DEFENDING OIL SUPPLIES CHAPTER 4

The United States needs oil. Despite some progress on alternatives, oil continues to fuel our transportation fleet and our military. However, much of the nation's oil is transported through fairly precarious means. Approximately, 25 percent of our domestic crude flows through the Trans-Alaska Pipeline System, and about 45 percent of our total petroleum consumption is transported through a limited number of oil tanker channels.[43,44] These delivery systems are vulnerable to disruption.

Markets react in three primary ways to vulnerable supplies. First, they demand a higher price to reflect the higher risks. Second, they invest in approaches to make the supply less risky. This includes diversification of suppliers, the development of new supplies, the establishment of stockpiles to cover demand if supply is interrupted, and the attempt to reduce the likelihood of supply disruptions. Third, markets develop substitute materials and ways to use the limited supplies more efficiently.

In the oil industry, corporations have invested in diversifying their supply base across countries. However, it has been the United States government, rather than private firms, that has developed the largest stockpiles (such as the Strategic Petroleum Reserve, described later in this chapter) and spent billions of dollars in defense costs to reduce the likelihood of supply interruptions and price shocks. Because the government has borne these costs of securing supply, they are not reflected in the current price of oil. Thus, producers and consumers lack important price signals that would encourage investment in substitutes. The government's costs act as a subsidy to oil. We estimate the costs of defending oil shipments and stockpiling reserves for our base year, 1995. This estimate has two elements: defending oil shipments from the Persian Gulf and the costs of building and maintaining the Strategic Petroleum Reserve. We also qualitatively discuss oil-related military activities within Alaska. In order for markets to make well-informed decisions between energy types, these costs should be reflected in the price we pay for oil.

[43] U.S. General Accounting Office, *Trans-Alaska Pipeline: Ensuring the Pipeline's Security*, GAO/RCED-92-58BR, November 1991, p. 5.

[44] Net petroleum imports account for approximately 45 percent of U.S. petroleum products supplied. See U.S. Energy Information Administration, *Annual Energy Review, 1996*, Table 5.7.

4.1 MIDDLE EAST OIL SECURITY

Although the Middle East supplies approximately 27 percent of the world's crude oil, the bulk of its production goes to Europe and Japan, not to the United States.[45,46] Nevertheless, the United States is not insulated from the market impacts of disruptions in Persian Gulf oil production. The current market share of the region's producers, as well as their share of known, low-cost reserves, influence markets. Changes in Middle East crude prices strongly affect world oil prices, and with them the United States.

Given the importance of oil in the world economy, events in the Middle East can severely impact economic stability worldwide. The economic importance of the region and its traditional instability have motivated a large U.S. military focus on the Middle East, and this focus has been clearly linked to oil even by Department of Defense personnel.[47] The protection from price spikes that DoD provides greatly benefits oil consumers worldwide. A separate question is whether the military's presence in the Middle East also benefits producers. To some degree, the answer is yes. The military presence protects industry investments in oil extraction and shipping infrastructure from hostile action. This protection directly reduces the cost of regional operations. However, price stability can hurt some producers in the short-term who would benefit from the price surges that sometimes accompany supply disruptions. In addition, the military's activities related to the Middle East clearly hurt domestic oil producers in the short-term, since they must compete with imports that do not reflect the military defense component in their delivered cost to U.S. markets. [48]

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[45] This figure is based on a ten year weighted average for the period 1986 to 1995. The Middle East's share of oil production rose more than eight percent over that period, to approximately 30 percent in 1995. See U.S. Energy Information Administration, *International Energy Annual 1995*, December 1996, Table 2.2.

[46] In 1995, the United States had net petroleum imports from the Persian Gulf of 1.563 million barrels per day versus 3.365 and 3.979 million barrels per day for Europe and Japan, respectively. See U.S. Energy Information Administration, *International Petroleum Statistics Report*, September 1997.

[47] Joshua Gotbaum, DoD's Assistant Secretary of Defense for Economic Security, was very candid about DoD's role in securing oil supplies and defending economic security in his testimony before the Senate Committee on Foreign Relations. In his prepared statement he wrote: "As this committee is only too well aware, the economic health of our Nation and its allies has on several occasions been severely affected by events in the Middle East, and their effect on oil supplies and prices. And it is the need to defend against military threats to such national interests that gives rise to the second perspective from which DoD must address the issue of U.S. dependence on stable global oil markets. The Department of Defense must be prepared to protect U.S. interests around the globe, wherever they may be threatened. This requires that we maintain the forces necessary to deter or defend against aggression. One of the key challenges that we face today is determining the appropriate strategy and force structure for the post-cold war era and to manage properly the drawdown of our forces without sacrificing the readiness to respond to threats in an increasingly complex world. And while that force structure is not predicated on meeting any single military threat, or protecting any single national interest, protecting against military threats to global oil supplies is an important factor for which we must be prepared." Joshua Gotbaum, Assistant Secretary of Defense for Economic Security, U.S. Department of Defense, *United States Dependence on Foreign Oil*, hearing before the U.S. Senate Committee on Foreign Relations, Senate Hearing 104-21, March 27, 1995, p. 24-25.

[48] The long-term impacts are less certain, as long-term volatility in prices could lead to permanent shifts away from oil, hurting the interests of all producers, both domestic and foreign.

In the following section, we quantify the subsidy from oil defense in the Persian Gulf. Deriving this estimate entails two main steps: estimating total U.S. military spending in the region and pro-rating an appropriate share of this spending to oil. Both of these steps are fairly complicated, and we discuss them in detail below. In addition, we evaluate which sectors of the oil market are most likely to benefit from the subsidy.

4.1.1 Military Spending in the Persian Gulf

Estimating the military costs for ensuring the security of the Middle East oil supply is not a clear-cut task. The Department of Defense neither reports its expenditures by geographic area nor by military objective. However, DoD and private researchers have provided estimates of defense costs for the Middle East region. They have used three main methods to do so:

- **Total Cost Approach.** The total cost approach allocates the military's entire conventional force budget geographically. The approach pro-rates the budget according to the estimated percentage of the military's active force structure that serves objectives in a region.[49] Thus, it considers the distribution of active combat units as a proxy for the geographic allocation of all defense resources, including general costs such as training and headquarters support. The approach generally uses routine, peacetime operations to avoid temporary biases caused by periodic regional flare-ups. However, some researchers add a premium for war risks, reflecting the expected value of a war occurring in any particular year.

- **Partial Cost Approach.** The partial cost approach estimates the full value of all operations that directly benefit the military's objectives in a region. It is the sum of the force, equipment, and support costs that serve the region. Unlike the total cost approach, it does not attempt to allocate the portion of DoD's budget that serves the military's activities as a whole.

- **Marginal Cost Approach.** This approach tries to assess the degree to which military spending would decline if there were no longer any objectives in a region. The estimates vary depending on whether one includes only short-term changes in operations or both short and long-term changes. In the short-term, cost savings include only the costs of operations that are dedicated exclusively to the region and are not useful for meeting objectives elsewhere. In the long-term, the military may realize added savings by restructuring to more efficiently fulfill remaining objectives. Thus, differences between the short-term and long-term marginal costs of an objective can be substantial. In addition, the marginal

[49] The total cost approach requires that combat units be assigned to individual regions. In reality, the military does not follow such rigid geographic assignments. Units may serve objectives over a broader area. In addition, they are often useful for meeting contingencies elsewhere. Under the total cost approach, they are generally assigned to the regions that are perceived as their primary areas of concern.

> cost approach varies as to whether direct costs in the field alone are included, or whether support provided at the headquarters level is included as well.

Exhibit 4-1 lists the primary estimates for the cost of the military presence in the Gulf. To improve the comparability of estimates made in different years, we scaled the values to standard 1995 dollars using the GDP implicit price deflator. Once this adjustment has been made, the Persian Gulf total cost estimates range between $50 and $79 billion per year.[50] GAO's partial cost estimate adjusts to $31 billion annually, and CRS's estimate of short-term marginal costs adjusts to roughly $500 million annually. [51]

The GAO and CRS estimates are based on numbers provided by DoD that may be inaccurately low. DoD's numbers reflect costs in the 1980s, but DoD's presence in the Persian Gulf appears to have increased since then (see note 51). While the CRS short-term marginal cost estimate is about $500 million for all objectives in Southwest Asia (scaled to 1995), DoD sought supplemental funding of $630 million that year for the incremental cost of heightened operations in the Persian Gulf resulting from perceived Iraqi threats to Kuwait.[52] That figure is for supplemental costs alone, and does not include any of DoD's baseline marginal costs for the region, raising questions regarding the accuracy of the estimate. Methodological issues aside, existing analyses suggest an extremely wide range of Persian Gulf defense costs -- from $500 million to $79 billion per year.

[50] Total cost estimates from Ravenal, Kaufmann and Steinbruner, and Copulos. Detailed sourcing is shown on Exhibit 4-1.

[51] We were unable to make a second adjustment for changes in real military spending for the Persian Gulf. Between 1988 and 1996, DoD reduced its personnel by 27 percent, and real military spending decreased by an equal amount. However, over that same period, DoD increased the number of personnel ashore, naval deployments, and land-based prepositioned equipment in the Persian Gulf. The increased attention given to the Persian Gulf is seen in the rising trend of Ravenal's cost estimates during the 1990s (see Exhibit 4-1). Because trends in the Persian Gulf do not appear to mirror trends in the military as a whole, simple metrics such as changes in total real military spending would not be valid as a scaling factor. Unfortunately, detailed historic annual data on the geographic attribution of force structure were not available. See (a) U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 1998*, March 1997, Chapter 6; (b) U.S. Department of Defense, Directorate for Information Operations and Reports, "Active Duty Military Personnel Strengths by Regional Area and by Country," obtained from http://web1.whs.osd.mil/mmid/military/309hist.htm, February 13, 1998; (c) U.S. General Accounting Office, *Overseas Presence: More Data and Analysis Needed to Determine Whether Cost-Effective Alternatives Exist*, GAO/NSIAD-97-133, June 3, 1997; and (d) William S. Cohen, Secretary of Defense, U.S. Department of Defense. *Annual Report to the President and the Congress*, April 1997.

[52] Gotbaum, pp. 24-25.

Exhibit 4-1

DEFENSE OF PERSIAN GULF OIL SHIPMENTS
(Billions of Dollars)

Source	Year of Estimate	Year of Dollars	Middle East Defense Estimate (a)	Scaling Factor to 1995 Dollars (Note 1) (b)	Adjusted Middle East Defense Estimate (1995$)	Allocation to Oil (Note 2) (c)	Oil Allocation Used by the Author	Estimate of 1995 Oil-Defense (a*b*c)	Notes	Sources	Type of Estimate (Note 3)
Ravenal, estimate of peacetime spending	FY 1992	1992	50	1.078	53.9	0.333	1.0	18.0	(4)	Ravenal, 1991	Total
Ravenal, estimate of peacetime spending plus conventional war risk premium	FY 1992	1992	55.3	1.078	59.6	0.333	1.0	19.9	(5)	Ravenal, 1991	Total
Ravenal	FY1995	1995	70	1.0	70.0	0.333	1.0	23.3	(4)	Ravenal, 1998	Total
Ravenal	FY1997	1997	82	0.959	78.6	0.333	1.0	26.2	(4)	Ravenal, 1997	Total
Kaufmann	FY 1990	1992	64.5	1.078	69.5	0.333	N/A	23.2	(6)	Kaufmann	Total
Copulus	FY 1988	1988	40	1.252	50.1	0.333	0.3	16.7	(7)	Copulus	Total
CRS, marginal costs	Note 8	1990	0.4	1.151	0.5	0.333	N/A	0.2	(8)	GAO, CRS	Marginal
GAO, partial costs	Note 9	1990	27.3	1.151	31.4	0.333	N/A	10.5	(9)	GAO, CRS	Partial

Notes:

(1) Estimates are adjusted to 1995 dollars using the GDP price deflator.

