construction and operation. Table 3-19 shows the major environmental scaling factors for plant operation.

Refinery emissions are the major source of air pollution for the reference case, even when the average emission rates for the well-controlled, relatively low emission refineries of Los Angeles are used in the calculations. Thus, the scaling factors in Table 3-19 reflect well-controlled sources.

Refineries demand more water than any other element in the reference case system.

Refineries also account for about one-third of the necessary employment for the reference case, with crude oil production requiring most of the remaining two-thirds of the employment. Many of the offsite or indirect impacts from population in the reference case result from refinery employment.

2. Environmental Impacts

a. Onshore Production

The environmental impacts from tertiary recovery which will be the major source of new impacts onshore are shown in Table 3-20. These impacts will be the drilling activity necessary to begin tertiary recovery,* the growth of a chemical industry to produce the necessary chemicals for micellar flooding, and the air pollutant emissions from oil combustion to produce steam for injection.

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*We have assumed a relative recovery rate for tertiary recovery by various methods of:[40] Thermal: 29%, Micellar: 58%, CO_2: 8%, Hydrocarbon miscible: 5%

Table 3-19

IMPACT SCALING FACTORS FOR 10^6-B/D REFINERY CAPACITY

Impact	Scaling Factor: Quantity	Scaling Factor: Units*
Disturbed land or land removed from alternative uses	4400	Acres[10]
Solid waste production (sludge)	80	Cubic yards per day[20]
Wastewater production	420	10^6 gallons per day[20]
Water pollution[10]		
BOD	15	Tons/day
COD	55	Tons/day
Oil	4.0	Tons/day
Phenols	1.0	Tons/day
Suspended solids	10	Tons/day
Dissolved solids	250	Tons/day
Sulfides	1.5	Tons/day
Phosphorus	0.5	Tons/day
Nitrogen	2.0	Tons/day
Air pollution[10]		
Particulates	5.5	Tons/day
SO_2	76	Tons/day
Hydrocarbons	69	Tons/day
NO_x	34	Tons/day
CO	41	Tons/day
Offsite impacts induced by employment, urbanization, and recreation demands		
Permanent employees[39]	9500	People
Total population	32,500	Population multiplier (6.5) times the number of people†

*Approximate conversion factors: 1 acre = 4000 m^2, 1 ton = 907 kg, 1 cubic yd = 0.76 m^3.

†Population multipliers are discussed in Chapter 23.

Table 3-20

ENVIRONMENTAL IMPACTS FROM ONSHORE OIL PRODUCTION UNDER THE REFERENCE CASE

Activity	Impact	Impact Scaling Factor: Quantity	Impact Scaling Factor: Units*	Scenario Quantity which Determines Impacts: 1975	1985	2000	Units*	Quantitative Indicator of Environmental Impact: 1975	1985	2000	Units*
Exploration	Urbanization and induced population										
	Employees	24	People/rig	1,100‡	1,250	1,250	Rigs	25‡	29	29	10^3 people
	Total population	6.5	People/employee	25‡	29	29	10^3 employees	160†	190	190	10^3 people
	Solid waste produced by drilling	63	Tons/10^3 ft	1975 - 2000: 9.5			10^8 ft of exploratory well†	1975 - 2000: 60			10^6 tons†
	Land area disruption by drilling	1	Acre/exploratory well	1975 - 2000: 190			10^3 wells†	1975 - 2000: 190			10^3 acres†
Production	Urbanization and induced population										
	Employees	13,000	People/employee	8.9	6.2	5.0	10^6 B/D	116	81	65	10^3 employees
	Total population	6.5		116	81	65	10^3 employees	750	520	420	10^3 people
	Wastewater production	210	g/water/B oil	9.9	6.2	5.0	10^6 B/D oil	1.9	1.6	1.1	10^6 g/D
Tertiary recovery by all methods								0	3.5	4.0	10^6 B/D
Tertiary recovery by chemical methods40		0.58	Total tertiary recovery	0	3.5	4.0	10^6 B/D Tertiary recovery	0	2.0	2.3	10^6 B/D
Chemical requirements	Chemical production										
	Biopolymer and Polyacrylamide	1-8	Lbs/B oil	0	2.0	2.3	10^6 B/D	0	0.7 - 5.8	0.8 - 6.7	10^9 lbs/yr
	Surfactants (Hydrocarbon Sulfonates)	7-15	Lbs/B oil	0	2.0	2.3	10^6 B/D	0	5.1 - 11	5.9 - 13	10^9 lbs/yr
	Co-surfactants (Isopropanol)	4-10	Lbs/B oil	0	2.0	2.3	10^5 B/D	0	2.9 - 7.3	3.4 - 8.4	10^9 lbs/yr

Page 1 of Table 3-20

Table 3-20

ENVIRONMENTAL IMPACTS FROM ONSHORE OIL PRODUCTION UNDER THE REFERENCE CASE

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor: Quantity	Impact Scaling Factor: Units*	Scenario Quantity which Determines Impacts: 1975	1985	2000	Units*	Quantitative Indicator of Environmental Impact: 1975	1985	2000	Units*
Tertiary recovery by thermal methods[40]		0.20	Total Tertiary recovery	0	3.5	4.0	10^6 B/D	0	1.0	1.2	10^6 B/D
	Air pollution										
	Particulates	0.12	10^3 tons/10^6 B oil recovered	0	1.0	1.2	10^6 B/D	0	0.12	0.14	10^3 tons/D
	SO_2	1	"					0	1	1.2	"
	NO_x	0.2 - 0.4	"					0	0.2 - 0.4	0.24 - 0.48	"
	CO	0.02	"					0	0.02	0.02	"
	Hydrocarbons	0.02	"					0	0.02	0.02	"
Production	Land disruption	1	Acres/development well		1975 - 2000: 570		10^3 development well‡		1975 - 2000: 570		10^3 acres†
	Solid waste production	3	Times the amount of waste produced by exploration		1975 - 2000: 70		10^6 tons†		1975 - 2000: 210		10^6 tons†

*Approximate conversion factors: 1 gal = $3.79 \times 10^{-3} m^3$, 1 ton = 907 kg, 1 acre = $4.05 \times 10^3 m^2$, 1 ft = 0.305 m, 10^6 B = 160,000 m^3, 1 pound = 0.454 kg, 1 mile = 1.61 km

†Accumulative for period indicated.

‡Applies to 1980 only, not 1975.

Tertiary recovery, which requires many new wells in fields already producing under primary and secondary recovery, will bring an influx of drill rigs and well development personnel. This influx of personnel and their families can be expected to produce boom-town conditions in small communities that border large oil fields. For example, West Texas and Rock Springs, Wyoming, currently experience considerable oil-related activity as a result of recent crude oil price increases.

The most significant potential for adverse environmental effect will result from the production and use of large quantities of chemicals necessary for tertiary recovery (up to 10 billion lbs/yr [4.5×10^9 kg/yr] of some of the chemicals). Many of these chemicals are hazardous; polyacrylamide, for example, is carcinogenic. The isopropanol production shown in Table 21 for example, will, in the year 2000, be at about the level of today's methanol production. At present, no large-scale commercial production capacity exists for manufacturing these chemicals.

With onshore production likely to begin a long-term decline sometime in the next few decades,[3,6,41] and with production unlikely to increase significantly up to the onset of long-term decline, little onshore construction directly related to production can be expected. For example, pipeline construction will be confined mainly to that necessary for the transport of oil from tanker ports and from new offshore and Alaskan oil fields.

Total oil industry employment directly related to onshore production should also remain constant or decline with production through the end of the century.

b. Alaska Production

Under the reference case, Alaska undergoes the most substantial increase in oil production since the current production of about 200,000 B/D (32,000 m^3/D) is projected to grow to over 3,400,000 B/D (540,000 m^3/D) by the year 2000--far greater than any increase projected for other regions. The environmental impacts from this production increase are shown in Table 3-21.

The large projected rise in oil production employment in Alaska, from the current 3,000 to 57,000 by the year 2000, suggests that this state, with a current population of only about 350,000, will experience considerably more population related impacts than any other region under the reference case. This is particularly true if the 6.5 employment multiplier can be used to estimate the total increase in population of over 370,000 people. These impacts will be concentrated along the coastline of the Gulf of Alaska, along the North Slope, and in the Fairbanks region since it is the only large city close to the North Slope.

