ENERGY RELATED DEVELOPMENT IN THE COLUMBIA RIVER ESTUARY:

POTENTIAL, IMPACTS, AND MITIGATION

Scott E. Smith

With Contributions By - George V. Blomberg
Duncan W. Thomas
Michael D. DeLapa

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COLUMBIA RIVER ESTUARY STUDY TASKFORCE

P.O. Box 175
Astoria, Oregon 97103
(503) 325-0435

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FIGURES

TABLES

1. INTRODUCTION

This study is intended to provide the necessary information for identification and mitigation of impacts associated with energy related development in the Columbia River Estuary. For the purposes of this study, the Estuary extends from the mouth of the river to River Mile 46, the region covered by the Columbia River Regional Management Plan. This includes riverfront portions of Clatsop County in Oregon and Pacific and Wahkiakum Counties in Washington. This report includes four elements. First, an overview of the existing transportation infrastructure, dredging requirements, and other constraints and opportunities for locating energy facilities in the Columbia River Estuary is provided. This includes a general bulk shipping cost comparison between ports on the Lower Columbia River (River Mile 46 to River Mile 105) and those on the Estuary. Also, information on potential energy related development options is presented. This includes a demand and benefit-cost analysis of coal transshipment, the most likely energy related development at this time, as well as a description of the competitive position of the Lower Columbia River with other west coast ports. The second element identifies potential energy related development sites within the Estuary and describes the most likely areas for deep draft development based on rail upgrade and dredging costs. Third is a description of estuarine impacts associated with selected energy related development options. This includes impacts associated with dredging a deeper channel, impacts to air and water quality and estuarine biota, impacts to the local economy, and impacts to the Columbia River Estuary from coal port development upriver. Finally, local, state, and federal mitigation policy is reviewed, and mitigation strategies for specific energy related development impacts are proposed.

To fulfill these objectives, many sources of data were utilized. Extensive computer modeling is required to accurately determine amounts of dredging that would be required for excavation of a substantially deeper navigation channel and for necessary maintenance dredging. These data are not available. Therefore, existing engineering studies,[7,42,63] U.S. Army Corp of Engineers data,[1,40,45] and information obtained from experts in the field were used to derive quantities and costs for dredging to various sites.

The descriptions of potential energy related development in the Columbia River Estuary were drawn largely from the study <u>Energy Related Use Conflicts for</u>

the Columbia River Estuary.[10] Potential sites within the Columbia River Estuary identified for development were drawn mainly from the Final CREST Mediation Panel Agreements, and the Columbia River Estuary Regional Management Plan.[38,39] The assumption was made that an appropriate planning designation would be a major factor in siting of new facilities in the Estuary region.

Costs of infrastructure upgrading were obtained from previously published reports[6,7] and discussions with the Port of Astoria staff, Burlington Northern engineers, and the Oregon Department of Transportation.

Impacts to the estuarine biota from increased salinity resulting from deepening the navigation channel were based on extrapolations of the U.S. Fish and Wildlife Service Fish and Wildlife Coordination Report Navigation Channel Deepening - Columbia River at the Mouth.[2] Other impact descriptions are drawn from a wide variety of federal, state, private, and university research.

Mitigation policy analysis was derived mainly from the Columbia River Estuary Mitigation Policy Paper,[100] and the resultant framework was used to formulate strategies to mitigate the impacts of energy related development.

This study proposes methods to mitigate for the specific impacts of energy related developments (e.g. coal dust) and other attendant impacts (e.g. increased bank erosion caused by ship wake). Mitigation strategies for site specific dredging and filling and offsite DMD will be considered in a later report.

2. POTENTIAL FOR ENERGY RELATED DEVELOPMENT

2.1 REGIONAL DEVELOPMENT: CONSTRAINTS AND OPPORTUNITIES

Environmental and economic characteristics of the Columbia River Estuary influence the siting of energy related development. Certain characteristics (e.g., deep draft vessel access, proximity of estuary ports to preferred international trade routes) favor energy related development in the area, while other characteristics (e.g., navigational access maintenance requirements, limited land transportation infrastructure) limit potential energy related development. The following is a brief discussion of the locational attributes of the Columbia River Estuary (from the river mouth to River Mile 46) in comparison to the Lower Columbia River (River Mile 46 to River Mile 105), presenting advantages and impediments affecting potential energy related development.

2.1.1 Deep Water Access

The U.S. Army Corps of Engineers has maintained a stabilized entrance channel across the Columbia River bar since the 1880's. The federally authorized project, last modified by Congress in 1954, provides an entrance channel 48 feet deep (measured from MLLW), one-half mile wide and five miles in length, extending two miles seaward and three miles landward. The bar entrance channel is stabilized by two converging rubble mound jetties extending seaward from the Washington and Oregon shores[1] (see Figure 1).

The Columbia River entrance channel, first authorized by Congress in 1877, has been deepened at intervals since that time, to 25 feet in 1885, to 30 feet in 1914, to 40 feet in 1917, to 45 feet in 1925, and then to 48 feet in 1956 [2]. The present authorized project provides for a navigation channel in the Columbia River 40 feet deep (measured at MLLW) and 600 feet wide from River Mile 3 to the Burlington Northern railroad bridge at Vancouver, Washington (River Mile 105.5). From Portland to Lewiston, Idaho, the river depth is maintained at a depth of 14 feet, linking the lower Columbia River to a 460 mile system of commercial river navigation.[1] Waterborne commercial traffic transiting the Columbia River bar and navigation channel in 1980 was 49,178,984 tons.[3]

Maintenance dredging at the mouth of the Columbia River (RM $^{-}2$ to $^{+}3$) averages approximately 5.3 million cubic yards per year (1976 through 1980 average), with an annual cost of about \$3.1 million.[1] Annual maintenance of the Columbia River navigation channel (RM 3 to 105) and Willamette River entrance requires excavation of approximately 3.2 million cubic yards of sediment (1976-1980 average), with an annual cost of approximately $1.7 million per year.[1] Annual dredging of the Columbia River bar alone represents 45 percent of the entire dredging performed by the Portland District of the Corps of Engineers, and 36 percent of the District's total dredging costs.

