oil Shale Guidance Document to be released in 1981. An estimate of environmental control costs made by Denver Research Institute for DOE concluded that capital costs for control equipment sould be 5 to 10 percent of the total plant cost. Annualized per barrel costs would range from 1 to 2 dollars per barrel depending upon the process. At a $30 per barrel world market price the environmental control cost appears to be minimal.