(2) We allocate 33.3 percent of DoD spending in the Middle East to oil. This percentage is based on an even split of spending among DoD's major objectives in the region: ensuring regional stability, the supply of oil, and the safety of U.S. citizens. Both Ravenal and Delucchi and Murphy believe that oil accounts for a larger percentage of spending (50-100 percent), arguing that securing supply is the largest, most important mission in the region.

(3) Total cost estimates reflect all spending related to the Middle East, regardless of whether such costs potentially serve objectives in other regions as well. These estimates include a share of DoD's general costs (e.g., overhead, support, training). Partial estimates are equivalent to total costs, but without the share of general spending. Thus, they reflect spending only for those operations directly related to meeting Middle East objectives. Marginal cost estimates reflect spending that is specific to the Middle East, or the incremental spending that would disappear immediately in the absence of U.S. objectives in the Middle East.

(4) This estimate includes peacetime defense costs for the Middle East. Ravenal allocates DoD's conventional forces budget based on the peacetime

geographic distribution of the military's active force structure. See Exhibit 4-1a for more information about this estimate.

(5) This estimate includes Ravenal's estimate of peacetime defense costs plus his conventional war risk premium. The premium is the product of Ravenal's estimate of the costs and probability of the U.S. engaging in a conventional war in the region. See Note 4 and Exhibit 4-1a for more information about the estimate.

(6) This estimate is based on DoD's FY1990 budget authority for conventional forces. Kaufmann estimated the geographic allocation of the budget authority based on the distribution of the military's active force structure. For more information about this estimate see Exhibit 4-1a.

(7) According to Copulus, this estimate is the amount listed in DoD's 1988 budget under the category "Gulf Contingencies."

(8) This estimate reflects the incremental costs of Southwest Asian operations. Southwest Asia includes the Middle East, Sudan, Kenya, and Somalia. The estimate is based on annualized DoD spending from 1980 through 1990. Only those costs are included that DoD acknowledges it would not incur in the absence of U.S. interests in that region. See Exhibit 4-1a for more information about this estimate.

(9) This estimate reflects all costs related to objectives in Southwest Asia. The estimate is based on annualized DoD spending from 1980 through 1990. It includes spending that DoD acknowledges is "dedicated" to, "oriented" towards, or otherwise useful for missions in that region. See Exhibit 4-1a for more information about this estimate.

Sources:

Copulus, Milton R. *Answering America's Energy and Environmental Dilemma*. The National Defense Council Foundation. 1990.

Delucchi, Mark A. and James Murphy. *U.S. Military Expenditures to Protect the Use of Persian-Gulf Oil for Motor Vehicles*. Report #15 in the Series: *The Annualized Social Cost of Motor Vehicle Use in the United States, based on 1990-1991 Data*. UCD-ITS-RR-96-3 (15). University of California, Davis, Institute of Transportation Studies. April 1996.

Kaufmann, William W. and John D. Steinbruner. *Decisions for Defense: Prospects for a New World Order*. Washington, D.C.: The Brookings Institution. 1991.

Ravenal, Earl C. *Designing Defense for a New World Order: The Military Budget in 1992 and Beyond*. Washington, D.C.: Cato Institute. 1991.

Ravenal, Earl C. Personal communications, August 1997 and March 1998.

Ravenal, Earl C. *The 1998 Defense Budget*. Chapter 7 in *The Cato Handbook for Congress*. Washington, D.C.: The Cato Institute. 1997. Obtained from http://www.cato.org/pubs/handbook/hb105-7.html, February 20, 1998.

U.S. Congressional Research Service. *The External Costs of Oil Used in Transportation*. CRS Report for Congress. 92-574 ENR. June 17, 1992.

U.S. General Accounting Office. *Southwest Asia: Costs of Protecting U.S. Interests*. GAO/NSIAD-91-250. August 1991.

4.1.2 Pro-rating Total Spending to Oil

Once total spending in the region is bounded, we evaluate the portion of that spending that is properly allocable to the defense of oil supplies versus other military objectives. Defense of oil shipments from the Persian Gulf is an example of *common costs*. Below, we provide a discussion of common costs in general and how to allocate such costs across products. We then discuss common costs in the context of Persian Gulf defense. Finally, based on our discussion of common costs, we pro-rate a portion of the military's Persian Gulf operations to oil.

4.1.2.1 Treatment of Common Costs

The term "common cost" refers to a situation in which two or more outputs are produced simultaneously from the same production process.[53] The presence of the U.S. military in the Persian Gulf region, along with all of the general overhead support that makes that presence possible, is an example of such a "production process." The "outputs" are the multiple military objectives of this presence. Recently, analysts at the RAND Corporation identified three primary purposes of the military activity related to the Persian Gulf region:[54]

- Ensuring access to oil supplies
- Preserving regional stability
- Preventing the emergence of regional hegemonic powers

Common costs create challenges for allocating production costs to individual beneficiary products. What portion of the U.S. military costs for the region is properly attributed to ensuring access to oil supplies versus another, simultaneously produced objective such as preserving regional stability? The analysis by the Congressional Research Service (CRS) cited in Exhibit 4-1 attempted to answer this question indirectly using a marginal cost approach. CRS estimated savings from defense reductions if the entire Middle East were no longer a U.S. strategic interest. Their result was a paltry $500 million in annual savings out of a total presence of $31.4 billion

[53] Shared production costs are often referred to as *joint costs* rather than common costs. In fact, joint costs are a sub-set of common costs, and refer to situations in which a shared production process yields fixed proportions of outputs, such as leather and beef from a cattle operation. See Ben Johnson Associates, Inc., "Costing Definitions and Concepts," obtained from http://www.microeconomics.com/ essays/cost_def/cost_def.htm, January 27, 1998.

[54] See Graham Fuller and Ian Lesser, "Persian Gulf Myths," *Foreign Affairs*, May/June 1997, pp. 42-52. Fuller and Lesser, both with RAND, argue that supplemental objectives such as maintaining Israel's security; maintaining preferential access to Gulf markets; and encouraging political and economic reform and human rights, while beneficial, are not policy drivers for the regional military presence.

(1995 dollars), or roughly 1.4 percent.[55] The marginal savings from a change in the oil objective alone, rather than the entire Middle East, would undoubtedly be smaller still. For example, if each objective has the same marginal costs, the marginal savings from eliminating oil security would be one-third of the total, or less than $200 million per year. Even if we are to assume for the moment that the CRS did a true, long-term, assessment of marginal costs, the strong common cost attributes of the defense presence (i.e., military forces are useful for more than one objective and in more than one region) make relatively small cost savings an inevitable and pre-ordained result of the marginal analysis.

Assessing the benefit of services provided at their very low marginal cost misrepresents both the real costs and the value of this military presence. In addition, the idea that the real costs should not be attributed to individual beneficiaries at all because they are common costs contradicts standard practice in both industry and in other areas of government activity.[56] Consider, for example, expensive federally-owned dams. The dam represents a massive common cost that provides electricity, irrigation, and flood control services. Once the dam is built, the marginal cost of any of these services is near zero -- yet the fixed costs must be paid by somebody, and the government allocates these costs back to the various beneficiaries of the dam.

The issue with oil is not whether common defense costs should be allocated to beneficiaries, but the fairest method of doing so. The approaches developed to allocate common costs in other industries such as dairies and oil refineries provide some useful insights to valuing oil defense.[57]

- **Split-off points.** The production of a good or service involves multiple steps. Even where some of the steps are identical for two or more outputs, a careful assessment often reveals one or more "split-off points" where inputs (and costs) can be isolated for a single output. As shown on Exhibit

[55] The Congressional Research Service analysis is based on data developed in an earlier GAO Report. Delucchi and Murphy conclude that the GAO estimates on which the CRS marginal cost analysis is based, understated defense costs by a large margin. See (a) U.S. Congressional Research Service, *The External Costs of Oil Used in Transportation*, 92-574 ENR, June 17, 1992, pp. 23-33; (b) U.S. General Accounting Office, *Southwest Asia: Costs of Protecting U.S. Interests*, GAO/NSIAD-91-250, August 1991; and (c) Mark Delucchi and James Murphy, "U.S. Military Expenditures to Protect the User of Persian-Gulf Oil for Motor Vehicles," Report #15 in the series *The Annualized Social Cost of Motor-Vehicle Use in the United States, Based on 1990-91 Data*, UCD-ITS-RR-93-3 (15), April 1996, pp. 9-12.

[56] Bohi and Toman argue that the military outlay, "to the extent it can be associated with energy protection, may be seen as a fixed cost that cannot be altered by marginal changes in energy prices and demands. As such, it is not relevant to energy policy." (See Douglas Bohi and Michael Toman, *The Economics of Energy Security*, Boston: Kluwer Academic Publishers, 1996, p. 26.) In fact, charging oil users for this protective service would very likely have an impact on energy demand patterns, by encouraging longer term shifts away from imported oil, or to more efficient mechanisms of securing the oil supply on the part of regional producers. Whether or not these market changes would then trigger longer-term military restructuring or simply reduced missions (i.e., no need to worry about oil anymore) is a separate question.

[57] Many other industries, such as organic chemicals, meat production, timber, and coal mining, have joint and/or common costs as well. Even more industries (airlines for example) have large fixed costs and *nearly* identical production processes for different products or services provided.

4-2, the split-off point for the military presence in the Persian Gulf divides the baseline presence from the objective-specific activities both in the field and at the headquarters level.

To the extent that the cost of defense analysts in DoD's Washington, DC office who are focused on oil security can be identified, these costs are properly allocated only to the oil-defense mission objective. Similarly, when the Persian Gulf force undertakes actual missions, if these missions are associated with oil rather than one of the other objectives, the costs are also properly attributed to oil. A similar line of reasoning would be used for costs specific to other objectives as well. The remaining multi-objective (common) costs would be smaller than the total, but would nonetheless need to be allocated across the objectives.

- **Bounding Common Costs.** Although common costs are impossible to allocate precisely, economists have developed some rules that help bound the reasonable costs attributable to a single output. These conditions state that the costs allocated to any activity should never be:[58]

  - Less than the costs that would be saved by discontinuing that activity (i.e., its incremental cost), nor

  - More than the costs that would be incurred if only that activity was undertaken (i.e., its stand-alone cost).