With the largest area of unspoiled wilderness in the nation and the second largest volume of crude oil reserves of all the states (Texas has more), Alaska will likely become a legal and institutional battleground for advocates of wilderness values and advocates of resource development. Opening the road to Prudhoe Bay to the public will allow more people access to northern Alaska than ever before, and perhaps will result in more environmental damage than the current TAPS construction project or the construction of a second pipeline as required in the reference case.

Alaskan offshore production can be expected to result in oil spills off the coast. Two very large oil spills (over 100,000 barrels

Table 3-21

ENVIRONMENTAL IMPACTS ON ALASKA UNDER THE REFERENCE CASE

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor: Quantity	Impact Scaling Factor: Units*	Scenario Quantity which Determines Impacts: 1975	1985	2000	Units*	Quantitative Indicator of Environmental Impact: 1975	1985	2000	Units*
Exploration	Urbanization and induced population										
	Employment										
	Onshore	12	People/rig	125‡	150	150	Rigs	1,500‡	1,800	1,800	Employees
	Offshore	60	People/rig	52‡	110	110	Rigs	3,100‡	6,500	6,500	Employees
	Total population§	6.5	People/employee	5,000‡	8,000	8,000	Employees	33‡	52	52	10^3 people
	Solid waste production				1975 - 2000				1975 - 2000		
	Onshore	63	Tons/10^3 ft of well		6600		10^3 ft of well†		0.42		10^6 tons†
	Offshore	63	Tons/10^3 ft of well		3800		10^3 ft of well†		0.24		10^6 tons†
					1975 - 2000				1975 - 2000		
	Onshore land area disruption	5	Acres/well		660		Number of exploratory wells†		3300		Acres†
					1975 - 2000				1975 - 2000		
	Offshore	3,000	Acres/well		380		Number of exploratory wells drilled†		1.1		10^6 acres†
Production (normal)	Urbanization and induced population										
	Employees	13,000	Employees per 10^6 B/D	0.2	3.6	4.4	10^6 B/D production	2.6	47	57	10^3 employees
	Total population	6.5	People	2.6	47	57	10^3 employees	17	300	370	10^3 people
	Low-level oil releases to the offshore marine environment	9	B per 10^6 B/D production	0.2	0.5	0.96	10^6 B/D	1.8	4.5	8.6	B/D oil
	Wastewater production from onshore production	210	gal/B oil	0	3.1	3.4	10^6 B/D	0	0.65	0.71	10^9 gal/D
	Onshore land area disruption	65	10^3 acres per 10^6 B/D oil production	0	3.1	3.4	10^6 B/D oil	0	200	220	10^3 acres
	Offshore land area disruption	3	10^3 acres per production platform	12‡	25	25	Production platform	39‡	75	75	10^3 acres

Page 1 of Table 3-21

Table 3-21

ENVIRONMENTAL IMPACTS IN ALASKA UNDER THE REFERENCE CASE

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor: Quantity	Impact Scaling Factor: Units*	Scenario Quantity which Determines Impacts: 1975	1985	2000	Units*	Quantitative Indicator of Environmental Impact: 1975	1985	2000	Units*
					1975 - 2000				1975 - 2000		
Production (normal)	Solid waste production										
	Onshore	3	Times total solid waste from exploration		0.42		10^6 tons†		1.3		10^6 tons†
	Offshore	3	"		0.24		10^6 tons†		0.72		10^6 tons†
Exploration (abnormal operations)	Blowouts and accidental release of oil into the environment. Bird losses, oiled beaches, fire, loss of life.				1975 - 2000				1975 - 2000		
	Onshore	0.4	per 10^3 wells drilled		660		Number of wells drilled†		0.3		Mean number of blowouts†
	Offshore	0.3	per 10^3 wells drilled		280		Number of wells drilled†		0.1		"
Production (abnormal operations)	Size of accidental oil spills from offshore operations				1975 - 2000				1975 - 2000		
	Greater than 100,000 B	4.3	Mean number of spills per 10^6-B/D production over 25 years		0.5		(Average production) 10^6 B/D†		2.2		Mean number of very large oil spills†
	Between 10,000 B and 100,000 B	13	Mean number of spills per 10^6-B/D production over 25 years		0.5		(Average production) 10^6 B/D†		6.5		Mean number of large spills†
	Size of oil spills Between 2,000 B and 10,000 B	39	Mean number of spills per 10^6-B/D production over 25 years		0.5		(Average production) 10^6 B/D†		19		Mean number of moderately large spills over 25 years†

Page 2 of Table 3-21

Table 3-21

ENVIRONMENTAL IMPACTS IN ALASKA UNDER THE REFERENCE CASE

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor Quantity	Impact Scaling Factor Units*	Scenario Quantity which Determines Impacts 1975	1985	2000	Units*	Quantative Indicator of Environmental Impact 1975	1985	2000	Units*
Pipeline construction over 1000 miles of terrain from Naval Petroleum Reserve Number 4 to Valdez.	Air pollution from second TAPS	1000	Miles/TAPS	0	3.1	3.4	10^6 B/D production	0	1,000	1,000	
	Particulates	2	Tons/day	0	1	1	Number of additional TAPS	0	2	2	Tons/day
	SO_2	26	Tons/day	"	"	"		0	25	25	Tons/day
	Hydrocarbons	2	Tons/day	"	"	"		0	2	2	Tons/day
	NO_x	36	Tons/day	"	"	"		0	36	35	Tons/day
	CO	11	Tons/day	"	"	"		0	11	11	Tons/day
	Induced urbanization population and employment										
	Employees	300	People/TAPS	0	2	2	Number of TAPS	0	600	600	Employees
	Total population	6.5	People/employee	0	600	600	Employees	0	4,000	4,000	People
	Land disruption through construction of new oil storage facility for TAPS Number 2.	600	Acres	0	1	1	Number of new TAPS	0	800	800	Acres
									1980 – 2000		
Pipeline and distribution system (abnormal operations)	Potential oil spill from rupture of storage tanks at Valdez	510,000	B/tank	0	44	44	Number of tanks		20		Maximum potential oil spill-10^6 B
	Potential oil spill from rupture of TAPS	50,000	B/rupture						0.05		"
	Potential oil spill from tanker grounding	1.5×10^6B	B/tanker						1.5		"

*Approximate conversion factors: 1 gal = $3.79 \times 10^{-3}m^3$, 1 ton = 907 kg, 1 acre = 4.05×10^3 m^2, 1 ft = 0.305 m, 10^6B = 160,000 m^3, 1 pound = 0.454 kg, 1 mile = 1.61 km.

†Cumulative for period indicated.

‡Applies to 1980 only, not to 1975.

§Employees plus associated population.

of oil) can be expected as the mean number over the next 25 years. All Alaskan crude oil will probably be shipped to the West Coast states by tanker; which implies oil spills and sewage production that occur from tanker operations may impact the Pacific coastline from Alaska to California.[11]

Oil spill from earthquake damage to the Valdez storage facility, with its 20-million barrel capacity, is possible, particularly with the frequency and severity of tremors along the Gulf of Alaska* (Valdez was destroyed by the 1964 earthquake).

A second TAPS for transportation of oil from Naval Petroleum Reserve Number 4 (NPR4) to Valdez is required sometime in the 1980s. Considerable impact will be associated with its construction although additional road construction would be needed only across the North Slope tundra from the present pipeline corridor to NPR4.

Many of the impacts in Alaska, although quantitatively less than for onshore production (compare similar categories in Tables 3-20 and 3-21), will be severe in Alaska because relatively few areas will be impacted due to the geographic concentration of resources. Oil production from Alaska will increase many fold under the reference case and the impacts can be expected to rise proportionately.

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*Between 1899 and 1973, 13 earthquakes with magnitude over 7.0 on the Richter Scale have occurred.[11]

c. Offshore Production with Attendant Transport and Refining Operations

The impacts from refinery construction under HG3 are given for two cases: (1) in which all imported oil is unrefined, and (2) in which 50 percent of the imported oil is already refined. If all imported oil is in the form of refined products, then no new refinery capacity is required. Table 3-22 shows the environmental impacts from offshore production, Tables 3-23 and 3-24 show the requirements for additional refinery construction and operation, and Table 3-25 shows the environmental impacts from refinery operation.