During periods of high swell, vertical motion of ships transiting the mouth may exceed 20 feet.[4] Because of the 48 foot maintained depth of the entrance channel, vessel draft is restricted to about 38 feet. The Corps of Engineers is currently studying the feasibility of deepening the entrance channel to 55 feet to allow 40 foot draft ships to transit the mouth.

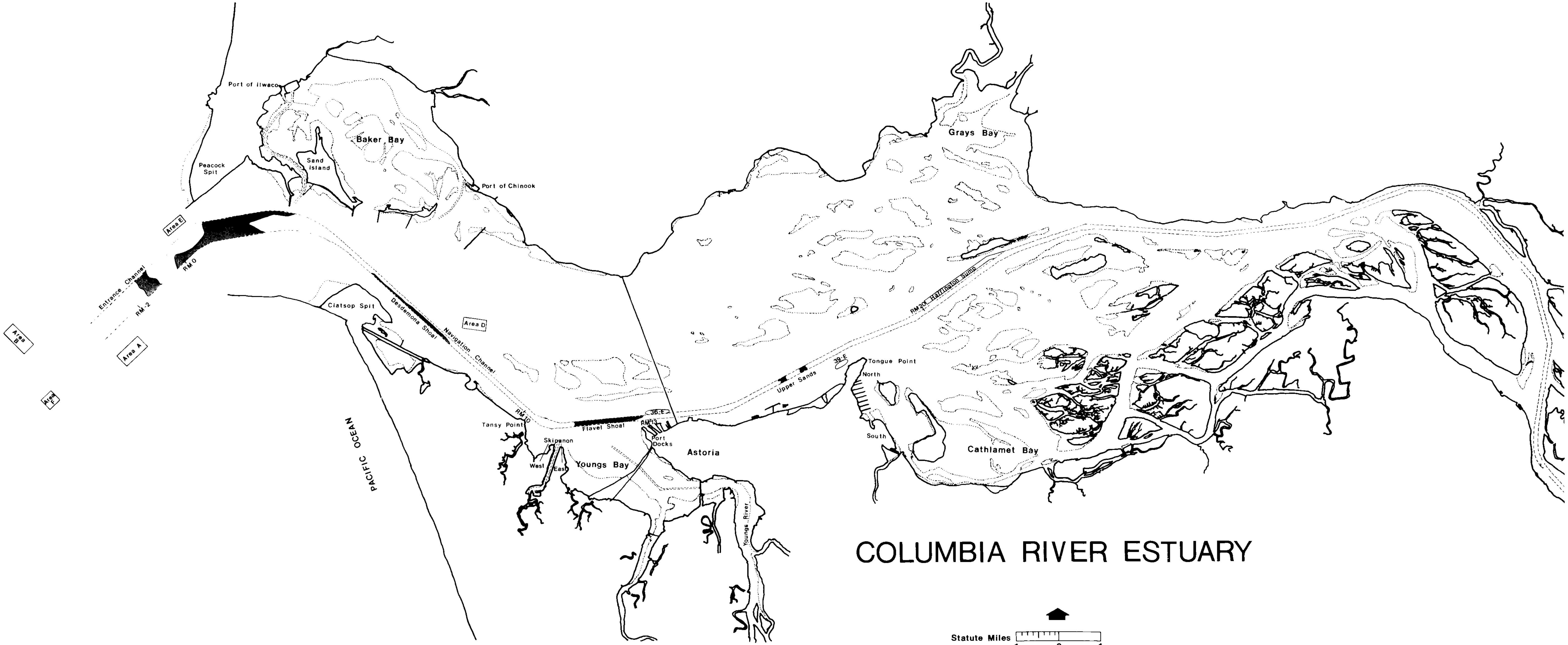
- Dredging and Dredged Materials Disposal Requirements

Columbia River at the Mouth (MCR): Historically, most of the dredge spoils from the entrance channel have been placed in three in-water disposal areas beyond River Mile ¯3.5: (areas A, B, and E), with in-estuary disposal at site D when bar conditions prohibit ocean disposal (see Figure 1). The Corps of Engineers has stated that the present sites are not capable of dispersing the large amounts of material that would be generated by substantially deepening and maintaining the mouth and navigation channel,[5] and has begun consultation with resource agencies on additional or alternate sites. Alternate sites are discussed in Section 3.4, Dredging Estimates and DMD Costs.

Navigation Channel Hopper dredge spoils originating from Clatsop Shoal (RM 0-2.6) and Desdemona Shoals (RM 5-7.8) are primarily placed at Site E, with disposal at Site D when bar conditions prohibit passage to open ocean sites. Flavel Shoal (RM 11.3-12.6) spoils are primarily placed at Site D or Site 54, the Harrington Sump. Spoils disposed of at the Harrington Sump are periodically rehandled by pipeline dredge to Rice Island.