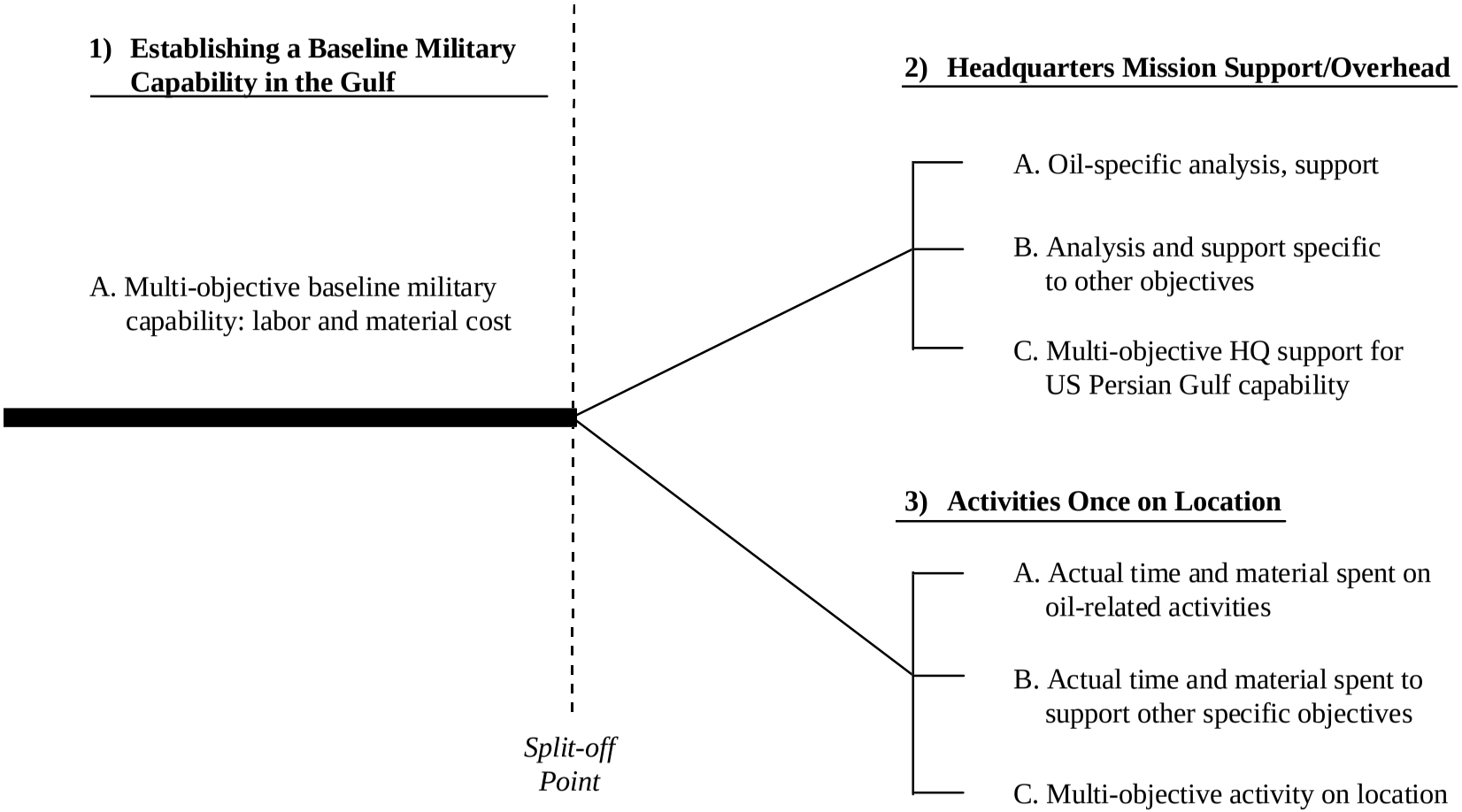
Thus, the CRS estimates for the cost of oil defense (which we estimate as one-third of the CRS estimate for total incremental costs in the region) form the absolute *lower bound* for oil-related defense costs.[59] The upper bound, the stand-alone cost, would be equivalent to all oil-

[58] These bounding statements are referred to as "Baumol-Willig" conditions, after the economists that developed the argument. See Zolton Biro, "Cost Allocation in Principle and Practice," London Economics, Ltd., October 1994, obtained from http://www.londecon.co.uk/pubs/comp/costall.htm, January 27, 1998.

[59] The use of the CRS estimate as a bounding value is complicated by a number of factors. First, the CRS measured the marginal cost of all Persian Gulf defense, not just the oil objective, although we have used their results to estimate a marginal cost for oil defense alone. Second, their numbers seem to be downwardly-biased since they appear to examine only immediate savings rather than savings from longer-term restructuring, and because they do not appear to have evaluated the marginal costs for Persian Gulf defense outside of the region (e.g., in headquarters). In addition, they originate with DoD, which is not a disinterested source. As Ravenal puts it: "When attempting to justify its entire defense budget request, or when demonstrating to our allies that we are paying a disproportionate share of the costs of an alliance, the Pentagon prefers to state its costs fully. But when defending against proposed cuts, it claims that deleting this or that unit or program from the force structure or the budget would save only the tip of its marginal costs." (Ravenal, 1991, p. 19).

Exhibit 4-2

COSTING OVERVIEW OF DEFENDING PERSIAN GULF OIL



KEY

- Common costs requiring allocation = 1.A. + 2.C. + 3.C.
- Incremental cost of oil defense = 2.A + 3.A.
- Stand-alone cost of oil defense = 1.A. + 2.A. + 2.C. + 3.A. + 3. C.

specific costs, plus all multi-objective baseline costs, since these costs would be the same for one objective (oil defense) as they are for several objectives. The stand-alone cost would likely be over 95 percent of the total costs of the Persian Gulf presence.[60]

4.1.2.2 Allocating Common Costs Across Multiple Objectives

To determine a fair way to allocate costs among the various military objectives, consider a less complex example than Persian Gulf defense -- that of a dairy. The cost of buying, housing, and feeding the dairy herd must be recovered from the sale of milk if the farmer is to stay in business. Yet, a dairy takes in raw milk and converts it into a variety of products such as skim milk, cream, and cheese. The processing costs after the split-off point (the creation of new products from raw milk) may well be small relative to the common costs of caring for the herd. If none of these products are saddled with the costs of looking after the herd, the dairy will underprice its output and not earn enough revenue to survive as a business. Yet, if any particular product is loaded with too large a share of the common costs, that product will not be competitive in the market.

Determining how much of the common cost should be allocated to each product is not a perfect process. According to one practitioner, "the most to be expected is an allocation method that produces reasonable and equitable results."[61] There are, however, a few common methods used. These approaches rely on pro-rating the common costs based on the ratio of one product to the total products produced. This ratio may be based either on some variant of the value in the market of the goods produced, or on the relative physical quantities (e.g., pounds of cheese versus pounds of milk).[62] Some complex industries do not allocate the common costs at all, simply viewing their residual earnings (revenues less output-specific costs) as "contribution to joint/common costs and profit". If their residual earnings are too low, they adjust their production and pricing decisions accordingly. Each approach relies on the ability to measure the market value and/or quantity of the goods produced. Thus, they are of limited application to the allocation of a non-traded service such as defense.

[60] Assuming the incremental costs for the other military objectives are similar to those for oil defense ($100 million each), the stand-alone cost of oil defense would only be about $200 million per year less than the total cost of the Persian Gulf military presence.

[61] Ben Johnson and Associates, op. cit.

[62] Revenue-based approaches include the sales value at split-off [(quantity of product A x sales price)/(market value of all products produced)]; the estimated net realizable value (same as above, with the sales price reduced by the separable product costs after the split-off point); the constant gross-margin percentage net realizable value (same as estimated net realizable value approach except that revenues from each product are reduced by a gross margin as well as separable costs, with the gross margin equal to that earned on all products co-produced). See Charles Horngren and George Foster, *Cost Accounting: A Managerial Emphasis, 7th Edition*, Englewood Cliffs, NJ: Prentice Hall, 1991, pp. 529-536.

Another common approach for recovering fixed costs is that of *Ramsey pricing*. Stated simply, a Ramsey pricing approach allocates fixed costs based on the relative strength of demand for the products co-produced. That is, if people really need/want the product, they end up paying a much higher share of the fixed costs. A good example of this is the airline industry. The fixed costs of a business and a leisure traveler are virtually the same: reservations system, gate agents, baggage handling, plane, crew, and fuel. The business traveler gets a few extra perks -- primarily more flexibility in changing tickets -- but the cost implications of these differences are quite small. Yet business travelers, because they need the service more (they have to get transportation on short notice and cannot wait for later flights) end up paying three to four times as much for the same passage.[63] Thus, the business traveler pays a much higher proportion of fixed costs than the leisure traveler.

4.1.2.3 Allocating Persian Gulf Costs to Oil Defense

While the bounding conditions can sometimes narrow the range of uncertainty for allocating common costs substantially, they provide little help in the allocation of common costs of oil. If we take the oil share of the CRS assessment (despite the limitations discussed in note 59) to be the absolute lower bound of the cost of defending oil (the "incremental cost" parameter), we reach a value of less than $200 million per year. If we assume that the incremental cost of the other regional objectives is similar (assuming three primary objectives), we generate an upper bound "stand alone" condition for oil of nearly $70 billion annually.[64] That the truth stands somewhere in the middle is hardly helpful, as the possible range is so wide.

The Ramsey pricing model is perhaps the most applicable to oil defense. The three primary objectives that we outlined above (preserving regional stability, ensuring access to oil supplies, and preventing the emergence of regional hegemonic powers) appear to be interrelated. Demand for all three "products" fluctuates depending on the relative state of unrest in the region. For example, concern for the three objectives increased dramatically after Saddam Hussein invaded Kuwait. During periods of relative stability, demand for the three objectives decreases somewhat, but they continue to be policy drivers in the region. Because we have no means of judging each objective's relative share of total demand for "defense services," we allocate common costs equally between them. This allocation yields cost estimates for oil defense of $10.5 billion to $23.3 billion dollars in 1995.[65] In contrast, one prominent defense analyst believes that nearly all of the costs should be attributed to oil, resulting in estimates three times

[63] In economics terminology, the business traveler has a more inelastic demand for travel services than the leisure traveler.

[64] The upper bound is calculated using Ravenal's 1995 estimate of $70 million. Ravenal made an estimate of $79 million for 1997, but we do not use this value because it includes increases in spending since the base year of our analysis. Earl C. Ravenal, personal communication, March 1998; Earl C. Ravenal, "The 1998 Defense Budget," Chapter 7 in *The Cato Handbook for Congress*, Washington, D.C.: The Cato Institute, 1997, obtained from http://www.cato.org/pubs/handbook/hb105-7.html, February 20, 1998.

[65] Due to the methodological problems associated with using a short-term marginal cost approach for a service with large common costs, we exclude the CRS figure from our range.

higher than we report.[66] Yet, even our conservative estimates demonstrate the importance of oil defense in reducing the delivered cost of oil to the U.S., Europe, and Japan.

4.1.4 Identifying Beneficiaries of the Subsidy Within Oil Markets

There are two central issues regarding the beneficiaries from the defense of oil shipments. The first is whether the subsidy primarily benefits oil producers or oil consumers. This is important in evaluating how markets are likely to react were subsidies removed. The second involves dividing benefits between domestic versus foreign sectors, which addresses strong concerns expressed by domestic producers that the military spending puts them at a competitive disadvantage.

4.1.4.1 Producers versus Consumers

The benefits from Persian Gulf defense accrue to both oil consumers and producers. Delucchi and Murphy point out that as of 1992 there were at least $4 billion in U.S. petroleum investments in the Middle East, and more likely closer to $17 billion.[67] They estimate that, because of this large investment, benefits to U.S. producers are worth between 50 and 100 percent of those to U.S. oil consumers.[68] Others feel this value probably overstates benefits to producers.[69] Despite the uncertainty regarding which sector benefits most, it is apparent that both oil producers and consumers benefit in a substantial way from the military presence.

4.1.4.2 Domestic versus Foreign

Analysts have taken two main approaches to weighing the domestic versus foreign benefits of our Persian Gulf defense activity. Some have argued that the military's central interest in oil security is to protect domestic consumers from oil price shocks. Given the interest in insulating domestic markets, some have argued that the entire cost of the military defense should be allocated to domestic oil consumption.

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[66] Earl C. Ravenal, personal communication, March 1998.

[67] This figure includes investments made by foreign subsidiaries of U.S. firms. See Delucchi and Murphy, pp. 16-17.

[68] *Ibid*., p. 16-17.

[69] Ron Steenblik, OECD, personal communication, February 20, 1998.

Other analysts point out that the price stability provided by the U.S. presence benefits oil consumers throughout the world, not just domestic markets. In reality, price stability even for foreign producers provides some indirect benefits to the U.S., since in an international trading arena the U.S. could still suffer from price shocks affecting our key trading partners. Our summary metrics in Chapter 7 incorporate both perspectives.

4.1.5 Persian Gulf Defense Results and Summary

We estimate that defending Middle East oil costs U.S. taxpayers between $10.5 and $23.3 billion annually. While these estimates are higher than reported by the Department of Defense, which uses a faulty short-term marginal cost approach, they are lower than estimates made by independent analysts.