The coastlines receive a large share of the environmental impacts under the reference case, not only because considerable crude oil production will take place offshore, but because the possibility of large-scale oil spills from production and tanker accidents adds ecological disaster potential without analogy in onshore oil production. New refinery capacity is likely to be built along the coastlines at locations at which the increase in crude oil production under HG3 will be delivered. Unless all imports are in the form of refined products, additions to refinery capacity will be required under HG3. Expansion of existing refineries (already concentrated on the coastal regions, particularly the Gulf coast) will cover much of the projected needs.

The mean number of large oil spills (over 100,000 barrels) under HG3 is projected to be 13 over the next 25 years.

Employment-related impacts from offshore oil production will triple under HG3. Offshore-production-related employment will grow from 18,000 to 52,000. Of course, the impacts related to this employment will be dispersed over the Atlantic, Gulf, and Pacific coasts.

The coastal regions experience the most pipeline construction under the reference case. Offshore solid waste from well drilling will

Table 3-22

ENVIRONMENTAL IMPACTS FROM OFFSHORE DEVELOPMENT AND TANKER OPERATIONS UNDER THE REFERENCE CASE.

Impact Scaling Factors and Scenario Quantities

Activity*	Impact	Impact Scaling Factor: Quantity	Impact Scaling Factor: Units*	Scenario Quantity which Determines Impacts: 1975	1985	2000	Units*	Quantative Indicator of Environmental Impact: 1975	1985	2000	Units*
Exploration	Urbanization and induced population along coastlines										
	Employees	100	Employees/rig	370†	500	500	Rigs	37†	52	52	10^3 employees
	Total population	6.5	People per employee	37†	52	52	10^3 employees	240†	340	340	10^3 people
	Tons of drill cuttings	63	Tons/10^3 ft of exploratory well		1975 – 2000: 11		10^7 ft of well†		1975 – 2000: 6.9		10^6 tons†
	Offshore land disruption	3,000	Acres per exploratory well		11		10^3 wells†		11		10^6 acres†
Production	Induced urbanization and employment										
	Employees	13,000	Employees per 10^6 B/D	1.4	3.0	4.0	10^6 B/D	18	39	52	10^3 employees
	Total population	6.5	People per employee	18	39	52	10^3 employees	117	254	338	10^3 people
	Tons of drill cuttings	3	Times that produced by exploration		1975 – 2000: 6.9		10^6 tons†		1975 – 2000: 21		10^6 tons†
	Offshore land disruption	3,000	Acres/production platform	150†	200	200	Production platforms	0.5	0.6	0.6	10^6 offshore acres
	Low concentration oil releases to the marine environment										
	Atlantic OCS	9	B/10^6 B oil produced	0	0.04	0.6	10^6 B/D oil production	0	0.36	0.54	B oil per day
	Gulf OCS	9	B/10^6 B oil produced	1.3	2.3	2.0	10^6 B/D oil production	12	21	18	B oil per day
	Pacific OCS	9	B/10^6 B oil produced	0.058	0.6	1.2	10^6 B/D oil production	0.5	5.4	11	B oil per day

Page 1 of Table 3-22

Table 3-22

ENVIRONMENTAL IMPACTS FROM OFFSHORE DEVELOPMENT AND TANKER OPERATIONS UNDER THE REFERENCE CASE.

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor		Scenario Quantity which Determines Impacts				Quantative Indicator of Environmental Impact			
		Quantity	Units†	1975	1985	2000	Units*	1975	1985	2000	Units*
Exploration (Abnormal activities)	Blowouts and accidental oil releases to the marine environment: bird deaths, spoiled beaches, damage to fisheries, cleanup costs, fire and equipment damage	0.3	per 1000 exploratory wells drilled		1975 - 2000 11,000		Exploratory wells†		1975 - 2000 3		Mean number of blowouts expected†
Production (Abnormal activities)	Sizes and frequency of probable number of oil spills:										
	Greater than 100,000 B	4.3	Mean number of spills per 10^6 B of production per 25 years		3.0		Average over 25 years 10^6-B/D oil production		13		Mean number of very large spills over 25 years
	Between 10,000 B and 100,000 B	13	Mean number of spills per 10^6-B/D production over 25 years		3.0		"		39		Mean number of large spills over 25 years
	Between 2,000 B and 10,000 B	39	Mean number of spills per 10^6-B/D production		3.0		"		120		Mean number of moderately large spills over 25 years
Crude Oil Pipeline System	Offshore pipeline construction - seabed disturbance and potential navigational hazard	8,000	Miles of pipeline per 10^6 B/D increase in crude oil supply	0	1.7	2.7	10^6 B/D increase over 1974 production	0	14	22	10^3 miles of offshore pipeline

Page 2 of Table 3-22

Table 3-22

ENVIRONMENTAL IMPACTS FROM OFFSHORE DEVELOPMENT
AND TANKER OPERATIONS UNDER THE REFERENCE CASE.

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor: Quantity	Impact Scaling Factor: Units*	Scenario Quantity which Determines Impacts: 1975	1985	2000	Units*	Quantitative Indicator of Environmental Impact: 1975	1985	2000	Units*
Crude Oil Pipeline System	Air pollutant emissions increase from new offshore crude oil pipelines:										
	Particulates	1.25	Tons per 10^3 miles of pipeline	0	14	22	10^3 miles of pipeline	0	18	28	Tons/day
	SO_2	16					"	0	220	350	"
	Hydrocarbons	0.38					"	0	5.3	8.4	"
	NO_x	5-8.8					"		70-120	110-190	"
	CO	0.50					"		7	11	"
	Urbanization and associated population; recreation demands										
	Employees	70	Employees per 1000 miles of new pipeline	0	14	22	1000 miles new pipeline	0	0.9	1.5	10^3 employees
	Total population	6.5	People/employee	0	0.9	1.5	10^3 employees	0	5.8	10	10^3 people
Tanker Operations	Oil release to the marine environment from ballast cleaning operations										
	Alaskan Pacific Coast oil shipped to west coast ports	13-270	B/10^6 B transported from Alaska	0.2	3.6	4.4	10^6 B/D oil from Alaska	2.6 to 54	47 to 970	57 to 1200	B/D
	Sewage produced in coastal waters by tankers:										
	By imports	1.5	10^3 gal/tanker	4	7.5	12	200,000 dwt tankers/day	6	11	18	10^3 gal/D
	By Alaskan oil tankers	1.0	10^3 gal/tanker - day	3	40	50	Tankers	3	40	50	10^3 gal/D
	Probable oil spills										
	Major										
	Imports	34	B/10^6 B transported	6.0	11.5	18.4	10^6 B/D oil transported	200	390	630	B/D oil
	Alaskan oil	34-180	B/10^6 B transported	0.2	3.6	4.4	10^6 B/D oil transported	6.8 to 36	120 to 650	150 to 790	B/D oil

Page 3 of Table 3-22

Table 3-22

ENVIRONMENTAL IMPACTS FROM OFFSHORE DEVELOPMENT
AND TANKER OPERATIONS UNDER THE REFERENCE CASE.

Impact Scaling Factors and Scenario Quantities

Activity	Impact	Impact Scaling Factor		Scenario Quantity which Determines Impacts				Quantative Indicator of Environmental Impact			
		Quantity	Units*	1975	1985	2000	Units*	1975	1985	2000	Units*
Tanker operations	Probable oil spills										
	Minor										
	Imports	1.5	$B/10^6$ B transported	6.0	11.5	18.4	10^6 B/D oil transported	9	17	23	B/D oil
	Alaskan oil	3	$B/10^6$ B transported	0.2	3.6	4.4	10^6 B/D oil transported	0.6	11	13	B/D oil

*Approximate conversion factors: 1 gal = 3.79×10^{-3} m^3
1 ton = 907 kg
1 acre = 4.05×10^3 m^2
1 ft = 0.305 m
10^6 B = 160,000 m^3
1 pound = 0.454 kg
1 mile = 1.61 km

†Cumulative for period indicated.

‡Applies to 1980 only, not to 1975.