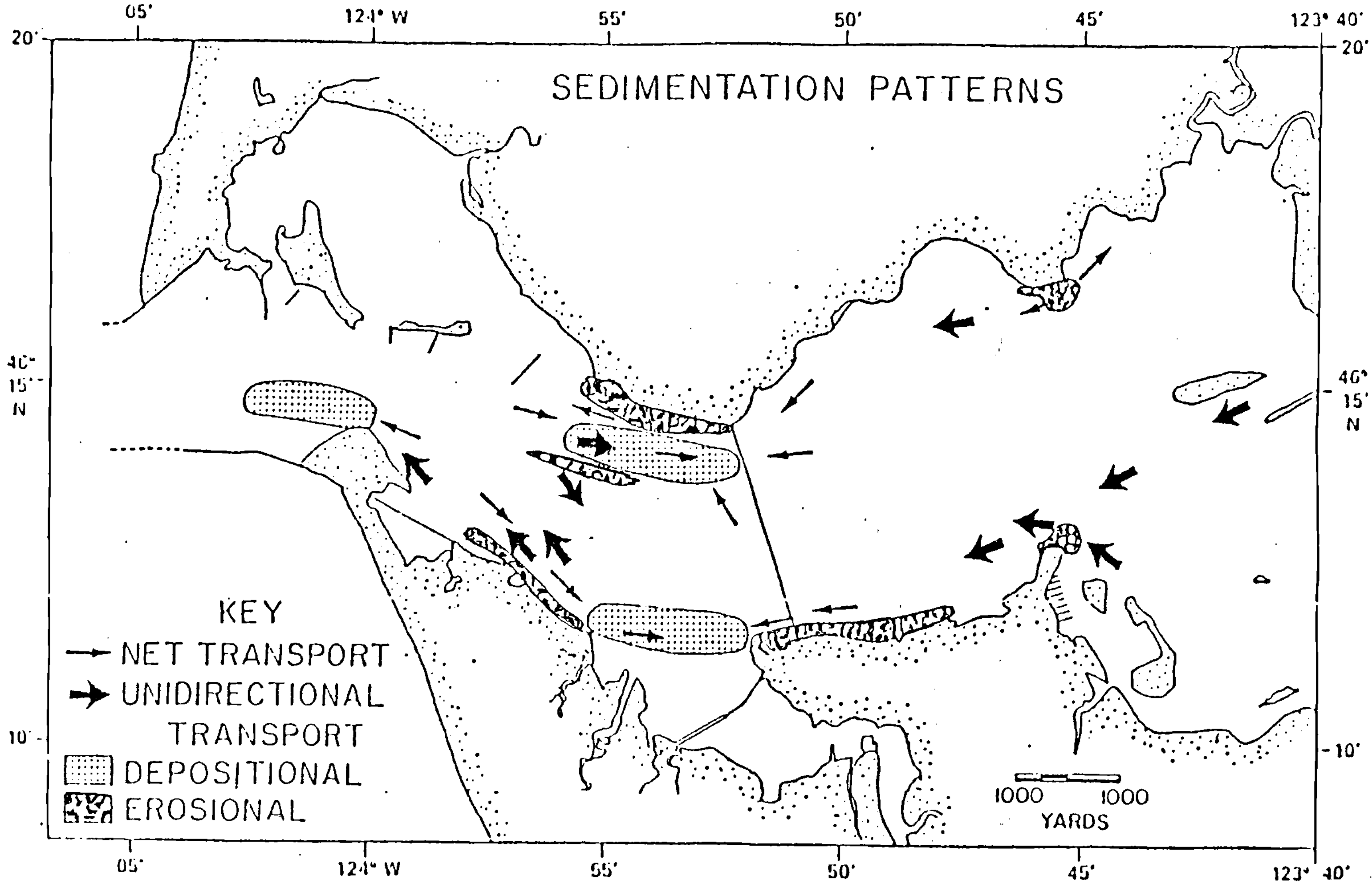
Upper Sands Shoal is handled in the same manner as the Flavel Shoal. Spoils are first placed by hopper dredge at Site 54, Harrington Sump, then subsequently rehandled by pipeline dredge to Rice Island. For a generalized representation of shoaling areas in the Columbia River Estuary see Figure 2.

Movement of placed material offsite due to hydrological conditions is discussed in Section 4.1.2., Ecological Effects of Sediment Removal and Relocation.



COLUMBIA RIVER ESTUARY

FIGURE 2. From: E. H. Roy et al, 1982[63]



Sedimentation patterns in the Columbia River Estuary based on convergences and divergences of bedform sediment transport. Unidirectional transport arrows reflect dominant transport directions for all seasons. Net transport direction arrows reflect resultant direction of reversing transport indications, integrated over tidal and seasonal time frames.

2.1.2 Rail Infrastructure

The Columbia River navigation channel is linked with railroad service throughout most of its navigable length. Three railroads service the Portland-Vancouver area: Burlington Northern, Union Pacific, and Southern Pacific. Burlington Northern and Union Pacific provide mainline, heavy-duty service to Washington ports downriver as far as the Longview-Kelso area. No rail transportation exists along the Washington shore of the Columbia River downriver from Longview-Kelso.