Beneficiaries of the oil defense subsidy include both domestic and foreign oil producers and consumers. The Persian Gulf defense costs are quite large, representing the single largest subsidy to the oil fuel cycle in our analysis. This spending helps to stabilize world oil prices, and should therefore be seen as purchasing a benefit: protection from major price swings in petroleum and security for key petroleum investments in the region. Because this benefit is being purchased by the taxpayer rather than by oil producers and consumers, important price signals to conserve oil and shift to other energy sources are being lost. U.S. policy should recover defense costs in the same way they recover other common costs such as dam construction: through user fees. Only then would the price of oil from the Persian Gulf begin to reflect more fully the resources now expended to make it available to consumers throughout the world.

4.2 ALASKA DEFENSE

Alaska is another region that has vulnerable oil supplies and may benefit from a military presence. As with the Persian Gulf, the military accomplishes multiple objectives with a core presence in Alaska, and budget data are not available to analyze in detail which costs are properly attributed to oil. The Alaska presence also differs somewhat from the Persian Gulf since the region is under domestic control and supply disruptions may be less likely.

Alaska accounts for nearly 25 percent of total crude oil production in the United States, and most of that oil travels approximately 800 miles from the North Slope, via the Trans-Alaska Pipeline System (TAPS), to a tanker terminal at the Port of Valdez on Prince William Sound. The quantity of North Slope production and the importance of oil to the United States economy make the Alaskan oil supply a key strategic asset and an obvious target for enemies of the U.S. Yet, securing the full length of the Alaskan pipeline is an enormous challenge, if not impossible.[70]

[70] U.S. General Accounting Office, *Trans-Alaska Pipeline: Ensuring the Pipeline's Security* , pp. 5 and 15.

Officially, Alyeska, the company that operates TAPS, is responsible for the pipeline's security. Alyeska maintains its own security force, which performs a combination of live visual surveillance and video and aerial surveillance. Although federal and state agencies are not directly responsible for daily security measures, the Federal Bureau of Investigation, Department of Defense, Alaska National Guard, and Alaska State Troopers serve as reactionary elements that would respond to security incidents that are beyond Alyeska's capabilities. The Federal Emergency Management Agency would be involved in the event of a natural disaster.

The military representatives that we contacted in Alaska stressed that the security of TAPS is the sole responsibility of Alyeska, and that the U.S. military does not engage in security operations.[71] One representative from Elmendorf Air Force Base's Public Affairs Office flatly denied that ensuring the security of the oil supply is among the military's objectives in Alaska, suggesting that none of the common costs of the Alaska defense presence should be allocated to oil.[72]

Historically, Alaska was considered a front line of defense during the Cold War due to its proximity to the former Soviet Union. As such, military personnel in Alaska noted that it was the focus of many Cold War defense operations. Today, the state is a useful base for operations not only in the former Soviet Union, but in Asia as well. Defense personnel there also pointed out that the military has a strong interest in the region simply because Alaska is U.S. territory and home to U.S. citizens.[73] Yet, our research indicates that Alaska's role as a large oil producer receives consideration from the government and defense community, and that the federal (and perhaps also the state) government does incur costs related to the defense of Alaskan oil shipments.

Unlike the Persian Gulf situation, federal and state agencies do not appear to be directly involved in the daily security of the Trans-Alaska Pipeline. Furthermore, the Department of Defense does not explicitly allocate its spending and activities in Alaska among differing objectives such as defense of natural resources, United States citizens, and United States borders. However, our research found the following examples of federal involvement in Alaskan oil security:

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[71] Sergeant Mike Jones, Elmendorf Air force Base, Public Affairs Office, personal communication, September 10, 1997. Lieutenant Colonel Stanley J. Dougherty, U.S. Department of Defense, Alaska Command, personal communication, August 27, 1997. Ed Barubie, Comptroller, U.S. Department of Defense, Alaska Command, personal communication, September 10, 1997. Captain Tanner, Alaska State Troopers personal communication, August 19, 1997. Jerry Bosie, Joint Pipeline Office, personal communication, September 3, 1997.

[72] Sergeant Mike Jones, personal communication, September 10, 1997.

[73] *Ibid*.

- The Alaska Command of the Department of Defense maintains plans for assisting Alyeska security in the event of a hostile action. Likewise, the Federal Bureau of Investigation maintains plans for responding to terrorist activities involving the pipeline.[74]

- The Defense Investigative Service of the Department of Defense performs vulnerability assessments of industrial facilities that are considered essential to the nation's defense. Once its assessments are completed, the Department of Defense develops plans to defend the individual facilities. As of six years ago, the Department of Defense had nominated several TAPS facilities for "key asset" designation.[75] Defense Investigative Service personnel were unwilling to confirm whether these facilities had ultimately been designated.[76]

- The Department of Defense's Alaska Command conducted training exercises in 1985, 1987, and possibly in other years under Operation Brimfrost for the Alaska pipeline's defense.[77] Operation Brimfrost was replaced by Operation Northern Edge in 1993. Although the Alaska Command has not conducted pipeline defense exercises under Northern Edge, it initiated harbor defense exercises in 1995. Valdez, the transfer point for oil from the pipeline to tankers, is one of the ports that has been used for these harbor defense exercises.[78]

While some of these activities may have involved oil-related infrastructure simply because they provided a useful stage for training missions, others are clearly baseline support related to oil security. Unfortunately, much of the data needed to assess the spending on oil-related activities is unavailable. As a result, we were not able to prepare a quantitative estimate.

[74] U.S. General Accounting Office, *Trans-Alaska Pipeline: Ensuring the Pipeline's Security*, pp. 5 and 15.

[75] *Ibid.*

[76] Leslie R. Blake, the Manager of the Defense Investigative Service's Office of FOIA & Privacy responded to our request for information, but that response did not address our questions. She forwarded our request to the Commander of the U.S. Forces Command at Fort McPherson, Georgia. We did not receive any response from that organization. Leslie R. Blake, Manager, U.S. Department of Defense, Defense Investigative Service, Office of FOIA & Privacy, personal communication, September 12, 1997.

[77] U.S. General Accounting Office, *Trans-Alaska Pipeline: Ensuring the Pipeline's Security*, p. 11.

[78] Lieutenant Colonel Stanley J. Dougherty, personal communication, August 27, 1997. Ed Barubie, personal communication, September 10, 1997.

4.3 STRATEGIC PETROLEUM RESERVE

Many sectors of the U.S. economy are dependent on oil, and much of this oil is imported. An absence of alternative fuels makes the nation's economy vulnerable to rapid changes in the price and availability of crude. As noted by DOE's Deputy Secretary, "Disruptions in global oil markets and energy price shocks have been followed by recessions three times in the past 25 years."[79]

The Strategic Petroleum Reserve (SPR) was initiated in 1975 with the stated mission of protecting the United States from oil supply shocks that could potentially result from political, military, or natural causes. As of 1995, the existing storage capacity within the Strategic Petroleum Reserve was 680 million barrels, with a drawdown capacity (i.e., rate at which oil can be removed) of 3.9 million barrels per day.[80] By protecting consumers and refiners from oil market disruptions, SPR reduces both the need for private sector entities to establish their own inventories and the incentives for oil consumers to increase their ability to shift fuels in times of oil shortages.

4.3.1 Estimating the Annual Subsidy to SPR

The cost of SPR is commonly depicted in government publications as comprising the cost of building and maintaining the storage facilities, operating the facilities on a day-to-day basis, and purchasing oil. While all of these items are important cost elements, they present only a small part of the real cost of SPR to taxpayers.

As shown in Exhibit 4-3, we estimate the cost of providing SPR between $1.6 and $5.4 billion for 1995. These estimates are based on two different approaches. The first is an annualized cost approach that assumes SPR can write off its unpaid interest each year instead of accumulating greater debt. Depending on the interest rate used, this approach yields estimates of $1.6 billion to $2.2 billion for 1995. The largest single component of these costs is the imputed interest charges on the more than $16 billion spent to purchase oil since 1976. The second largest cost item is the financing cost on funds invested to build and maintain the capital infrastructure. Neither of these cost elements are accounted for in the government's financial reports.

[79] Elizabeth Anne Moler, Deputy Secretary, U.S. Department of Energy, testimony before the House Subcommittee on Energy and Power of the Committee on Commerce, September 16, 1997, obtained from http://www.fe.doe.gov/remarks/916moler.html, February 25, 1998.

[80] This capacity was reduced from 750 million barrels and a drawdown of 4.5 million barrels per day due to the closure and decommissioning of the Weeks Island storage facility. See U.S. Department of Energy, *Strategic Petroleum Reserve Annual Report*, February 15, 1996, p. 6.

Exhibit 4-3

STRATEGIC PETROLEUM RESERVE SUBSIDIES TO OIL, 1995
(Millions of Dollars)

	Annualized Cost to Treasury	Annualized Value to Private Sector	Cost to Treasury with Compounded Interest
Management Cost	17	17	17
Facilities Operating Cost	68	68	68
Capital Depreciation (Note 1)	81	113	81
Imputed Interest Charge on Gross Capital Investment (Note 2)	208	304	
Loss (Gain) on 1995 Oil Sales	0	0	0
Imputed Interest Charge on Working Capital for Oil Inventory (Note 2)	1,187	1,737	
Incremental Compounded Interest on New Investment During 1995 (Note 3)			5
Incremental Compounded Interest on Principal and Accrued Interest During 1995 (Note 3)			5,257
Summary of Subsidy Estimates (Note 4)	**1,560**	**2,238**	**5,427**

Notes:

(1) Depreciation is based on an asset life of 35 years in the estimate of the cost to the Treasury and 25 years in the estimate of the value to the private sector.
(2) The public cost of capital equals the is based on the 30-year Treasury bond rate. The private cost is based on the weighted average cost of capital for the largest oil refineries.
(3) See Exhibit 4-4 for more information about compounding.
(4) Numbers do not add due to rounding.

Sources:

See Exhibit A-4b for the list of sources used for this analysis.

The second approach recognizes that the Treasury must pay interest each year on SPR's debt, and that it must issue new debt to pay that interest. Thus, SPR's effective cost to taxpayers includes compounding of interest (i.e., interest accruing on unpaid interest). Using this approach, we estimate the upper bound cost of SPR in 1995, $5.4 billion. As shown in Exhibit 4-3, interest charges account for virtually all of SPR's cost under this approach.

In the remainder of this chapter, we explain in greater detail how we developed each of these estimates.

4.3.2 Annualized Cost to Build and Operate the SPR

Federal accounting for SPR is done on a cash basis. Each year, funds appropriated by Congress are reported in one of three main SPR accounts: storage facility development, management, and oil acquisition. This approach is useful in assessing the cash investment within a particular year, but provides little information on the full annualized cost of SPR to taxpayers. To estimate this annualized cost, we have adjusted many of the data elements provided in SPR's Annual Report and developed estimates for data not provided. Each element of our analysis is described below. This analysis results in SPR subsidy estimates between $1.6 and $2.3 billion in 1995.

4.3.2.1 Storage Facility Development

SPR's Storage Facility Development account is used to purchase physical capital lasting for multiple years. The account includes both capital and operating costs, though these have not been broken out in SPR's financial statements. Based on conversations with reserve staff, we estimate that at least 30 percent of the costs incurred were for operations. For the 70 percent that were capital costs, we use the standard methods of accounting to spread the costs of capital purchases over time based on the annual depreciation (or wearing out) of the capital assets[81]. Our low estimate assumes assets last 35 years, while our high estimate assumes assets last only 25 years, and thus have a higher annual depreciation charge[82].

[81] Marycarol Shannahan, Strategic Petroleum Reserve, personal communication, April 27, 1998. The capital share was close to 100 percent of costs in 1976, dropping to roughly 30 percent in 1991 prior to the beginning of renovations. After 2000, the capital share is expected to be less than 10 percent of the facility account.

[82] The appropriate asset life of SPR appears closer to the short end of this range. Construction on SPR began in 1976; in 1991, only 15 years later, major renovations began to repair and upgrade the Reserve. Work is expected to be completed in 2000, and these investments are anticipated to last until 2025. Shannahan, personnel communication.