Table 3-23

NEW REFINERY REQUIREMENTS FOR REFERENCE CASE OVER AND ABOVE 1975 REFINERY CAPACITY
IMPORTS ARE CRUDE OIL ONLY

Data and Assumptions			Impact for Year		
			1975	1985	2000
Production Schedule: Refinery Capacity increase over 1975 in 10^6 Barrels per Day			0	12.0	19.0
Inputs and Outputs		Scaling Factors per 10^6 B/D of new capacity (in units specified)			
Items	Units*				
Construction					
Capital	10^6 1973 $ (cumulative)	2,000	0	2.4×10^4	3.8×10^4
Labor	Man-years (cumulative)	38,000	0	4.5×10^5	7.1×10^5
Steel	10^3 tons (cumulative)	850	0	1.0×10^4	1.6×10^4
Land	10^3 acres	22	0	260	420
Operation					
Operating costs	10^6 1973 $/year	500	0	6×10^3	9.5×10^3
Labor force	Number of people	9,500	0	1.1×10^5	1.8×10^5
Water	10^3 acre-ft/year	60	0	720	1,100
Electric power	MW	250	0	3,000	4,800

*Approximate conversion factors: 1 gal = $3.79 \times 10^{-3} m^3$, 1 ton = 907 kg, 1 acre = $4.05 \times 10^3 m^2$, 1 ft = 0.305 m, 10^6B = 160,000 m^3, 1 pound = 0.454 kg, 1 mile = 1.61 km

Table 3-24

NEW REFINERY REQUIREMENTS FOR REFERENCE CASE OVER AND ABOVE 1975 REFINERY CAPACITY
(50 PERCENT OF IMPORTS ARE REFINED PRODUCTS)

Data and Assumptions			Impact for Year		
			1975	1985	2000
Production Schedule: Additional Capacity in Units of 10^6 B/D			0	5.9	9.3
Inputs and Outputs		Scaling Factors for a 10^6 B/D Plant (in units specified)			
Items	Units*				
Construction					
Capital	10^6 1973 $ (cumulative)	2,000	0	1.2×10^4	1.9×10^4
Labor	Man-years (cumulative)	38,000	0	2.2×10^5	3.5×10^5
Steel	10^3 tons (cumulative)	850	0	5.0×10^3	7.9×10^3
Land	10^3 acres	22	0	130	200
Operation					
Operating costs	10^6 1973 $/year	500	0	3×10^3	4.7×10^3
Labor force	Number of people	9,500	0	5.6×10^4	8.8×10^4
Water	10^3 acre-ft/year	60	0	350	560
Electric power	MW	250	0	1,500	2,300

*Approximate conversion factors: 1 gal = $3.79 \times 10^{-3} m^3$, 1 ton = 907 kg, 1 acre = $4.05 \times 10^3 m^2$,
1 ft = 0.305 m, 10^6B = 160,000 m^3, 1 pound = 0.454 kg, 1 mile = 1.61 km

Table 3-25

ENVIRONMENTAL IMPACTS FROM THE OPERATION OF NEW REFINERIES UNDER THE REFERENCE CASE.

		Impact Scaling Factors and Scenario Quantities							Quantative Indicator of Environmental Impact				
Activity	Impact	Impact Scaling Factor		Scenario Quantity which Determines Impacts				Imports refined				
		Quantity	Units*	1975	1986	2000	Units*	in U.S.	1975	1985	2000	Units*
Refineries	Wastewater production											
	Coastal regions	420	10^6 gal/D per 10^6B/D refined	0	5.9	9.3	10^6 B/D	50%	0	2.5	3.9	10^9 gal/D
				0	12	19		0%	0	5.0	8.0	
	Water pollution											
	BOD	15	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	89	140	Tons/D
				0	12	19		0%	0	180	290	
	COD	55	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	320	510	Tons/D
				0	12	19		0%	0	660	1,000	
	Oil	4	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	24	37	Tons/D
				0	12	19		0%	0	48	76	
	Phenols	1	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	5.9	9.3	Tons/D
				0	12	19		0%	0	12	19	
	Suspended solids	10	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	59	93	Tons/D
				0	12	19		0%	0	120	190	
	Dissolved solids	250	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	1,500	2,300	Tons/D
				0	12	19		0%	0	3,000	4,800	
	Sulfides	1.5	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	8.9	14	Tons/D
				0	12	19		0%	0	18	29	
	Phosphorus	0.5	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	3.0	4.7	Tons/D
				0	12	19		0%	0	6.0	9.5	
	Nitrogen	2.0	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	12	19	Tons/D
				0	12	19		0%	0	24	38	
	Air pollution											
	Particulates	5.5	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	32	51	Tons/D
				0	12	19		0%	0	66	100	
	SO_2	76	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	450	710	Tons/D
				0	12	19		0%	0	910	1,400	
	Hydrocarbons	69	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	410	640	Tons/D
				0	12	19		0%	0	830	1,300	
	NO_x	34	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	200	320	Tons/D
				0	12	19		0%	0	410	650	
	CO	41	Tons/D per 10^6 B/D	0	5.9	9.3	10^6 B/D	50%	0	240	380	Tons/D
				0	12	19		0%	0	490	780	

Page 1 of Table 3-25

Table 3-25

ENVIRONMENTAL IMPACTS FROM THE OPERATION OF NEW REFINERIES UNDER THE REFERENCE CASE.

		Impact Scaling Factors and Scenario Quantities							Quantative Indicator of Environmental Impact				
		Impact Scaling Factor		Scenario Quantity which Determines Impacts									
Activity	Impact	Quantity	Units*	1975	1985	2000	Units*	Imports refined in U.S.	1975	1985	2000	Units*
Refineries	Employment, urbanization, and recreation											
	Employment	9,500	Employees per 10^6 B/D capacity	0	5.9	9.3	10^6 B/D	50%	0	56	88	10^3 employees
				0	12	19		0%	0	114	180	
	Total population	6.5	People per employee	0	56	88	Employees	50%	0	360	570	10^3 people
				0	114	180		0%	0	740	1,200	

*Approximate conversion factors: 1 gal = 3.79×10^{-3} m^3
1 ton = 907 kg
1 acre = 4.05×10^3 m^2
1 ft = 0.305 m
10^6 B = 160,000 m^3
1 pound = 0.454 kg
1 mile = 1.61 km

Page 2 of Table 3-25

create unconsolidated sediment and poor habitat around the sites of offshore drilling; the volume will be about 200 ft by 200 ft and 1 ft thick around the base of each drill site. However, this amount of solid waste is dwarfed by the amount of sludge produced by coastal cities (e.g., New York).

Employment-related impacts from refinery construction and operation could be more substantial than for crude oil production. Refinery employment under HG3 could double from 150,000 in 1975 to over 300,000 in 2000 if all imports are in the form of crude oil.

The coastal regions will experience impacts that are quantitatively similar to the impacts from onshore production (compare similar categories in Tables 3-21 and 3-22); however, the impacts will be concentrated in a smaller region. In addition, pipeline construction, refinery construction and operation, and increased tanker activity will bring impacts to the coastal regions unlike those in onshore production. Tables 3-22 and 3-25 support the conclusion that under the reference case the coastal regions will experience the most significant air pollution increases of the three reference case regions and the greatest potential for large oil spills, in addition to major employment-related impacts.

APPENDIX A

QUANTITIES OF OIL RESOURCES AND RESERVES

The distinction between resources and reserves is often misunderstood. In general, resources refer to physical quantities, while reserves implies recoverability of a fraction of the resource as determined by prevailing economics and technology. Figure A-1 illustrates the relationship of the various classes of oil resources and reserves. The quantities of the important classes of resources and reserves are:[2]

- 440×10^9 barrels of crude oil resources identified in the United States as of January 1975.
- 106×10^9 barrels of crude oil resources produced as of January 1975.
- 40×10^9 barrels of discovered crude oil resources classified as economically producible (demonstrated reserves) as of January 1975.
- 82×10^9 barrels of undiscovered oil resources estimated by the USGS as producible with 50 percent certainty at 1973 crude oil prices (assumes 32 percent recovery of the undiscovered resources).
- Up to an additional 130×10^9 barrels of oil of the resources (discovered and undiscovered), which may be recoverable with advanced recovery techniques (up to 50 percent recovery of the original resources both discovered and undiscovered) at much higher crude oil prices.