On the Oregon side west of Portland, Burlington Northern railroad is the only line connecting Estuary ports with mainline rail traffic. The 93 mile branchline connecting Astoria with Portland is adequate for only light-to-moderate traffic, and upgrading would be necessary for heavy bulk transport. The branchline to Astoria passes through several small towns en route from Portland. Relocation of the line to bypass these towns would add significantly to the cost of upgrade. It should be noted, however, that the railroad is under no legal requirement to bypass these towns, as the rail companies own the right-of-way for the present track location. Estimates of upgrade costs (not including bypasses) range from 17 to 55 million dollars,[6,7] with 30-35 million dollars being the most likely figure.[8]

2.1.3 Highway Systems

Portland and Astoria are connected by U.S. Highway 30, located on the Oregon shore of the Columbia River. Highway 30 is a principal arterial highway that is well maintained and has been improved in past years. It passes through all population centers along the river. On the Washington side of the river, Interstate Highway 5 connects Portland-Vancouver and Kelso. Downstream of Kelso, Cowlitz and Wahkiakum Counties are served by Washington State Highway 4, paralleling the river to Cathlamet. Highway 4 is considered a medium duty road.[6] From Cathlamet to the northern end of the Astoria-Megler Bridge, no improved highway access to the Columbia River is present. A portion of U.S. Highway 101 follows the Columbia River from the Astoria-Megler Bridge to Ilwaco, near Cape Disappointment.

2.1.4 Air and Water Quality

Water and air quality in the Estuary region are good. The ability of the region to incorporate new, moderate contributors to present water discharges and air emissions is good in comparison to upstream areas. New industry proposed for siting in the Portland-Vancouver vicinity would, generally, represent significant marginal increases in existing water and air pollutant loadings.[9]

2.1.5 Labor Force

The civilian labor force in Clatsop County, Oregon, and Pacific and Wahkiakum Counties in Washington has fluctuated little in recent years. Clatsop County has a labor force of between 12,000 and 13,000, while the labor pool in Pacific and Wahkiakum counties is approximately 6,200 and 1,300 respectively.[6] Due to the recent slump in economic activity within the Estuary region, these figures may have increased somewhat. Lumber, wood products and fishing have figured prominently in the employment history of the estuary area. Heavy industry and manufacturing are not present in Clatsop, Pacific, and Wahkiakum Counties, nor are support services or supply networks for such activities.

2.2 CATEGORIES OF POTENTIAL ENERGY RELATED DEVELOPMENT

The following discussion identifies five categories of energy related development, the factors which influence each category of development, and the probability of such development in the Columbia River Estuary. A thorough and inclusive analysis describing all energy facilities and the interrelationships and competition between different categories of energy development is not possible here. However, the potential for siting of each category of energy related development is described in order to establish a basis for formulating strategies to mitigate for estuarine resource impacts.

2.2.1 Electric Generation Facilities

At present, electric power resources in the Northwest are a combination of hydroelectric generation (73 percent of average load capacity) and thermalelectric generation (27 percent).[10] No generation facilities are located in the Columbia River Estuary area.

- Hydroelectric

Future development of hydroelectric power resources, traditionally an abundant energy resource in the Northwest, is limited. In the next 20 years, increases in peak generation capacity will focus on small to medium sites (i.e., low head hydroelectric projects and refitting of existing diversion structures).[10] A 1980 hydroelectric power inventory prepared by the Corps of Engineers identified thirty-four existing and potential hydro sites on tributaries of the lower Columbia River. Only two of these sites are on tributaries to the Estuary, one on the Gray's river (Wahkiakum county, Washington) and one on Big Creek (Clatsop County, Oregon).[10] An additional site at Youngs River Falls, Clatsop County, has been identified by the City of Astoria as a potential hydroelectric generation facility.[11] All three of these projects are viewed as local opportunities and are not in response to regional demands for electricity. Power generation in excess of local needs could be sold to the Bonneville Power Administration or Pacific Power and Light Company.

- Coal and Nuclear

It is generally accepted that major new additions to electric generation capability in the Northwest must rely on thermalelectric generation facilities.[10] These facilities include nuclear and fossil fuel plants.

Such facilities are expected to meet regional growth in Northwest power demand. Planned thermal generation facilities are distributed inland in the Northwest, with plants located east and west of the Cascades. The lead time for siting and construction of thermalelectric facilities is well in excess of ten years. No thermalelectric plants have been proposed for the Estuary area.[10] Two large thermalelectric generating facilities exist on the Columbia River, both located in Oregon. The Trojan pressurized water nuclear reactor (1130 megawatts) at River Mile 70 and the Beaver combined cycle gas/oil power plant (660 megawatts) at River Mile 53 are the nearest thermalelectric facilities and would be the primary sites for expansion of generation capacity. The Beaver facility is well suited to relieve the larger thermal power plants in the region (Trojan and the 530 megawatt coal-fired plant at Boardman) of peaking capacity. It is likely that additional generation capacity will be added at Beaver within 15 years.[10] The Trojan plant was originally planned for two units and that site could accommodate another unit if necessary. The probability of expansion at the Trojan site over the next 25 years is low. The economies of scale leading to construction of large new fossil fuel thermal power plants dictate that new plants be sited near fossil fuel sources and fossil fuel transportation networks, and near existing power distribution grid infrastructures.[10]

Air quality is another important consideration. Fossil fuel thermal power plants must be sited in low population density areas, such as eastern Oregon, where marginal increases in air pollution are more readily accommodated. Thus, major new thermal power installations in the Columbia River Estuary area are unlikely.

Non-conventional sources of electric power, including wind, solar and tidal driven systems and use of waste materials as heat for thermal power plants, have not been proposed for the Lower Columbia River area.

2.2.2 Fuel Processing Facilities

Energy processing facilities convert carbonaceous raw materials (petroleum, coal or biomass) to fuel commodities and non-fuel derivatives. All types of processing entail the transport of raw materials and processed products. Processing facilities that need marine terminals and are dependent upon waterborne transportation of raw materials and products are included in this category of potential energy related development.