4.3.2.2 Oil Acquisition

The largest cost item in any single year is the purchase of crude oil for the reserve and its transportation to SPR sites. Our assumption is that this oil will eventually be sold. Thus, we do not count the funds spent on oil as a subsidy. Rather, when sales have occurred, we compare the sale price to the purchase price of the oil to estimate the nominal gain or loss on that sale.

4.3.2.3 Imputed Interest

In the private sector, unless a company's investments can grow at least as fast as the interest rate over the long-term, a private enterprise will lose money and go out of business.[83] Thus, oil held in an inventory must grow in value at the rate of interest -- or must protect such a rate of growth in other parts of the company that would otherwise be harmed if oil were not continuously available.

Many discussions of the cost of SPR focus only on annual appropriations for oil purchases and facility construction and maintenance, implicitly treating the government investment as "free" money. However, with the United States running a budget deficit during the entire duration of SPR's existence, the government has had to issue additional debt in the form of Treasury bonds to develop and operate SPR, and it must pay interest on that debt. These are real costs to U.S. taxpayers that are directly attributable to SPR; however the government omits them from SPR's reported costs.

We estimate these interest costs in two ways. First, we use the government's long-term Treasury bond interest rate (since SPR is a long-term investment). This estimates SPR's hidden cost to the taxpayer. Second, we calculate the cost of the capital if SPR were owned and operated by the private sector instead of a service provided by the government. For this calculation, we use the weighted average cost of capital (WACC) for the largest oil refining companies because low cost government debt would not be available.[84] This second approach estimates not only the hidden interest costs of SPR, but the benefit to oil markets of having this service publicly provided.

[83] Firms can, and do, survive for short periods of time without fully recovering their fixed costs of operations.

[84] We use a 5-year rolling average rate from the 30-year Treasury bond to reflect the ability to refinance debt in a market with falling interest rates. A 5-year average is used because debt can not always be refinanced immediately, and doing so is not costless. We were unable to calculate a 5-year rolling average for the private financing cost because data were not available. Instead, we assume all debt is held at 1995 interest rates. This assumption reduces our subsidy value, since 1995 rates were lower than in the previous years. Our use of the WACC for the largest oil refiners also reduces our estimate, since interest charges for smaller firms would have been even higher.

4.3.2.4 Miscalculating the Market: Declines in Asset Value

Changes in the value of past investments can complicate the analysis of SPR's annual costs. When a private firm determines that particular assets are now worth less than what they paid for them (net of depreciation), they write these assets down to reflect a best estimate of their current value. These write-downs improve the accuracy of the firm's reported financial results, but generally do not change the original financing obligations entered into in order to purchase those assets in the first place.[85] Consider the purchase of a new automobile, for which the buyer obtains a $15,000 loan. The individual may ruin the car in an accident the next day, but still must repay the loan.

SPR has two situations where asset write-downs would be appropriate, though the program does not appear to have explicitly done so:

- **Decline in the Value of Oil Inventory.** The average acquisition cost per barrel of oil added to SPR between 1976 and 1995 was $27.30. The market price of that oil in 1995 was only $17.20 per barrel, suggesting a capital loss on oil acquisition of nearly $6 billion -- even excluding the time-value of money This is currently a paper loss, as theoretically the price of oil could rise to $27 per barrel or higher prior to when it is actually sold. We have counted only losses on actual sales in our subsidy estimates, not paper losses due to the declining market price for crude, because crude prices continue to fluctuate over a fairly wide margin. However, it may be appropriate for the SPR program to write down its inventory more formally if price projections indicate full recovery of the purchase price is unlikely. If oil inventory had been depreciated each year of the 1976 to 1995 period to reflect the decline in its market value, the reported cost of the SPR program in 1995 would have increased by about $300 million.[86]

- **Defunct Physical Assets.** SPR consists of five large underground storage facilities for oil. In 1995, one of these facilities, Weeks Island, was permanently closed due to problems with oil leakage and the potential for environmental contamination. With 9.3 percent of the SPR's total storage

[85] Private equity investors may bear the brunt of such write-offs through reduced share values and deferred dividend payments. To the extent that share values fall and equity investors lose money, future borrowing costs are likely to rise.

[86] Marginal analyses of the cost of SPR, such as conducted by Mark Delucchi for the Union of Concerned Scientists, do not evaluate these costs because they estimate the savings in SPR costs from today going forward if motor vehicle use were curtailed or eliminated. Thus, the starting point for such analyses is today, instead of 1976, and all past subsidies for facility construction, oil acquisition, and accrued interest are ignored. While appropriate for marginal decision making, such an approach does not accurately measure the full taxpayer cost of SPR over time. See Roland Hwang, *Money Down the Pipeline: Uncovering the Hidden Subsidies to the Oil Industry*, Union of Concerned Scientists, September 1995, pp. B-1 to B-3.

capacity, the implied capital write-off is at least $237 million.[87] Increasing past annual depreciation deductions so that Weeks Island would be worth zero in 1995 would add about $12 million per year to our subsidy estimate.

4.3.2.5 Return on Investment

The U.S. government is a non-profit entity, and therefore does not seek a return on its investment in SPR. This investment, totaling nearly $20 billion with no expected payback for decades, entails substantial financial risks. If SPR were privately owned and operated, private investors would require compensation in the form of a return on their investment for taking on those risks. The fact that SPR is provided by the government rather than the private sector increases the value of the subsidy enjoyed by oil consumers. We have not estimated these additional savings to oil consumers in our analysis.

4.3.3 Cost of SPR Including Compounding of Interest

Interest payments were the largest components in the estimate of SPR's annual cost of operations shown above. Implicit in the calculations was the write-off of each year's interest bill. In reality, this is not what happens. When individuals take out a loan from a bank to buy a $15,000 car at 10 percent interest, they must pay 10 cents per year in interest for every dollar borrowed, or roughly $1,500.[88] If they fail to pay the interest in the first year, it is capitalized (i.e., added to the original amount borrowed), increasing the total debt to $16,500. Thus, in the second year of operations they would owe the bank not only interest on the original $15,000, but interest on the $1,500 in unpaid interest from the previous year. The process of paying (or earning) interest on accrued interest is called compounding.

It is worth considering compounding when assessing the cost of SPR. Given the government's fiscal deficits throughout SPR's life, the Treasury had to issue debt to provide SPR's funding, and it had to pay interest on that debt. To pay the interest, the Treasury would have needed either to receive compensation for its investment or to issue more debt, effectively requiring it to pay interest on accrued interest. As the purpose of issuing the debt in the first place was to fund SPR, this compounding of interest would be directly attributable to SPR as well.

[87] This amount is equal to 9.3 percent of our low estimate for the remaining undepreciated capital in 1995. In fact, facility development costs are unlikely to be linearly related to the storage capacity. Rather, costs per barrel are likely to be lower for larger facilities. This suggests that the appropriate Weeks Island write-off would be higher than its share of total storage capacity.

[88] The exact amount will depend on the number of times per year interest is calculated, and the number of times per year payments are made on the debt, both of which affect the annual interest charge.

If the Treasury fully accounted for SPR's costs, it would have treated investments in SPR as formal debt obligations between the program and the Treasury, and charged SPR interest to cover the actual costs incurred by the Treasury for its debt. Thus, interest would have been calculated at the Treasury's cost of long-term borrowing (since SPR requires long-term funds), measured by the average 30-year Treasury Bond rate. To pay the interest and principal on the original investment, SPR would have collected a "price-shock insurance premium" in the form of a user fee from oil consumers. If the program did not repay the interest on its debt, the unpaid interest would have been added to its overall debt burden, and the program would have begun to pay interest on both the original debt and the accumulated unpaid interest. Thus, if the Treasury fully accounted for its investment in SPR, its costs would include compounding of unpaid interest.

SPR has paid off none of its principal and none of its accrued interest since its inception. The few oil sales it has implemented have been at prices below its average oil acquisition cost, yielding capital losses. The billions of dollars tied up in SPR for as long as 20 years, with interest compounded on unpaid interest from earlier periods, provides a proxy for the total public cost of SPR if treated as a formal enterprise during its lifetime through 1995.

We used this approach to provide an alternative estimate to the annualized cost method described above. It mirrors the financial flows that the federal government actually incurred. Funds put into SPR required the issuance of Treasury Bonds, on which taxpayers paid debt. Interest not paid throughout this period required the issuance of still more debt. Exhibit 4-4 illustrates the impact of the compounding process, and shows that the interest cost alone on the accrued debt was more than $5.2 billion in 1995, far higher than our high annualized cost estimate of $2.3 billion. As principal and accrued interest increase over time, the growth in interest charges accelerates. Thus, the incremental addition to debt in 1995 greatly exceeds that during 1979 ($360 million), when the total unpaid balance was much smaller.

As is also shown in Exhibit 4-4, SPR's total debt from direct investment and compounded interest on unpaid debt was $74.7 billion in 1995. In comparison, the value of SPR's tangible assets in that year was only $10.2 billion in oil inventory (valued at the 1995 market price) and capital assets with a book value of about $1.9 billion.[89]

[89] Although the book value of capital assets may not be an accurate representation of the market value of the assets in question, we had no data with which to assess the market value. Depending on the value of alternative uses of the storage capacity, the book value may be more or less than the actual market value of the assets.

Exhibit 4-4

FULL TAXPAYER COST OF INVESTMENT IN SPR ENTERPRISE, 1976-1995
(Millions of Dollars)

A. Annual Growth in Compounded Interest

Year	Starting Principal and Accrued Interest	New Investment (Note 1)	Government Cost of Capital (Note 2)	Effective Annual Interest Rate (Note 2)	Interest on Existing Debt	Interest on New Investment (Note 1)	End-of-Year Principal Plus Interest
1976	0	314	7.61%	7.88%	0	11	325
1977	325	448	7.68%	7.96%	26	16	815
1978	815	3,182	7.95%	8.25%	67	119	4,183
1979	4,183	3,007	8.28%	8.60%	360	117	7,667
1980	7,667	(2,000)	8.88%	9.25%	709	(83)	6,292
1981	6,292	3,333	10.05%	10.52%	662	158	10,445
1982	10,445	3,875	11.05%	11.63%	1,214	202	15,737
1983	15,737	2,316	11.59%	12.22%	1,924	127	20,104
1984	20,104	809	12.21%	12.92%	2,598	47	23,558
1985	23,558	2,509	12.12%	12.81%	3,019	144	29,229
1986	29,229	108	10.98%	11.55%	3,377	6	32,720
1987	32,720	147	10.15%	10.64%	3,480	7	36,354
1988	36,354	603	9.71%	10.15%	3,690	28	40,674
1989	40,674	415	8.91%	9.29%	3,778	17	44,885
1990	44,885	564	8.48%	8.82%	3,957	22	49,428
1991	49,428	309	8.55%	8.89%	4,396	12	54,146
1992	54,146	273	8.37%	8.69%	4,708	11	59,137
1993	59,137	51	7.89%	8.18%	4,840	2	64,029
1994	64,029	207	7.68%	7.95%	5,092	7	69,335
1995	69,335	136	7.33%	7.58%	5,257	5	74,732

Notes:

(1) New investment includes all funding to SPR in a given year, including capital, oil purchases, and management costs. Within an enterprise, all of these elements must be financed either through revenues, debt, or equity. Interest calculations assume investment funds are provided in twelve equal installments.

(2) We use a five year rolling average of 30-year Treasury bond rates to calculate the interest accrual on outstanding debt. This allows for debt refinancing in the case of falling interest rates (which we assume to be costless). The effective annual rate assumes monthly compounding. Were debt instead held to term at the initial interest rates, total program costs through 1995 would have been approximately $12 billion higher.