Much of the oil resource cannot be recovered because of the difficulties of extracting oil from the porous oil-bearing rock strata, which can lie up to 20,000 ft (6000 m) underground. Estimates of the percentage of the resource eventually producible generally vary between 30 and 50 percent.[40] Primary recovery (producing oil from self-pressured fields

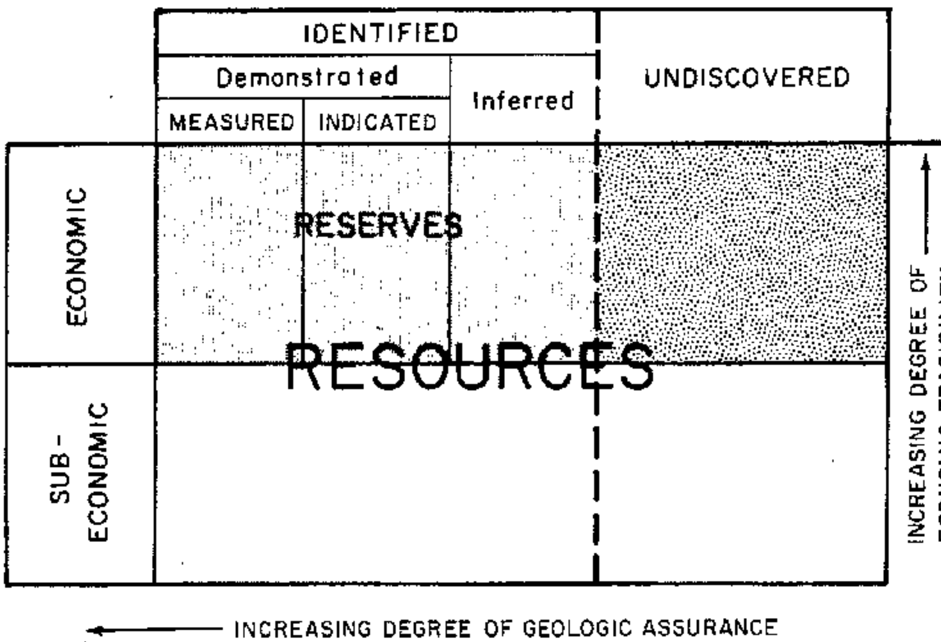
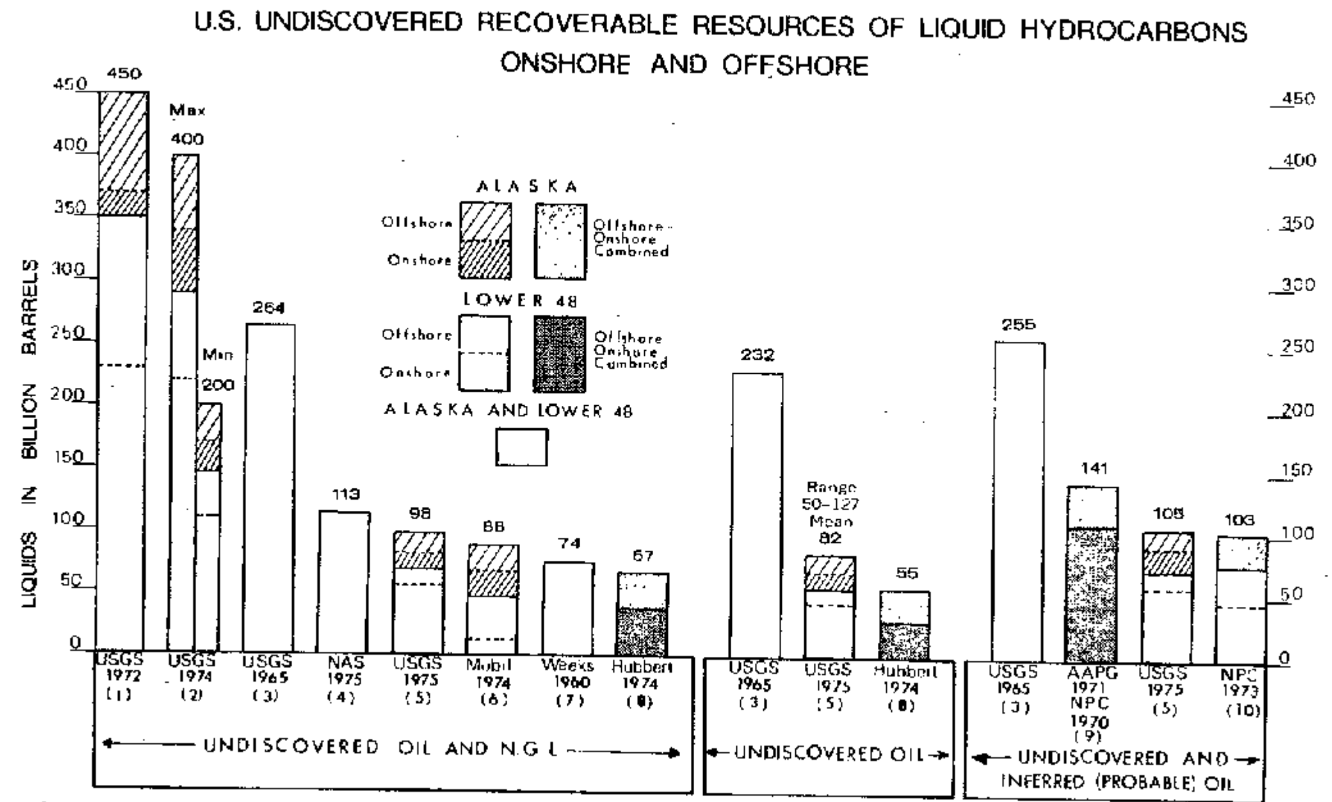


FIGURE A-1. DIAGRAMATIC REPRESENTATION OF PETROLEUM RESOURCE CLASSIFICATION BY THE U.S. GEOLOGICAL SURVEY AND THE U.S. BUREAU OF MINES or from artificially pumped fields) and secondary recovery (producing oil by pressurizing the field through water injection or through natural gas injection) together generally achieve about 30 percent recovery of the original resource. Advanced recovery or tertiary recovery (producing oil by injecting solvents, steam, CO_2, or other chemicals or producing oil by any technique not classed as primary or secondary recovery) may achieve an additional 20 percent recovery of the initial resource. This additional recovery percentage varies considerably among actual fields--in some cases 90 percent recovery can be achieved. Unfortunately, however, no general agreement exists over the percentage of the resource that can be recovered by advanced recovery techniques.[40]

Today's technology and economics make 70 percent of the resources either too expensive to produce or impossible to produce. For future oil production, increased oil prices can make some of the last 70 percent of the resources available. However, it takes considerable time to bring advanced recovery into widespread use and significant production by advanced recovery cannot begin for at least a decade.

Considerable controversy surrounds the quantity of undiscovered oil resources, although recent estimates agree remarkably.[2] Figure A-2 shows several of the important estimates. In mid-1975, USGS estimated that undiscovered ultimately recoverable oil resources (at 1973 crude oil prices) consist of between 50 and 127 billion barrels with the mean estimate of 82 billion barrels (assuming 32 percent recovery of the undiscovered resources). A recent study by the National Academy of Sciences reports that about 113 billion barrels remain to be found and produced.[42] These estimates implicitly assume recovery at 1973 prices.



Source: U.S. Geological Survey, Circular 725

(1) Theobald and others, USGS Circ. 650 (1972). Includes water depth to 2,500 m (8,200 ft).
(2) USGS News Release (March 26, 1974). Includes water depth to 200 m (660 ft).
(3) Hendricks, USGS Circ. 522 (1965). Adjusted through 1974. Includes water depth to 200 m (660 ft).
(4) National Academy of Sciences, "Mineral Resources and the Environment," (1975). Water depth not indicated.
(5) USGS "Mean," Oil and Gas Branch Resource Appraisal Group (1975). Includes water depth to 200 m (660 ft).
(6) Mobil Oil Corp., "Expected Value," Science (12 July 1974). Includes water depth to 1,830 m (6,000 ft).
(7) Weeks, L.G., Geotimes (July-August 1960). Adjusted through 1974. Water depth not indicated.
(8) Hubbert, M.K., Senate Committee (1974). Includes water depth to 200 m (660 ft).
(9) American Association Petroleum Geologists Memoir 15, (1971); National Petroleum Council, "Future Petroleum Provinces of the United States," (1970). Some areas are excluded from this estimate. Includes water depth to 2,500 m (8,200 ft).
(10) National Petroleum Council, "U.S. Energy Outlook--Oil and Gas Availability," (1973). Includes water depth to 2,500 m (8,200 ft).