- Petroleum Refining

Petroleum refining (i.e., separation of petroleum into various petroleum products) generally requires a marine terminal, pipeline and rail service. Raw materials must be received in bulk quantities. Processed products are shipped from the site via land or water in order to establish efficient, integrated distribution operations. The Northwest presents a compact and well defined petroleum marketing area. Refining activities have in the past primarily served regional needs. Consumption of petroleum products is not expected to increase significantly within the next five years, although regional population growth may cause moderate increases in demand (conservation adjusted growth).[10] As an established regional market, approximately 70 percent of Northwest petroleum product supplies are satisfied by four major refineries located in Anacortes and Cherry Point, both in northern Puget Sound. Crude materials are received at existing refineries as marine shipments (Alaska and foreign sources), with nearly all refined products consumed in western Oregon and Washington.[10] Significant amounts of refined products also reach the Northwest via pipeline from Utah and Montana. Puget Sound production and the Willamette Valley are linked by the Olympic Refined Product Pipeline.

There are no significant facilities for petroleum refining in the Columbia River Estuary area. A small asphalt refinery located in Portland is the only refinery in the State of Oregon. At present, existing Puget Sound refineries operate at approximately 80 percent of capacity and are well situated for expansion of facilities.[10] It is expected that any supply deficits in crude materials and refined products may be overcome by moderate increases in marine imports, pipeline shipments, and refinery production. Factors that could stimulate new refinery development in the Columbia River Estuary area are: (1) the potential for transshipment of petroleum produced elsewhere on the West Coast and received on the Columbia River for shipment to regions outside the Northwest, and (2) potential oil production from state and federally controlled marine areas, i.e., development of outer continental shelf lands.

- Petrochemical Processing

Petrochemical processing includes production of non-fuel organic commodities (e.g., industrial chemicals and organic agricultural chemicals) and inorganic commodities (e.g., agricultural fertilizers) from petroleum derivatives, natural gas feed stocks, and other chemical raw materials. At present, production of industrial petrochemical products in the Northwest is limited. Existing facilities on the Columbia River include two chemical plants at Kalama, Washington (river mile 75) producing organic commodities used in the forest products industry.[10]

Production of agricultural chemicals occurs on a small scale in Western Oregon and Washington. A fertilizer plant near St. Helens, Oregon (river mile 85) represents the largest facility using petrochemical feed stocks for production of bulk chemical commodities along the lower Columbia River.

While significant demand is present in the Northwest for forest industry and agricultural chemicals, local production and shipment of commodities from remote domestic and foreign sources is adequate to meet supply needs. Moreover, production facilities at Kalama and St. Helens are well suited for expansion. Major growth in the production of petrochemical products is not anticipated since: (1) it would be necessary to significantly increase natural gas supplies and shipments to the area, (2) petroleum refining does not occur in the area as a source of by-product feed stocks, and (3) competition from existing petrochemical suppliers located near natural gas supplies and refinery complexes is sufficiently vigorous to meet near-term (within the next 25 years) increases in demand.[10]

Petrochemical production facilities require access to a wide variety of raw materials found only in proximity to petroleum sources. There is no advantage to importing liquified natural or petroleum gas for the sole purpose of producing industrial or agricultural chemicals. Thus, no petrochemical production facilities are expected in the Estuary, because there is not a distinct locational advantage to siting such industry in the area.

- Coal Gasification

Synthetic petroleum gas may be produced from coal by means of chemical addition of hydrogen under heat. A significant amount of heat is lost during the gasification process, requiring large quantities of cooling water to absorb waste heat. Differentiation of coal into synthetic gas allows shipment of a more concentrated source of energy while obviating the movement of great quantities of solid coal -- in effect exchanging energy lost as waste heat during gasification for energy expended in bulk transport of coal over significant distances. It is likely that industrial scale synthesis of gas from coal will occur near the sites of coal extraction in Montana, Wyoming, and North Dakota. However, if large quantities of coal are transported to locations along the Columbia River for use in coal-fired thermalelectric plants or for transshipment to foreign ports, undetermined quantities of coal might be utilized in small scale coal gasification facilities. Synthetic gas produced at such facilities would be used in specialized circumstances, probably near existing energy related development. For example, the Portland General Electric Company operates the Beaver gas/oil fired 660 megawatt power plant at Port Westward, Oregon, and has proposed production of medium BTU (British thermal unit) synthetic gas from coal as a source of fuel for this combined cycle, turbine plant.[10]

Gasification of coal is considered an inefficient use of fuel energy in certain applications, due to heat liberated during gasification. Although this heat may have some use in space heating in the immediate area of the generating plant, it is generaly of insufficient quality to be used as a source of electrical generating capacity. However, in instances of costly existing turbine generators (requiring gas or petroleum fuels and incapable of using coal), and where coal-fired plants would represent a significant marginal increase in air contaminants, use of relatively clean burning synthetic coal gas may be a feasible alternative. Generally, in light of present gasification techniques, power generation utilities consider plants fueled directly by coal in close proximity to extraction sources to be the most cost effective. Thus, coal gasification facilities of modest scale may occur in Oregon and Washington in the near future, but no locational advantage to siting a synthetic coal gas facility in the Estuary is perceived. No proposals for coal gasification plants have been made for the Estuary.[10]

- Alcohol Fuels

Alcohol fuels are produced by conversion of biomass to ethanol (produced from agricultural crops and crop wastes) or methanol. Forest industry wastes are the logical candidate material source in the Northwest for methanol production. Both methanol and ethanol are of particular interest as a supplement or partial replacement for petroleum fuels, especially in farm use. Alcohol fuels would be produced from renewable resources and might encourage full utilization of existing biomass commodities. The potential for large scale methanol production in the Northwest is generally unexplored. However, since methanol contains more energy per unit weight than export grade coal, and since use of methanol fuels creates less air and water pollution problems than combustion of coal or petroleum derived fuels, it is considered a likely high volume, long distance export commodity. In light of abundant wood waste resources in the Northwest, it has been suggested that future export of methanol may become competitive in foreign energy markets.[10] At present, large scale methanol production facilities have not been proposed for the Columbia River Estuary area. Bulk shipment of methanol probably would not be constrained by the present navigational limits of the Columbia River system.