B. Aggregate Taxpayer Cost of SPR, 1976-1995

Liabilities in 1995	
Cumulative Invested Funds, All Purposes (i.e., Debt)	20,606
Compounded Interest	54,126
Total Liabilities	74,732
Assets in 1995	
Market Value of Oil (Note 3)	10,195
Sale Price Premium (Note 4)	5,097
Estimated Book Value of Capital Assets, Net of Depreciation (Note 5)	1,932
Total Assets	17,224
Total Apparent Taxpayer Loss on SPR Investment through 1995	57,508

Notes:

(3) The 1995 market value of SPR's oil inventory is the product of SPR's end-of-year inventory (591.7 million barrels) and the 1995 average refinery acquisition cost ($17.23/bbl).

(4) The sale price premium assumes that the oil will be sold during periods of short supply when sale prices are higher than now. We assume that the oil would be sold if prices increased by 50 percent.

(5) The market value of SPR's capital assets may be higher or lower than the book value, but adequate data were not available to estimate it.

(6) The total apparent taxpayer loss for SPR is base on debt incurred for capital investments into SPR plus the compounding of unpaid interest on that debt. As the amount of debt accumulates over time, new interest charges increase in value. Incremental debt incurred in 1995 reflects the amount of new interest charged on the accumulated debt in 1995.

Sources:

See Appendix Exhibit A-4b for a list of the sources used in this analysis.

The value of oil inventory shown above fluctuates with market prices. Because SPR sales tend to occur at times of price shocks (when prices rise), the non-crisis price of oil may not be the best indicator of the Reserve's value. Our calculation ascribes a 50 percent price premium to adjust for this factor.[90] With this premium, the value of the oil inventory rises to $15.3 billion, and the value of the assets plus inventory reaches $17.2 billion.

Based on SPR's estimated debt and assets in 1995 ($74.7 billion and $17.2 billion respectively), the government's investment yielded a loss of $57.5 billion from the program's inception through 1995. This "loss" can be viewed as a proxy for the full cost to U.S. taxpayers of SPR's protection against economically damaging price spikes. As shown in Exhibit 4-3 the Exhibit 4-4: SPR Subsidy with compounding incremental cost in 1995 was $5.4 billion. As with the annualized cost approach, this estimate does not include declines in asset values, capital write-offs, or the incremental benefits to consumers of having SPR provided by a non-profit entity.

4.3.4 Strategic Petroleum Reserve Results and Summary

Maintaining a large supply of oil is far more expensive than SPR's annual reports imply. We estimate a range value for this cost of $1.6 to $5.4 billion per year, excluding unrecognized declines in asset and inventory values. The large subsidy value is due to the billions of dollars in capital that are invested in an enterprise, but do not produce income for long periods of time.

Our analysis does not attempt to answer the question of whether this program is a good or a bad investment. Even at $5.4 billion per year, SPR may be a cost-effective way for the country to protect against the many undesirable economic impacts of oil supply disruptions. Shifting full responsibility for this function to private firms may not be a feasible alternative. Because many benefits of price stability accrue to oil consumers rather than producers, it is unlikely that individual producers would voluntarily establish adequate oil stockpiles to provide the level of protection now provided by SPR. Thus, it is possible that SPR can only exist as a government service. Nevertheless, the full cost of providing this service, including financing costs, should be borne by oil consumers, rather than the general taxpayer.[91] As with the defense costs described earlier in this chapter, charging the costs directly to oil consumers will contribute to more accurate price signals that promote increased conservation and a shift to alternatives.

[90] While severe supply disruptions could drive up the market price of oil by more than 50 percent, the limited drawdown capacity of the reserves (3.9 million barrels per day) means that it would take four to six months to fully put SPR oil on the market. This would reduce the Reserve's ability to capitalize on the largest prices spikes, which do not tend to last that long. In addition, since the purpose of the reserve is to reduce the price spike, sales are likely to be aimed more at reestablishing price stability than maximizing sale revenues.

[91] DOE notes that the "United States is unique among oil stockpiling countries in assigning all of the cost of the Reserve to the general taxpayer. Most other stockpiling countries partially shift the cost burden to the oil industry by requiring that their oil companies maintain inventories in excess of working needs." U.S. Department of Energy, Office of Strategic Petroleum Reserve, "Opportunity for Public Comment on Strategic Petroleum Reserve Policy," *Federal Register*, April 24, 1997, obtained from http://www.fe.doe.gov/spr/sprfedrg.html on March 5, 1998.

4.4 SUMMARY

Disruptions in the supply of oil and increases in oil's price can have enormous deleterious impacts on both the U.S. and global economies. As DOE's Deputy Secretary pointed out, price shocks and supply disruptions have been followed by recessions three times in the past 25 years.[92] To protect the U.S. economy, the Department of Defense spends billions of dollars each year to ensure a stable flow of oil from the Persian Gulf, and the Department of Energy spends billions more to maintain a stockpile of oil in the Strategic Petroleum Reserve. We estimate that these measures cost $12 billion to $29 billion in 1995. Because these costs are borne by the general taxpayer, they are not reflected in the price of oil, preventing energy markets from functioning properly. Oil supply security is by far the largest area of subsidies to oil. Unless the costs of this security are borne directly by oil producers and consumers through additional user fees on oil, large distortions in energy markets and uninformed decision-making will continue.

[92] Moler, 1997.

Exhibit A-4a
BACKGROUND INFORMATION ON SOURCES OF DEFENSE ESTIMATES

Ravenal, 1991
(1992 Dollars)

Ravenal derived an estimate for defense spending in the Persian Gulf by allocating DoD's budget for general purpose forces according to the geographic distrubution of the military's active force structure. He derived separate estimates for the peacetime deployment in the region, and separate risk premiums for the expected costs (based on estimated costs and probabilities) of both conventional war and a nuclear war. The risk premium for conventional war is based on the estimated incremental defense cost, above peacetime spending, that would result. The risk premium for a nuclear war is calculated based on the estimated impacts on the national economy. Exhibit 1 reports the peacetime estimate and the sum of the peacetime and risk premium estimates. We do not include this portion of Ravenal's risk premium for nuclear war because it does not represent DoD spending.

	1992 Defense Budget (Billions of Dollars)	Share
Strategic Nuclear Forces	63	22.7%
General Purpose (Conventional and Tactical Nuclear) Forces	215	77.3%

Peacetime Estimate

	Peacetime Deployment of Active Land Divisions	Share of Divisions	Notes
Europe	7.3	43.1%	
East Asia	3	17.6%	
Other Regions and Strategic Reserve	6.7	39.2%	Includes the Persian Gulf
Worldwide	17		

Persian Gulf share of Other Regions and Strategic Reserve	60%	
Persian Gulf share of total General Purpose Budget	23.5%	(=39.2%*60%)
Persian Gulf Defense	$50 billion	The calculation actually yields a cost of $50.6 billion. Ravenal rounded the percentage of divisions in Other Regions and Strategic Reserve to 39 percent from 39.2, which lowers the estimate to $50.3 billion. He then rounded to the nearest billion.

Risk Premium for Conventional War

Ravenal calculates a risk premium to account for the incremental costs of a conflict in the region. His calculation is based on assumptions about the cost and probability of a conventional war in the region.

Cost Assumption

Conflict would be half the size of the Vietnam War. Size is based on the length and intensity of the conflict.

	Cost ($Billions)
Nominal cost of the Vietnam War	350
Estimate of the cost of the Vietnam War if it occurred at the current time	1,050

Exhibit A-4a
BACKGROUND INFORMATION ON SOURCES OF DEFENSE ESTIMATES

Cost of a 1/2 Vietnam-size war	525

Probability Assumption

Probability of a war over ten year period	10%

Risk Premium

Cost	525
Probability	10%
Risk Premium over 10yr period	52.5

Annualized Risk Premium	5.3

Source: Ravenal, Earl C. *Designing Defense for a New World Order: The Military Budget in 1992 and Beyond*. Washington, D.C.: Cato Institute. 1991.

Ravenal, 1995
(1995 dollars)

Ravenal derived an estimate for defense spending in the Persian Gulf using the same methodology as he used for his 1991 analysis (see above). His updated numbers indicate that the military's strategic nuclear forces had declined since the 1992 budget. Whereas general purpose forces previously accounted for about 78 percent of DoD's budget, in 1995 they accounted for 84 percent. The geographic distribution of combat units also shifted between the 1992 and 1995 budgets. The number of land divisions in the Persian Gulf stayed increased from four to five, but the total number of active land divisions declined from 17 to 15. Thus, the Persian Gulf's share of military resources increased from 24 percent to 33 percent.

	1992 Defense Budget (Billions of Dollars)	Share
Strategic Nuclear Forces	40	16%
General Purpose (Conventional and Tactical Nuclear) Forces	212	84%

Estimate

	Deployment of Active Land Divisions	Share of Divisions
Europe	4	26.67%
Pacific	6	40.00%
Persian Gulf	5	33.33%
Worldwide	15	

Persian Gulf Defense	$70 billion

The calculation actually yields a cost of $70.67 billion. Ravenal rounded the Persian Gulf's share of land divisions to 33 percent, yielding a cost estimate of $69.96 billion. He then rounded that figure to $70 billion.

Source: Ravenal, Earl C. Personal Communication. March 6, 1998.

Ravenal, 1997

Exhibit A-4a
BACKGROUND INFORMATION ON SOURCES OF DEFENSE ESTIMATES

(1997 dollars)

Ravenal derived an estimate for defense spending in the Persian Gulf using the same methodology as he used for his 1991 analysis (see above). His updated numbers indicate that the military's strategic nuclear forces had declined since the 1992 budget. Whereas general purpose forces previously accounted for about 78 percent of DoD's budget, in 1997 they accounted for 89 percent. The geographic distribution of combat units also shifted between the 1992 and 1997 budgets. The number of land divisions in the Persian Gulf stayed increased from four to five, but the total number of active land divisions declined from 17 to 13. Thus, the Persian Gulf's share of military resources increased from 24 percent to 39 percent.

	1992 Defense Budget (Billions of Dollars)	Share
Strategic Nuclear Forces	26	10.7%
General Purpose (Conventional and Tactical Nuclear) Forces	217	89.3%

Estimate

	Deployment of Active Land Divisions	Share of Divisions
Europe	3	23.08%
Pacific	5	38.46%
Persian Gulf	5	38.46%
Worldwide	13	

Persian Gulf Defense	$82 billion

The calculation actually yields a cost of $83.5 billion. Ravenal rounded the Persian Gulf's share of land divisions to 38 percent, yielding a cost estimate of $82.46 billion. He then rounded that figure to $82 billion.

Source: Ravenal, Earl C. *The 1998 Defense Budget*. Chapter 7 in *The Cato Handbook for Congress*. Washington, D.C.: The Cato Institute. 1997. Obtained from http://www.cato.org/pubs/handbook/hb105-7.html, February 20, 1998.

Kaufmann and Steinbruner
(1992 Dollars)

Kaufmann and Steinbruner base their estimate on FY1990 defense budget authority and the geographic distribution of the military's force structure. Like Ravenal, they do not include strategic nuclear forces in their estimate. However, unlike Ravenal, they exclude tactical nuclear forces as well. Although they provide a qualitative analysis of the military's major strategic considerations worldwide, they give little data on the distribution of U.S. forces or the steps they took to arrive at their estimate of the Middle East's share of spending ($64.5 billion). In their report, they indicate that the U.S. had deployed three carrier battle groups and one Marine amphibious force in the Persian Gulf. Ravenal also reported a deployment of three carrier battle groups in his description of the FY1992 peacetime deployment, compared to the six carrier groups in the area during the Persian Gulf war. Thus, Kaufmann and Steinbruner's estimate may also be for routine peacetime spending.

Source: Kaufmann, William W. and John D. Steinbruner. *Decisions for Defense: Prospects for a New World Order*. Washington, D.C.: The Brookings Institution. 1991.

Copulus
(1988 Dollars)

In his analysis of oil-related military spending in the Persian Gulf, Copulus wrote, "According to the Pentagon, in 1988 some $40 billion was included under the category 'Gulf Contingencies' in the Defense Department's budget." (p. 26) He does not identify the source of his data.