FIGURE A-2. COMPARATIVE ESTIMATES OF OIL RESOURCES IN THE UNITED STATES

Thus, taking into account reserves, the USGS estimates that, at 1973 prices, recoverable resources yet to be produced amount to about 120 billion barrels. If advanced recovery could be applied to the remaining discovered and estimated undiscovered resources so that 50 percent of the resource could be produced, the recoverable resource, which could actually be produced, would be about 250 billion barrels. More detailed estimates of the oil recoverable by advanced techniques are not available and the 250 billion barrels must, at this time, be viewed as the most credible upper limit to the amount of resources left to be produced. Furthermore, tertiary recovery is a slow process which takes many years to complete in a given field but it contributes to overall oil production by maintaining production rates higher and longer than possible under long-term primary and secondary recovery. If today's oil prices are maintained, then the limits of the reserves (120 billion barrels) virtually assure that U.S. crude oil production will begin a long-term decline in the early 1980s (completion of TAPS will stave off the decline in U.S. production rate for 5 to 8 years). Higher crude oil prices can extend the reserves to a maximum of 250 billion barrels, but because of the long time required to bring tertiary recovery projects up to full production and the generally slow rate of recovery by tertiary methods, production rates during the late 1980s and thereafter for the nation as a whole are unlikely to increase beyond those achievable in the early 1980s. Increasing crude oil prices will have the long-term effect of preventing declines in production, but because of the limits of the resource base now projected, substantial increases in future crude oil production rates would seem impossible.

APPENDIX B

METHOD FOR HG3 REGIONAL SUPPLY PROJECTION

The limitations of the oil resource base discussed in Appendix A help determine a credible upper limit to the future production rate from U.S. resources. Of the 120 billion barrels available at 1973 oil prices and producible by primary and secondary recovery, about half of this amount is physically producible by the year 2000 if prices remain constant in 1973 dollars. Thus, cumulative production of more than about 60 billion barrels by the year 2000 requires much higher crude oil prices and the application of advanced recovery to many fields. Indeed, physical considerations together with the new USGS estimates imply that crude oil production rates past the year 2000 cannot exhibit long-term increases, not even a constant production rate.

With these limitations imposed on the quantity and the rate at which oil can be recovered, we selected from among the EPP scenarios of domestic oil production in the absence of synthetic crude oils scenario HG3, which has the lowest cumulative production between 1975 and 2000 and a non-increasing rate of domestic production between 1985 and 2000. The remainder of the scenarios in Table 3-1 imply that the rate of domestic production increases to the year 2000 and beyond.

Scenario HG3 itself requires that about 70 billion barrels of oil be produced by advanced recovery techniques by the year 2000. Since cumulative production over the last 100 years has only been 106 billion barrels using conventional oil recovery techniques, the 70 billion barrels recovered in 25 years by applying advanced techniques probably represent the upper limit to domestic oil production, and indeed lower cumulative production and smaller production rates in the year 2000 than HG3 are more likely, particularly if the new USGS estimates of the domestic resources base are approximately correct. Thus, HG3 represents a scenario of maximum credible domestic oil production, even assuming much higher crude oil prices. (It is not possible to estimate at this time what price of crude oil would be necessary to bring about production of the 70 billion barrels of oil by advanced recovery techniques for HG3, since not enough is actually known about the economics of applying advanced recovery techniques on a wide scale.)

For analysis of the impacts of HG3, we have used the Project Independence scenarios in the Oil Task Force Report[4] for determining the percentage breakdown of regional oil supplies from national production under HG3 as shown in Table 3-1. Table B-1 shows the regional oil supply projected by HG3 and serves to illustrate environmental impacts. The supplies shown in Table B-1 may never be realized; they are intended to serve a similar function in this study to that served by the maximum credible implementation scenario, Chapter 6. One major difference in credibility between the two scenarios rests in the area of the resource estimated. No one really knows how much oil is left for discovery, where it is, or how rapidly it can be produced. However, the location and the quantities of the oil shale and coal resources for syncrude are known.

Table B-1

HISTORICAL GROWTH SUBSCENARIO 3--REGIONAL SUPPLY
OF OIL AND NATURAL GAS LIQUIDS
(Millions of barrels per day)

Region or Source	1974	Percentage of Total Supply*	HG3 1985	Percentage of Total Supply†	HG3 2000
Prudhoe	0	13.4	1.80	8.6	1.20
North Slope	0	9.4	1.30	5.1	0.68
NPR4	0	0	0	11.7	1.60
NPR1	0	0	0	0.6	0.08
Military Reserves	0	0	0	1.2	0.16
1	0.201	4.0	0.54	7.2	0.96
2	0.792	4.4	0.59	2.8	0.38
2A	0.058	4.5	0.60	9.0	1.20
3	0.215	1.2	0.16	0.9	0.12
4	0.614	2.5	0.34	1.7	0.23
5	2.553	12.1	1.60	8.0	1.10
6	3.526	24.0	3.20	18.1	2.40
6A	1.311	17.4	2.30	15.2	2.00
7	0.994	6.4	0.86	4.2	0.56
8-10	0.213	2.1	0.28	1.4	0.19
11	0.007	0	0	0.1	0.013
11A	0	0.3	0.040	4.5	0.60
Totals*	10.50	100	13.400	100	13.400

*Items may not sum to totals due to rounding.

†Percentages based on data on[4] Exhibit IV-2, Business-As-Usual, $7/B, 1985.

†Percentages based on data in[4] Exhibit IV-2, Accelerated Development, $7/B, 1988.

APPENDIX C

TRENDS IN PAST U.S. PRODUCTION AND THEIR IMPLICATIONS FOR FUTURE PRODUCTION

Hundreds of oil fields produce oil in the United States. Production into the rest of this century is certain to include oil from most of the existing fields, some of which have been producing for over 60 years, and presumably from fields yet to be discovered. Section 1 below presents a brief history of U.S. consumption of crude oil and crude oil prices. Declining annual discovery rates for new oil fields and declining crude oil prices (in constant dollars) characterize the 20 years prior to 1973. Dramatic crude oil price increases characterize the last two years.

1. A Brief History of U.S. Oil Production and Oil Exploration

Table C-1 summarizes the history of U.S. crude oil production and discovery. Column 2 of the table shows the annual U.S. crude oil production for the selected years. Each year, oil is produced from the economically proven reserves (Column 3 of Table C-1) remaining at the end of the previous year. Production increased nearly 3 percent per year on the average from 1890 until production peaked in 1970. After 1970, production began a decline, which continues (late 1975). This trend is expected to continue until TAPS is completed. In 1974, reserves were estimated to be about 34 x 10^9 barrels, and production was 3.0 x 10^9 barrels. Thus, if all else were constant, economically producible known reserves would be exhausted in only 11 years. However, each year brings new discoveries and new economic conditions, which change estimates of reserves. Increasing the real price of crude oil can result in new

Table C-1

HISTORICAL RECORD OF PRODUCTION AND PROVEN RESERVES: ALSO THE ULTIMATE RECOVERY AND ORIGINAL OIL IN PLACE BY YEAR OF DISCOVERY--TOTAL UNITED STATES FOR SELECTED YEARS (Billions of barrels of 42 U.S. gallons)

	For All Fields Discovered to Date		For Fields Discovered During Year	
Selected Years (1)	Production During Year (2)	Proved Reserves at End of Year (3)	1974 Estimate of Ultimate Recovery (4)	1974 Estimate of Original Oil in Place (5)
Pre-1920	5.1		25.8	98.0
1925	0.8		1.0	4.0
1930	0.9		7.7	13.6
1935	1.0		2.5	7.1
1940	1.3		3.8	9.6
1945	1.7	19.9	2.2	7.0
1950	2.0	25.3	2.6	7.3
1955	2.4	30.0	1.5	5.6
1960	2.5	31.6	0.9	3.1
1965	2.7	31.3	1.3	4.5
1966	2.9	31.4	0.5	2.0
1967	3.0	31.4	0.7	2.9
1968	3.2	30.7	10.6	25.4
1969	3.2	29.6	0.6	2.3
1970	3.3	39.0	0.7	2.2
1971	3.3	38.1	0.4	1.3
1972	3.3	36.3	0.2	1.0
1973	3.2	35.3	0.2	1.0
1974	3.0	34.3	0.06	0.3
Total cumulative for all years	106		140	440

Source: Summarized from Tables III and IV of[43] Reserves of Crude Oil, Natural Gas Liquids in the United States and Canada; and United States, Productive Capacity as of December 31, 1974.

reserves. The following equation shows the relationship.