2.2.3 Gas and Oil Exploration

The lower Columbia River, adjacent estuarine shorelands in Oregon and Washington, and related marine areas are not considered significant locations for gas and oil production, nor does it appear that significant potential for oil and gas production exists in this region of the Northwest, at least during the next 25 years. Discussion of the extraction of gas and oil in this section includes exploration and production activities onshore (areas east of the Columbia River mouth) and in offshore areas in state and federally controlled marine waters. Onshore regions in the study area have received little or no attention regarding extraction of oil resources, while exploration and modest commercial production of gas is underway on the Oregon side of the lower Columbia. Gas production near Mist, Columbia County, Oregon, 10-15 miles south of the Columbia River at River Mile 50, is of sufficient volume to warrant construction of a pipeline connecting with existing distribution lines near Clatskanie.[10] North and west of the Mist area commercial gas companies have leased privately owned and publicly held lands for the purpose of exploration and extraction. In 1980, the State of Oregon leased approximately 10 square miles along the south shore of the Columbia River, including certain aquatic areas, extending from Westport Slough (River Mile 43) to Wallace Island (River Mile 48) for gas exploration and extraction.[10] Thus, additional potential for gas production is suspected and, following two to three years of exploration, gas wells could be in production within five years.[10] If production ensues, leasing activity may be expanded, reaching further north and west into submerged and submersible lands in the Columbia River occupied by the Columbia White-Tailed Deer and Lewis and Clark National Wildlife Refuges. Commercial interest in gas resources is also evident on the Washington side of the river. Washington State has leased 46 parcels on or near the Columbia River in Wahkiakum and Cowlitz counties for the purpose of gas exploration and subsequent extraction activity. Lease activities have focused on the Puget Island (River Mile 38-46) area, though this is not indicative of special knowledge of major reserves in the area.[10] Generally, exploration for gas resources may be expected to take place in the Columbia River Estuary area within the next five years. However, little information is available to suggest if commercial extraction will take place along the margins of the Estuary or in submerged or submersible areas of the study area. Present gas production may be from relatively confined pockets or narrow geological folds rather than from major reservoirs.[10] Further, it is not possible to state that gas production, if feasible in the area, would lead to activities in estuarine shorelands and aquatic areas. Directional drilling could be used to tap gas resources beneath the estuary, holding operational impacts in estuarine areas to a minimum. The magnitude of gas resources may not be sufficient to require extensive pipe, pump station, treatment, storage, or transshipment terminal facilities.

State and federally controlled marine waters of the Pacific Northwest have not been the object of intensive oil and gas exploration. The status of marine areas near the Columbia River as a source of oil and gas has been generally perceived as low, since the region has not been a candidate for federal leasing since 1977, and is not included in Department of Interior lease planning in the present five year lease schedule (commencing 1982).[12] The low priority of these marine areas results from three principal factors: (1) insignificant resource estimates based on preliminary explorations,[13] (2) frequency of severe weather and extreme wave conditions, and (3) presence of commercially valuable fishery resources and general vulnerability of these and other marine resources. While the latter two factors are not significant impediments in and of themselves, considered in relation to other west coast gas and oil resource potential in California and Alaska, the Pacific Northwest is at present categorized as a low priority region. It is likely that marine areas in the Northwest will be reevaluated for the presence of gas and oil resources at some future time due to depletion of proven petroleum resources elsewhere. With the Department of Interior's accelerated oil and gas leasing program, oil companies have recently shown increasing interest in the outer continental shelf areas off Washington and Oregon. During the last two years, for example, four seismic surveys have been conducted off Washington, with apparent emphasis on the Astoria Canyon area off the mouth of the Columbia River.[14] Actual exploration (drilling) will not take place until the Pacific Northwest region is included in the Department of Energy's leasing program. This could be done within one year, as the Secretary of the Interior can amend the program on a yearly basis. Renewed exploration is probably at least five years off.[14] Since extraction of identified resources follows exploration by three to five years, no probability of commercial production of oil and gas in federal marine waters near the Columbia River is foreseen during the next eight to ten years, at a minimum. Although petroleum leasing policy in state marine areas controlled by Washington and Oregon is independent of federal policy, it may be assumed that the absence of commercial interest in federal marine areas implies that exploration and extraction of petroleum resources will not take place in state marine waters during the next 5 years.

If extraction of petroleum resources takes place, facilities supporting near shore and outer continental shelf activities might be sited in the Estuary. The possibility of necessary support facilities is as speculative as the likelihood of petroleum production in the region. However, bases for material staging and transport and for transfer of work crews would be needed during exploration or small scale commercial testing, while extensive regional scale petroleum development may require large industrial port sites for fabrication of marine structures and handling of large volumes of extraction equipment. The Columbia River Estuary would be a prefered location for this type of activity. In the late 1970's, a large offshore drilling rig fabrication facility was proposed at the Skipanon River to supply structures for California and Alaska OCS drilling activities. The project was never carried out because of lack of demand, but the site is still available for this type of activity.