Exhibit A-4a
BACKGROUND INFORMATION ON SOURCES OF DEFENSE ESTIMATES

Source: Copulus, Milton R. *Answering America's Energy and Environmental Dilemma*. The National Defense Council Foundation. 199

GAO / CRS
(1990 Dollars)

The General Accounting Office reports DoD's estimates for defense spending related to Southwest Asia during the period 1980 through 1990. The definition of Southwest Asia used in the report comprises the Middle East, Kenya, Somalia, and Sudan. DoD classifies spending in three categories: dedicated, oriented, and contingency programs. Dedicated programs were driven by objectives in Southwest Asia. Oriented programs were motivated by objectives in that region as well as other regions. Contingency programs were motivated by interests outside of Southwest Asia, but are useful for meeting objectives in that region.

In its report, CRS uses GAO's findings to develop a marginal cost estimate by summing only those costs that DoD said would not occur in the absence of objectives in Southwest Asia. CRS also includes an estimate of incremental costs for conflicts that occurred during the decade of analysis, but these costs are excluded from the figure we report because they do not represent baseline. We then annualize the remaining costs.

The total cost estimate is the annualized sum of all dedicated, oriented, and contingency programs related to Southwest Asia that are included in the GAO report. DoD acknowledges that all of these programs have been useful for fulfilling its mission in Southwest Asia, although it claims many of the programs would still exist in the absence of that mission.

Marginal Costs for Meeting Southwest Asia Objectives

	Cost ($Billions)
- Military construction in Bahrain, Kenya, Oman, and Somalia	0.4
- Afloat prepositioned ships	1.6
- Air Force prepositioning and bare-base support	1.0
- Central Command headquarters	0.6
- Training	0.6
- Joint combined exercises	0.3
11yr total	**4.5**
Annualized marginal cost	0.4

Other Costs Related to Southwest Asia (DoD claims would occur even if no mission in Southwest Asia)

	Cost ($Billions)
Dedicated Programs	
- Maritime prepositioned squadron at Diego Garcia	0.8
- Aircraft carrier battle group in Indian Ocean	16.1
11yr Subtotal	16.9
Oriented Programs	
- Military construction in Diego Garcia, the Azores, and Morocco	0.7
- Fast sealift ships	1.2
- Ready Reserve Force	1.0
- Flat racks and sea sheds	0.4
- Logistics over shore	0.8
- Maritime prepositioned squadron	1.7
11yr Subtotal	5.8

Exhibit A-4a
BACKGROUND INFORMATION ON SOURCES OF DEFENSE ESTIMATES

Contingency and Mobility Programs

- Marine Corps aviation support ships	0.1
- Hospital Ships	0.7
- Strategic airlift	49.5
- Conventional B-52s	2
- Forces available to the Central Command	220.3
11yr Subtotal	272.6
Total of all categories of programs, including marginal costs	299.8
Annualized total cost	27.3

Military and Economic Assistance Costs for Southwest Asia (not counted in our oil-defense estimate)

	Cost ($Billions)	
- Foreign military financing program expenditures	30.3	(grant funds and forgiven, canceled, and concessional loans)
- Military assistance program	0.5	
- International military and education training program expenditures	0.1	
- Bilateral economic assistance expenditures	28.3	(Economic Support Fund and Development Assistance administered by the Agency for International Development and food assistance)
- Multilateral assistance	6.6	
11yr Subtotal	65.8	
Annualized assistance cost	6.0	

Sources: U.S. Congressional Research Service. *The External Costs of Oil Used in Transportation*. CRS Report for Congress. 92-574 ENR. June 17, 1992.
U.S. General Accounting Office. *Southwest Asia: Costs of Protecting U.S. Interests*. GAO/NSIAD-91-250. August 1991.

Exhibit A-4b

DEPARTMENT OF ENERGY
Strategic Petroleum Reserve
(millions of dollars)

Year	Constants		1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
I. SPR Annualized Cost of Operations - Assuming Annual Interest Write-off																						
High Estimate: Value to Private Sector																						
Management Costs			16.8	15.8	14.2	13.4	12.8	13.0	13.4	12.3	13.4	13.5	17.9	16.4	19.6	20.1	19.4	22.3	18.1	14.7	7.8	14.0
Operating Costs on Facilities Acct.			68.1	57.3	48.6	51.5	56.3	53.9	48.0	45.6	40.2	32.1	132.4	42.7	66.8	52.7	32.5	0.0	189.8	139.2	0.0	90.0
Capital Depreciation (25-year)			113.3	107.4	102.5	97.8	92.8	87.6	82.9	78.5	74.5	71.1	63.4	55.3	50.2	44.6	40.6	39.1	30.2	14.9	8.4	4.2
Imputed interest charge on capital at private sector rates			303.7	304.5																		
Loss (Gain) on Oil Sales			0.0	0.0	0.0	0.0	146.5	0.0	0.0	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imputed interest charge for working capital to finance oil inventory at private sector rates			1,736.7	1,842.8																		
Total			**2,238.5**	2,327.9																		
Low Estimate: Cost to Government																						
Management Costs			16.8	15.8	14.2	13.4	12.8	13.0	13.4	12.3	13.4	13.5	17.9	16.4	19.6	20.1	19.4	22.3	18.1	14.7	7.8	14.0
Operating Costs on Facilities Acct.			68.1	57.3	48.6	51.5	56.3	53.9	48.0	45.6	40.2	32.1	132.4	42.7	66.8	52.7	32.5	0.0	189.8	139.2	0.0	90.0
Capital Depreciation (35-year)			80.9	76.7	73.2	69.8	66.3	62.6	59.2	56.1	53.2	50.8	45.3	39.5	35.8	31.8	29.0	27.9	21.6	10.6	6.0	3.0
Imputed interest charge on capital at government rates			207.5	206.1	202.2	204.5	198.3	185.7	184.7	190.5	189.0	195.3	192.2	168.8	145.3	123.2	102.0	86.8	62.6	29.6	16.1	8.0
Loss (Gain) on Oil Sales			0.0	0.0	0.0	0.0	146.5	0.0	0.0	0.0	0.0	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imputed interest charge for working capital to finance oil inventory at government rates			1,187.0	1,247.1	1,287.2	1,366.0	1,387.7	1,355.6	1,398.0	1,489.1	1,535.0	1,661.8	1,710.0	1,558.7	1,321.0	941.7	510.5	398.6	357.9	142.4	16.9	0.0
Total			**1,560.2**	1,603.0	1,625.3	1,705.3	1,867.9	1,670.7	1,703.2	1,793.5	1,830.8	1,968.8	2,097.8	1,826.1	1,588.5	1,169.5	693.3	535.6	650.0	336.6	46.8	115.0
II. Data Inputs to Annualized Cost Estimate																						
A. Invested Capital																						
New Funding: Storage Facility Development & Ops.			226.9	191.0	161.9	171.7	187.7	179.5	160.0	151.9	134.0	107.0	441.3	142.4	222.5	175.7	108.2	0.0	632.5	463.9	0.0	300.0
Est. Operating Share	30%		68.1	57.3	48.6	51.5	56.3	53.9	48.0	45.6	40.2	32.1	132.4	42.7	66.8	52.7	32.5	0.0	189.8	139.2	0.0	90.0
Est. Capital Share	70%		158.9	133.7	113.4	120.2	131.4	125.7	112.0	106.3	93.8	74.9	308.9	99.6	155.8	123.0	75.7	0.0	442.8	324.8	0.0	210.0
Total Invested Capital			2,910.7	2,751.9	2,618.2	2,504.8	2,384.6	2,253.2	2,127.5	2,015.5	1,909.2	1,815.4	1,740.5	1,431.6	1,332.0	1,176.2	1,053.2	977.5	977.5	534.8	210.0	210.0
Mid-year Gross Capital Base for (F) calculation of interest charges			2,831.3	2,685.0	2,561.5	2,444.7	2,318.9	2,190.4	2,071.5	1,962.4	1,862.3	1,778.0	1,586.1	1,381.8	1,254.1	1,114.7	1,015.4	977.5	756.1	372.4	210.0	105.0
Depreciation Period	High Estimate	25	years																			
	Low Estimate	35	years																			
Gross PPE, mid-year new investment			146.3	123.5	116.8	125.8	128.5	118.8	109.2	100.1	84.3	191.9	204.3	127.7	139.4	99.3	37.9	221.4	383.8	162.4	105.0	105.0
Depreciation																						
High Estimate																						
Start-of-year net PPE			1,539.1	1,523.0	1,508.7	1,480.7	1,444.9	1,413.7	1,387.3	1,365.8	1,355.9	1,235.1	1,094.3	1,021.9	932.7	877.9	880.7	698.4	344.9	197.4	100.8	0.0
Mid-year net PPE, including new investment			1,685.4	1,646.5	1,625.4	1,606.5	1,573.4	1,532.5	1,496.5	1,465.8	1,440.3	1,427.0	1,298.6	1,149.6	1,072.0	977.2	918.5	919.8	728.6	359.8	205.8	105.0
Depreciation Charge for New Investments			5.9	4.9	4.7	5.0	5.1	4.8	4.4	4.0	3.4	7.7	8.2	5.1	5.6	4.0	1.5	8.9	15.4	6.5	4.2	4.2
Depreciation Charge for Past Investments			107.4	102.5	97.8	92.8	87.6	82.9	78.5	74.5	71.1	63.4	55.3	50.2	44.6	40.6	39.1	30.2	14.9	8.4	4.2	0.0
Total Annualized Depreciation			113.3	107.4	102.5	97.8	92.8	87.6	82.9	78.5	74.5	71.1	63.4	55.3	50.2	44.6	40.6	39.1	30.2	14.9	8.4	4.2
Net PPE, End-of-Year			1,572.2	1,539.1	1,523.0	1,508.7	1,480.7	1,444.9	1,413.7	1,387.3	1,365.8	1,355.9	1,235.1	1,094.3	1,021.9	932.7	877.9	880.7	698.4	344.9	197.4	100.8
Low Estimate																						
Start-of-year net PPE			1,866.5	1,819.7	1,776.1	1,720.2	1,657.9	1,601.6	1,551.6	1,507.6	1,476.5	1,335.4	1,176.4	1,088.2	984.7	917.2	908.3	714.9	352.7	201.0	102.0	0.0

Exhibit A-4b

DEPARTMENT OF ENERGY
Strategic Petroleum Reserve
(millions of dollars)