(Proven reserves in previous year) - (Production that year) + (Discoveries in new fields) + (Extensions to old fields) = (Proven reserves at the end of the year).

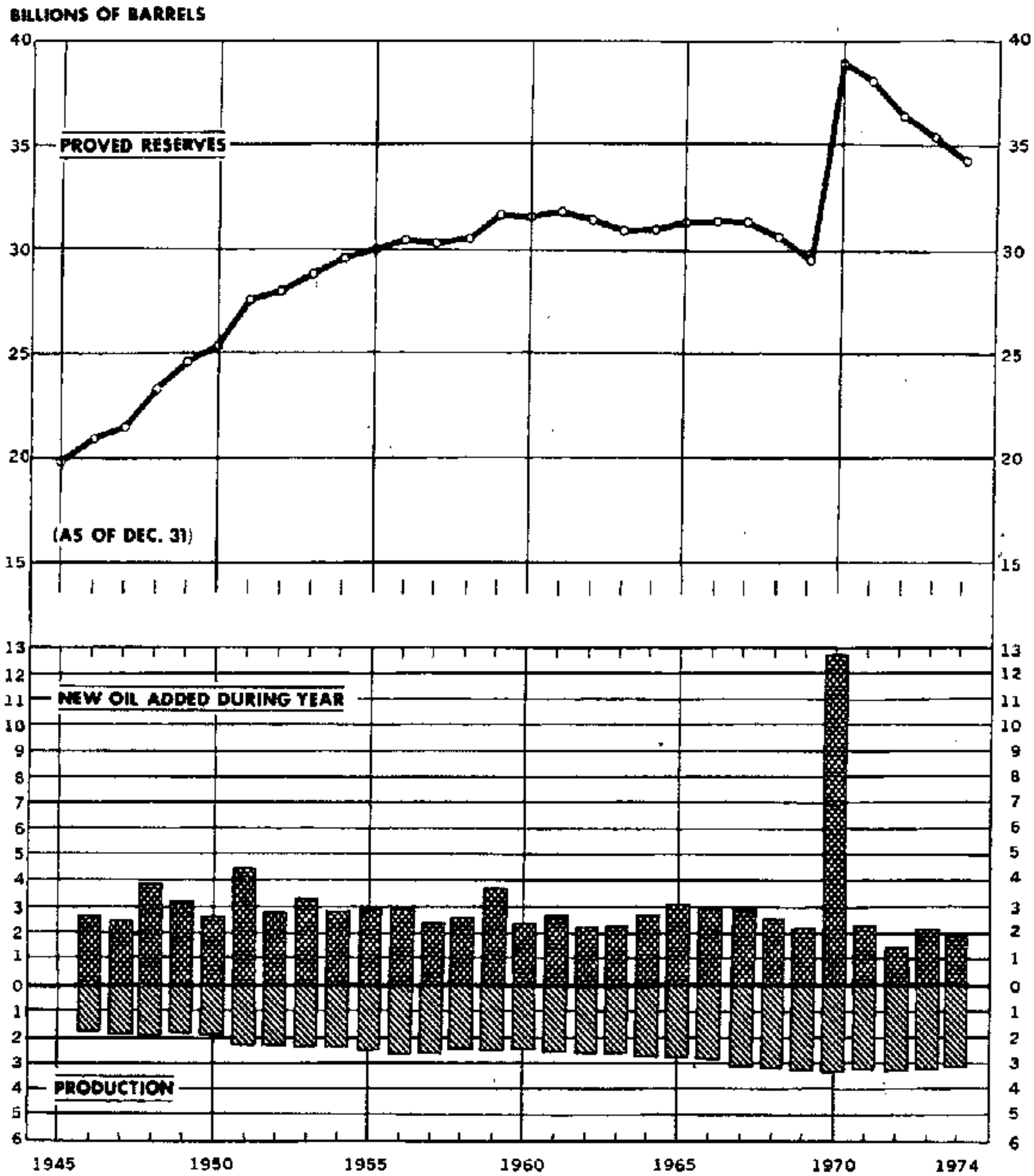
Indeed, since 1945, reserves have fluctuated around 10 times the annual production.

For the past 20 years, discoveries in existing oil fields exceeded discoveries of new fields--except for 1969 with 10×10^9 barrel discovery under the Alaskan North Slope. The year 1974 exemplifies this dominance trend. Discoveries in new oil fields (column 4 of Table C-1) added only 0.1×10^9 barrels to ultimately recoverable oil while extensions to old oil fields added approximately 1.9×10^9 barrels.

Column 4 of Table C-1 reflects the 1974 estimate of the ultimate recovery from all known oil fields at January 1974 crude oil prices--approximately 140×10^9 barrels, of which 106×10^9 barrels have been produced. Figure C-1 shows the history of U.S. reserves since 1945. A comparison of new field discoveries (column 4 of Table C-1) with the new oil added (cross-hatched histogram in Figure C-1) demonstrates the trend discussed in the previous paragraph.

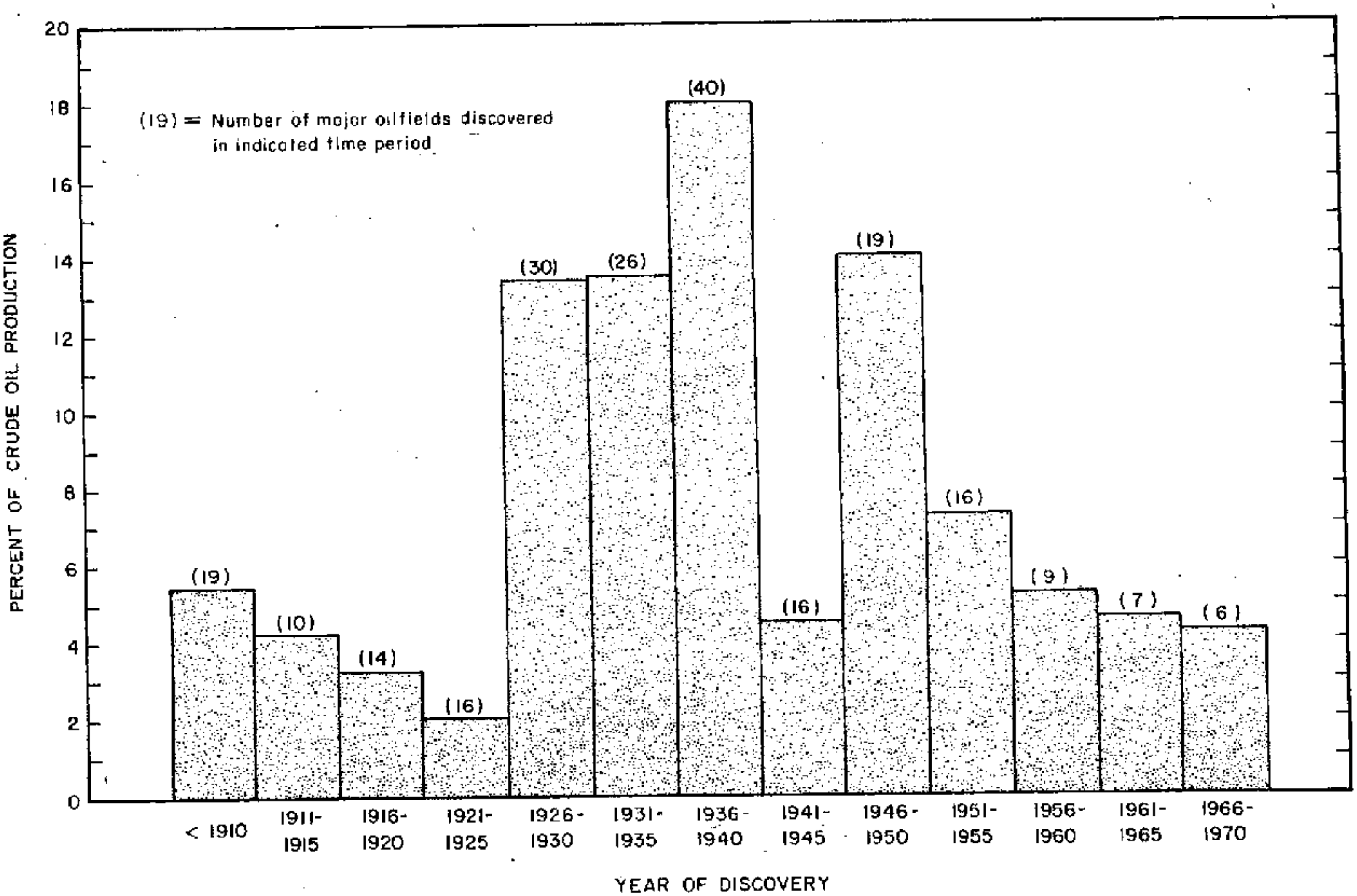
Not only does much of the exploration activity take place in known fields, but all production takes place in them as well. Figure C-2 shows the oil produced in 1973 from 228 major U.S. oil fields (fields which produced at least 1×10^6 barrels during the year). The data are tabulated by year of discovery of the field. Several apparent facts are:

- Approximately 80 percent of the oil from the 228 major fields was produced from 190 fields, all at least 20 years old.
- The 228 major fields accounted for almost 60 percent of all domestic production.



Source: American Gas Association

FIGURE C-1. PROVED RESERVES OF CRUDE OIL IN THE UNITED STATES, 1945-1974



Source: Based on data in 1974 International Petroleum Encyclopedia, p. 223.

FIGURE C-2. 1973 CRUDE OIL PRODUCTION FROM 228 MAJOR DOMESTIC OILFIELDS BY YEAR OF DISCOVERY

- Production from most of these major fields is likely to continue into the rest of the century.
- Any impacts already associated with these oil fields will continue.

A comparison of the statistics for 1968 on major U.S. oil fields (those producing over 10^6B per year)[44] with statistics for 1973[8] shows that production in many of these major fields increased substantially-most often due to more wells coming into production by 1973 (i.e., new wells were drilled).

Predicting future production from currently producing oil fields is difficult. Future production depends on the price of crude oil, on the existence of economic or other incentives for developing oil reserves which are uneconomic to produce at today's prices and, crucially, on the amount of oil left to produce.

2. A Brief History of U. S. Crude Oil Supply and Demand

Table C-2 shows the history of U.S. crude oil supply and demand between 1944 and 1973. While domestic supply was 11.3 million barrels per day in 1970, it declined to 10.5 million barrels per day in 1974; imports nearly doubled, from 3.2 x 10^6 barrels per day to 6.2 x 10^6 barrels per day. Total U. S. demand between 1944 and 1973 rose at about 4 percent per year, while imports grew from supplying 23 percent of domestic demand in 1970 to 36 percent of domestic demand in 1974. Table C-2 makes three important points:

- Domestic demand grew between 1944 and 1973 at 4 percent per year to 17.3 x 10^6 barrels per day in 1973.
- Imports grew between 1970 and 1974 to supply 36 percent of domestic demand.
- Domestic supply fell between 1970 and 1974 to only 10.5 x 10^6 barrels per day in 1974.

Table C-2

STATISTICS OF THE PETROLEUM INDUSTRY

YEAR	PRODUCTION			IMPORTS			OTHER SUPPLY*	TOTAL	PETROLEUM DEMAND		
	Crude Oil (1,000 B/D)	Nat. Gas Liquids (1,000 B/D)	Total (1,000 B/D)	Crude Oil (1,000 B/D)	Refined Products (1,000 B/D)	Total (1,000 B/D)		SUPPLY (1,000 B/D)	Domestic (1,000 B/D)	Export (1,000 B/D)	Total (1,000 B/D)
1945	4,695	315	5,010	203	108	311		5,321	4,857	501	5,558
1946	4,751	322	5,073	236	141	377	—	5,450	4,912	419	5,331
1947	5,088	364	5,452	266	170	436	—	5,868	5,452	450	5,902
1948	5 520	402	5,922	353	161	514	—	6,436	5,775	368	6.143
1949	5,047	431	5 478	421	224	645	—	6,123	5,803	327	6,130
1950	5.407	499	5,906	487	363	850	2	6.758	6,508	305	6,814
1951	6.156	562	6,720	491	353	844	7	7,571	7,060	422	7,482
1952	6,256	612	6,868	573	379	952	7	7,827	7,263	436	7.719
1953	6 458	655	7,113	648	386	1,034	20	8.167	7,624	401	8.025
1954	6,343	692	7,035	656	396	1,052	23	8,110	7.784	355	8,139
1955	6,807	772	7,579	762	466	1,248	34	8,881	8,493	368	8,861
1956	7,151	801	7,952	934	502	1,436	43	9,431	8,822	430	9 252
1957	7,170	809	7,979	1,023	552	1,574	42	9,595	8,860	568	9,428
1958	6,710	808	7,518	953	747	1,700	64	9,282	9,146	276	9,422
1959	7,053	880	7,933	966	815	1,780	86	9,799	9,494	255	9,749
1960	7,035	930	7,965	1,015	709	1,815	146	9,926	9,807	202	10,009
1961	7,183	991	8,174	1,045	871	1 917	179	10,270	9,985	174	10,159
1962	7,332	1,021	8,353	1,126	956	2,082	175	10,610	10,410	168	10,578
1963	7,542	1,098	8,640	1,131	992	2.123	202	10,965	10 753	208	10,961
1964	7,614	1,155	8,769	1,198	1,060	2.258	217	11,244	11,032	202	11,234
1965	7,804	1,210	9,014	1,238	1,230	2 468	220	11,702	11.523	187	11,710
1966	8,295	1,284	9,579	1,225	1,348	2 573	245	12,397	12.095	198	12,293
1967	8,810	1,410	10,220	1,128	1.409	2,537	292	13,049	12,569	307	12 876
1968	9.096	1.503	10.599	1,290	1,550	2,840	348	13,787	13.404	231	13,635
1969	9,238	1,589	10,827	1,409	1.757	3 166	340	14,333	14,148	233	14,381
1970	9,637	1,660	11,297	1,324	2,094	3,419	355	15,071	14.709	259	14,968
1971	9,463	1,692	11,155	1,681	2 245	3,926	439	15,520	15,225	224	15,449
1972	9,441	1,744	11,185	2,216	2.525	4,741	444	16,370	16,380	222	16,602
1973	9,208	1,738	10,946	3,244	3,012	6,256	485	17,687	17,321	231	17,552
1974	8,774	1,688	10.462	3,477	2,611	6,088	500	17,050	16.642	220	16,862

Source: Reference 25

Table C-3 shows a history of crude oil prices. Although prices in current dollars rose between 1954 and 1973, prices in constant 1973 dollars fell until 1974. The effective decline in crude oil prices made drilling and exploring for oil increasingly unprofitable. For example, the number of new oil wells drilled fell from 30,000 in 1954 to 9900 in 1973.[25] The total footage of wells drilled also declined from 220×10^6 ft in 1954 to 140×10^6 ft in 1973.[25] Recent increases in crude oil prices stimulated drilling activity and it remains to be seen if many new resources are added and if a net U.S. production increase takes place.

Table C-3

OIL PRICES

Year[25]	Crude Oil at Well (per barrel) Current $	Constant 1973 $
1954	2.78	4.77
1955	2.77	4.69
1956	2.79	4.57
1957	3.09	4.88
1958	3.01	4.63
1959	2.90	4.39
1960	2.88	4.29
1961	2.89	4.25
1962	2.90	4.22
1963	2.89	4.15
1964	2.88	4.07
1965	2.86	3.97
1966	2.88	3.89
1967	2.91	3.81
1968	2.94	3.70
1969	3.09	3.71
1970	3.18	3.62
1971	3.39	3.38
1972	3.39	3.57
1973	3.89	3.89
1974	6.74	6.32
November 1975[45]	8.75	7.18

Source: References 25, 45

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