2.2.4 Transportation and Transportation Systems

This category of energy related development is not directly linked with local or regional electric generation, processing of energy related materials or petroleum extraction activities. Rather, commercial shipments of energy resources are either received and distributed inland or shipped from inland locations and stockpiled at marine terminals for subsequent overseas export.

- Petroleum Transshipment

A major petroleum transshipment facility would not likely be sited in the Lower Columbia River or the Estuary because of bar and river constraints to movement of deep draft ships. Efficient and cost effective bulk shipment of crude oil requires vessels of draft deeper than that feasible for the present 48 foot Columbia River bar and 40 foot navigation channel. In addition, offshore sites for oil transfer (mooring buoys and offshore terminals) are not feasible due to the wave regime of the Northwest coast.[10] In the event of new nearshore or outer continental shelf oil production in the vicinity of the Columbia River mouth, oil would most likely be brought ashore via pipeline and shipped to existing refineries or loaded directly from offshore sites. For offshore production sources, new refinery capacity would not be established in the Estuary due to the limited market potential of the Northwest. Crude petroleum would be shipped elsewhere on the West Coast.

- LNG and LPG Transshipment

Shipment of liquified natural gas (LNG) and liquified petroleum gas (LPG) requires marine terminal facilities and processing plants for gas liquifaction or conversion of low temperature or pressurized liquid to gas. Marine terminals may be sited in the Estuary since bulk marine transport of these petroleum based commodities commonly takes place in vessels which are not impeded by the depth limitations of the Columbia River. Consumption of natural gas and petroleum gas in the Northwest, as a preferred fuel in domestic, utility, and industrial applications, is expected to increase moderately during the next 25 years.[10] Present gas demand is met by supplies piped from Canada and the Southwest. Reduction of gas supplies brought about by the expected termination of Canadian gas shipments could be compensated by increased supplies from new continental U.S. sources or by Alaskan gas. Additional delivery capacity is present in the existing pipeline systems extending to the East and Southwest, while Alaskan gas may be received via marine shipments or newly constructed pipelines. Marine shipment of LNG to the Northwest through the Columbia River Estuary area within the next 15 to 25 years -- although unconstrained by present channel and bar dimensions -- is unlikely for two reasons. Existing refineries on northern

Puget Sound have pipeline systems to the Willamette Valley and an LNG facility capable of augmenting Oregon's present gas supply by approximately 14 percent is in place at Newport, Oregon.[10] The latter is likely the only such facility that will be developed in Oregon in the near future. No LNG terminals are anticipated along the Washington shore of the Columbia River.

Expected future consumption of LPG, as with LNG, may increase moderately. Shipment of LPG does not require cryogenic equipment. Due to the longer history of LPG use, distribution throughout the Northwest is more complex. LPG is shipped, stockpiled and marketed by a number of small companies. Bulk shipment is commonly in smaller quantities than other petroleum products. LPG is distributed by pressurized tank cars, trucks and small supply vessels rather than by extensive pipeline systems. Present sources of supply are Canada, California and South America. In the event of moderate consumption increases, large LPG marine terminals in the Columbia River Estuary are not expected because existing distribution facilities based in Puget Sound and the Portland-Vancouver area could be expanded. No proposals for establishing LPG marine terminals in the Estuary area are expected during the next 25 years.[10]

2.2.5 Coal Transshipment

As discussed above, the probability of siting marine terminals in the Columbia River Estuary for importing of petroleum, LNG/LPG or other non-solid fossil fuel materials is very low. In contrast, the probability of export of fuel commodities from locations on the Estuary is relatively high. The conclusion that transportation facilities for the export of energy resource commodities, specifically coal, will be sited on the Columbia River within the next ten to twenty years is supported by several identifiable factors. First, the Columbia River Estuary is the threshold of a low-level transportation route through the Coast and Cascade mountain ranges, extending through a high interior plateau to the Rocky Mountains. Waterborne and rail transportation facilities may use this corridor for shipment of bulk quantities of coal mined in the central and northern Rocky Mountains. Shipments from the interior (Montana, Wyoming, and Utah) may move over the existing transportation infrastructure to Columbia River marine terminals with comparatively short transport distances to Western Pacific destinations. Second, the Western U.S. has extensive proven reserves of bituminous and sub-bituminous coal, quantities which surpass present and expected domestic demand and are available for export.[15] Further, the rapidly expanding economies of the Pacific Rim represent a long term market for

U.S. coal since the nations of this region have indicated (1) the intention to expand present sources of energy supply, with the objective of decreasing dependence on petroleum based fuel sources, (2) the need to stabilize existing sources of imported coal, emphasizing diversification of coal supplies less subject to interruption due to labor disputes or political difficulties, and (3) the need to offset present bilateral trade imbalances with the U.S. through importations of bulk quantities of coal.[7,16]

These factors are central to U.S. participation in the Pacific Rim coal export market since U.S. mined coal is not competitive on the basis of price. Pacific Rim nations have indicated a willingness to obtain 15 to 25 percent of their coal demands from the U.S. in the interests of security of supply, supply diversification, and correcting trade imbalances while foregoing marginally cheaper, higher BTU sources of coal mined in Australia, Canada, China and South Africa.[7,16,17] Demand for U.S. coal is expected to increase, and aggressive marketing efforts of Northwest coal consortia suggest that some portion of the Pacific Rim coal export market will be captured by ports on the Columbia River within the next 20 years.

The amount of coal that will be exported from Northwest ports is uncertain, yet it is expected that higher BTU central Rocky Mountain coal will represent a significant portion of the Pacific Rim export market initially.[6] Northern Rocky Mountain coal may be exported from Northwest ports in increasing quantities in later years.