Year	Constants	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
Mid-year net PPE, including new investment		2,012.8	1,943.2	1,892.9	1,846.0	1,786.4	1,720.5	1,660.8	1,607.7	1,560.8	1,527.3	1,380.7	1,215.9	1,124.0	1,016.5	946.2	936.3	736.5	363.4	207.0	105.0
Depreciation Charge for New Investments		4.2	3.5	3.3	3.6	3.7	3.4	3.1	2.9	2.4	5.5	5.8	3.6	4.0	2.8	1.1	6.3	11.0	4.6	3.0	3.0
Depreciation Charge for Past Investments		76.7	73.2	69.8	66.3	62.6	59.2	56.1	53.2	50.8	45.3	39.5	35.8	31.8	29.0	27.9	21.6	10.6	6.0	3.0	0.0
Total Annualized Depreciation		80.9	76.7	73.2	69.8	66.3	62.6	59.2	56.1	53.2	50.8	45.3	39.5	35.8	31.8	29.0	27.9	21.6	10.6	6.0	3.0
Net PPE, End-of-Year		1,931.9	1,866.5	1,819.7	1,776.1	1,720.2	1,657.9	1,601.6	1,551.6	1,507.6	1,476.5	1,335.4	1,176.4	1,088.2	984.7	917.2	908.3	714.9	352.7	201.0	102.0
Imputed Interest Charges on PPE Investment																					
Actual Capital Charge Levied on SPR	(H)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
High Estimate																					
Interest Rate Subsidy at Private Sector Cost of Capital	(G)	10.73%	11.34%																		
Annual Imputed Interest Charge	(=G*F)	303.7	304.5																		
Low Estimate																					
Interest Rate Subsidy at Government Cost of Capital	(E)	7.33%	7.68%	7.89%	8.37%	8.55%	8.48%	8.91%	9.71%	10.15%	10.98%	12.12%	12.21%	11.59%	11.05%	10.05%	8.88%	8.28%	7.95%	7.68%	7.61%
Annual Imputed Interest Charge	(=E*F)	207.5	206.1	202.2	204.5	198.3	185.7	184.7	190.5	189.0	195.3	192.2	168.8	145.3	123.2	102.0	86.8	62.6	29.6	16.1	8.0
B. Inventory																					
Cost Basis																					
Petroleum Acquisition & Transport, net of sales proceeds		(107.8)	0.0	(125.6)	88.413	108.5	371.9	242.0	438.7	0.0	(13.0)	2,049.6	650.0	2,074.1	3,679.7	3,205.1	(2,022.3)	2,356.5	2,703.5	440.0	0.0
Cumulative Cost of Purchases, net of sales proceeds	(A)	16,139.2	16,247.0	16,247.0	16,372.6	16,284.2	16,175.8	15,803.8	15,561.8	15,123.1	15,123.1	15,136.1	13,086.5	12,436.5	10,362.4	6,682.7	3,477.7	5,499.9	3,143.5	440.0	0.0
Mid-year cost basis, for calculation of imputed interest	(B)	16,193.1	16,247.0	16,309.8	16,328.4	16,230.0	15,989.8	15,682.8	15,342.5	15,123.1	15,129.6	14,111.3	12,761.5	11,399.5	8,522.6	5,080.2	4,488.8	4,321.7	1,791.7	220.0	0.0
Year-End Inventory (million bbls)	(C)	591.7	591.7	585.7	571.4	568.5	589.6	577.1	554.7	533.9	506.4	489.3	431.1	361	277.9	199.2	92.8	91.2	49.1	1.1	
Average Acquisition Cost/bbl	(=A/C)	27.3	27.5	27.7	28.7	28.6	27.4	27.4	28.1	28.3	29.9	30.9	30.4	34.5	37.3	33.5	37.5	60.3	64.0	400.0	
Market Basis																					
Average Refinery Acquisition Cost/bbl	(D)	17.2	15.6	16.4	18.4	19.1	22.2	18.0	14.7	17.9	14.6	26.8	28.6	29.0	31.9	35.2	28.1	17.7	12.5	12.0	10.9
Market Value of SPR Inventory	(=C*D)	10,195.0	9,224.6	9,611.3	10,530.9	10,835.6	13,100.9	10,370.5	8,137.4	9,556.8	7,368.1	13,088.8	12,342.4	10,465.4	8,856.7	7,019.8	2,604.9	1,616.1	611.8	13.2	
Capital Gain (Loss) on Inventory	(=C*D-A)	(5,944.2)	(7,022.4)	(6,635.7)	(5,841.7)	(5,448.6)	(3,074.8)	(5,433.4)	(7,424.4)	(5,566.3)	(7,755.0)	(2,047.3)	(744.1)	(1,971.1)	(1,505.8)	337.1	(872.8)	(3,883.9)	(2,531.7)	(426.8)	
Gain (Loss) Realized on Sales																					
Barrels Sold (millions)		0.0	0.0	0.0	0.0	21.1	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sale Proceeds		0.0	0.0	0.0	0.0	457.9	0.0	0.0	0.0	0.0	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Avg. Sale Price per Barrel						21.7					14.6										
Realized Gain (Loss) in Millions		0.0	0.0	0.0	0.0	(146.5)	0.0	0.0	0.0	0.0	(15.3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Imputed Interest Charges on Working Capital Used in Inventory																					
Actual Capital Charge Levied on SPR	(H)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
High Estimate																					
Financing Subsidy at Private Sector Cost of Capital	(G)	10.73%	11.34%																		

Exhibit A-4b

DEPARTMENT OF ENERGY
Strategic Petroleum Reserve
(millions of dollars)

Year	Constants		1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
Annual Interest Charge	(=B*G)		1,736.7	1,842.8																		
Low Estimate																						
Financing Subsidy at Government Cost of Capital	(E)		7.33%	7.68%	7.89%	8.37%	8.55%	8.48%	8.91%	9.71%	10.15%	10.98%	12.12%	12.21%	11.59%	11.05%	10.05%	8.88%	8.28%	7.95%	7.68%	7.61%
Annual Interest Charge	(=B*E)		1,187.0	1,247.1	1,287.2	1,366.0	1,387.7	1,355.6	1,398.0	1,489.1	1,535.0	1,661.8	1,710.0	1,558.7	1,321.0	941.7	510.5	398.6	357.9	142.4	16.9	0.0
		Cumulative	20,872.3																			

III. Cost of SPR as a Formal Enterprise - Including Compounded Interest

A. Aggregate

New Costs																						
New Management Costs			16.8	15.8	14.2	13.4	12.8	13.0	13.4	12.3	13.4	13.5	17.9	16.4	19.6	20.1	19.4	22.3	18.1	14.7	7.8	14.0
New Capital Invested			226.9	191.0	161.9	171.7	187.7	179.5	160.0	151.9	134.0	107.0	441.3	142.4	222.5	175.7	108.2	0.0	632.5	463.9	0.0	300.0
New Oil Transport and Acquisition			(107.8)	0.0	(125.6)	88.4	108.5	371.9	242.0	438.7	0.0	(13.0)	2,049.6	650.0	2,074.1	3,679.7	3,205.1	(2,022.3)	2,356.5	2,703.5	440.0	0.0
Total New Costs			136.0	206.8	50.5	273.5	309.0	564.4	415.4	602.9	147.4	107.5	2,508.7	808.8	2,316.2	3,875.4	3,332.7	(2,000.0)	3,007.1	3,182.1	447.8	314.0
Interest Rates																						
Nominal Rate (5-yr rolling average)		7.04%	7.33%	7.68%	7.89%	8.37%	8.55%	8.48%	8.91%	9.71%	10.15%	10.98%	12.12%	12.21%	11.59%	11.05%	10.05%	8.88%	8.28%	7.95%	7.68%	7.61%
Effective annual rate, monthly accrual	12	7.28%	7.58%	7.95%	8.18%	8.69%	8.89%	8.82%	9.29%	10.15%	10.64%	11.55%	12.81%	12.92%	12.22%	11.63%	10.52%	9.25%	8.60%	8.25%	7.96%	7.88%
Starting Principal + accrued interest			69,335	64,029	59,137	54,146	49,428	44,885	40,674	36,354	32,720	29,229	23,558	20,104	15,737	10,445	6,292	7,667	4,183	815	325	0
Interest on Starting balance			5,257	5,092	4,840	4,708	4,396	3,957	3,778	3,690	3,480	3,377	3,019	2,598	1,924	1,214	662	709	360	67	26	0
Total New Investment			136	207	51	273	309	564	415	603	147	108	2,509	809	2,316	3,875	3,333	(2,000)	3,007	3,182	448	314
Interest on New Costs			5	7	2	11	12	22	17	28	7	6	144	47	127	202	158	(83)	117	119	16	11
End-of-year principal + interest			74,732	69,335	64,029	59,137	54,146	49,428	44,885	40,674	36,354	32,720	29,229	23,558	20,104	15,737	10,445	6,292	7,667	4,183	815	325
Incremental Debt			5,397	5,306	4,892	4,992	4,717	4,544	4,210	4,320	3,634	3,490	5,672	3,453	4,367	5,292	4,153	(1,374)	3,484	3,368	490	325

Total Investment through 1995	20,606		
Total Accrued interest through 1995	54,126		
Compounded value of investment, as of 1995	(J)	74,732	

Value of SPR in 1995

Market value of oil inventory, 1995		10,195	
Price premium allowance on oil sales to reflect change in oil prices and/or premium for selling during times of unrest	50%	5,097	Assumes that oil will be sold during times of market unrest when crude oil prices rise 50 percent higher than now.
Maximum book value of assets (assuming 40-year capital life)		1,932	
Estimated total value of SPR	(K)	17,224	

Net Value

Net losses of SPR if treated as a formal enterprise, including compounded interest	(=J-K)	57,508	
Net "price" paid for oil security if spread evenly from 1976-1995, inclusive	20 years	2,875	

B. Annual Cost of Operating SPR, including Compound Interest

Management Costs			16.8	15.8	14.2	13.4	12.8	13.0	13.4	12.3	13.4	13.5	17.9	16.4	19.6	20.1	19.4	22.3	18.1	14.7	7.8	14.0

Exhibit A-4b

DEPARTMENT OF ENERGY
Strategic Petroleum Reserve
(millions of dollars)

Year	Constants		1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
Operating Costs on Facilities Acct.			68.1	57.3	48.6	51.5	56.3	53.9	48.0	45.6	40.2	32.1	132.4	42.7	66.8	52.7	32.5	0.0	189.8	139.2	0.0	90.0
Capital Depreciation (25-year)			80.9	76.7	73.2	69.8	66.3	62.6	59.2	56.1	53.2	50.8	45.3	39.5	35.8	31.8	29.0	27.9	21.6	10.6	6.0	3.0
Loss (Gain) on Oil Sales			0.0	0.0	0.0	0.0	-146.5	0.0	0.0	0.0	0.0	-15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incremental Interest Charge on New Investment			4.7	7.4	1.9	10.7	12.4	22.5	17.4	27.6	7.1	5.6	144.1	46.8	127.1	202.4	157.8	-83.4	116.8	118.5	16.1	11.2
Incremental Compounded Interest on Principal and Accrued Interest			5,256.5	5,091.6	4,839.7	4,707.6	4,395.7	3,956.7	3,777.6	3,689.8	3,480.0	3,377.2	3,018.7	2,597.8	1,923.7	1,214.5	662.2	709.2	359.9	67.2	25.9	0.0
Total			5,427.0	5,248.8	4,977.6	4,853.1	4,397.0	4,108.6	3,915.6	3,831.3	3,593.9	3,463.9	3,358.5	2,743.2	2,172.9	1,521.5	900.9	676.0	706.2	350.3	55.8	118.2

IV. Cost of Capital Data

High Est. - Corporate Cost of Financing																						
Wgtd. Ave. Large Composite Rate for Petroleum Refining (SIC 291)		10.64%	10.73%	11.34%																		
Effective Financing Subsidy Rate		10.64%	10.73%	11.34%																		
Low Est. - Gov't Cost of Capital																						
Gov't Cost of Borrowing (30 yr T-bond)	(I)	6.71%	6.88%	7.37%	6.59%	7.67%	8.14%	8.61%	8.45%	8.96%	8.59%	7.78%	10.79%	12.41%	11.18%	12.76%	13.45%	11.27%	9.28%	8.49%	7.75%	7.61%
Interest Rate Subsidy	(=I-H)	6.71%	6.88%	7.37%	6.59%	7.67%	8.14%	8.61%	8.45%	8.96%	8.59%	7.78%	10.79%	12.41%	11.18%	12.76%	13.45%	11.27%	9.28%	8.49%	7.75%	7.61%
Five-year rolling average cost of capital (to allow for refinancing)		7.04%	7.33%	7.68%	7.89%	8.37%	8.55%	8.48%	8.91%	9.71%	10.15%	10.98%	12.12%	12.21%	11.59%	11.05%	10.05%	8.88%	8.28%	7.95%	7.68%	7.61%

Sources:

Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin*, June 1997, p. A23.
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Write-off of Weeks Island Storage Facility

Facility	Capacity (mil bbls)	% of total
Bryan Mound	226	30.1%
West Hackberry	219	29.2%
Bayou Choctaw	75	10.0%
Big Hill	160	21.3%
Weeks Island	70	9.3%
Total	750	100.0%

Source: U.S. Department of Energy, *Strategic Petroleum Reserve Annual Report,* February 15, 1996, pp. 6-10.

FUELING GLOBAL WARMING: FEDERAL SUBSIDIES TO OIL IN THE UNITED STATES

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