At present, feasibility studies for coal export terminals have been undertaken at seventeen sites on the West Coast. Of particular interest are three deepwater sites on Puget Sound (Cherry Point, Tulalip, and Steilacoom) and four sites on the Columbia River (Port of Astoria-Port docks, Port of Kalama, Port of Vancouver, and Port of Portland). Competition among proposed Puget Sound ports and proposed Columbia River terminals, with the likelihood of substantial inducements offered to buyers, will determine the distribution of coal transshipment facilities.

- Demand

It has been estimated that the U.S. share of the Pacific Rim coal export market may be 5 to 11 million short tons in 1985, expanding to 25.5 million short tons in 1990, and 40 to 65 million short tons in 2000, with a mean estimate of 50 million tons by 2000.[7,17] More recent projections assume slower growth rates, reflecting the present depressed price of oil.[18]

Demand for steam coal by Pacific Rim countries is the driving force behind West Coast coal port activities. Projections of expected exports vary considerably, with initial projections for 1985 differing by 5.6 million tons/year (from 5.3 to 10.9 mt/y) and growth rates varying from 1.5 mt/y to 3.2 mt/y.[17] High initial export projections and rapid growth estimates should be approached with caution for three reasons. First, present oil prices have depressed steam coal exports.[18] Second, China has plans to become a major coal exporter, investing over 1.7 billion dollars in machinery and technology to increase production, and opening 102 new mines with a projected output of 104 million tons per year by 1985.[19] Although Chinese coal will mainly be shipped from shallow draft ports (less than 30'), the proximity of this coal to Pacific Rim markets will represent a significant locational and cost advantage over western U.S. ports. Third, speculation on growth of the coal export market in the United States has led to almost 60% overcapacity at existing U.S. terminals for 1983, and similar situations exist in Australia and Canada.[20]

Using the mean growth rate from six coal export studies of 2.5 million tons/year,*[17] and the mean initial export projection in 1985 of approximately 8 million tons/year, a more conservative export tonnage estimate than the one above can be calculated. Utilization of this "medium growth" scenario leads to a West Coast export demand of 20 million tons/year by 1990, and 45 million tons/year by 2000.

One of the most recent export studies, published in February of 1982, predicts that Pacific Northwest coal ports can expect to move approximately 50% of projected West Coast tonnage by 1990, and 70% by 2000.[17] This would mean Pacific Northwest ports would share 10 million tons/year in 1990, and 32 million tons/year by 2000. This is very close to the estimate of 30mt/y in the Washington Public Ports Association (WPPA) report <u>Potential Coal Export Facilities in Washington: An Environmental Impact Analysis</u> (October, 1982).

- <u>Competitive Position of the Lower Columbia River on the West Coast</u>

Previously published reports[6,7,15,16,17] all concur that Southwestern coal ports (e.g., Long Beach/Los Angeles) will capture a certain portion of total projected export volumes regardless of port activity in the Northwest. This is due to the proximity to Utah coal, which is expected to constitute the major portion of coal exported from southern California ports. Therefore, competition with Columbia River Ports for Montana coal shipments from the

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*Burlington Northern, WPPA, WOCOL, ICE, Westpo, CPSEDD.

Midwest is expected to be mainly from Puget Sound (Washington) ports. For the purpose of this siting analysis, Tongue Point is compared with Cherry Point and Steilacoom in terms of delivered cost of coal to Yokohama, Japan. While these costs are estimates only, and are subject to constant change, they will serve to illustrate transportation cost attributes of the various sites.

The main component in this comparison is the total estimated cost of delivering coal to a given destination. Lack of deep water that will accommodate 150,000 dwt shipping (i.e., 50 feet depth) is a major constraint to potential Lower Columbia River coal export facilities because of marginally greater transportation costs related to extended rail transportation costs. The following figures for total delivered cost of coal are presented for comparison only. Recent reports indicate that the total delivered price of coal may be substantially higher than the figures presented here, possibly as high as $50 dollars per ton.[21]

Assuming that the Corps of Engineers MCR Project is completed and 55,000 DWT shipping is feasible to Tongue Point, total transportation cost of Montana coal to Yokohama through Tongue Point is estimated to be $36.01 per ton.[8*] This does not compare well with 100,000 dwt shipping of Montana coal from Cherry Point or Utah coal from Steilacoom to the same destination, at $33.05 per ton and $33.35 per ton respectively.[7] An average cost differential of $2.50 per ton means an individual coal shipper may save 12.5 million dollars per year by shipping out of Puget Sound ports, assuming 5 million tons per year shipping capacity.

Coal export potential in the Columbia River Estuary may be increased by dredging of the bar and navigation channel to depths sufficient to accommodate shipping of 150,000 DWT class vessels or larger. The Corps of Engineers is studying the feasibility of deepening the bar to 60-70 feet and the channel to 50-60 feet to Tongue Point.[5] This would allow 150,000 dwt shipping to call on ports within the Estuary.[17] Shipping Montana coal to Yokohama from Tongue Point in 150,000 dwt ships is estimated to cost $32.36 per ton.[8] This compares favorably with 150,000 dwt shipping of Montana coal to Yokohama from Cherry Point at $31.55 per ton and with Utah coal to Yokohama from Steilacoom at $31.80 per ton.[7**]

*Power function interpolation of previously published estimates.[7]

**These calculations do not include possible user fees associated with dredging of the Columbia River mouth and navigation channel to Tongue Point.

- Comparison Between Columbia River Estuary and Lower Columbia River Ports

A comparison of estimated bulk coal shipping costs between Tongue Point and the Port of Kalama demonstrates the effect of locational aspects of facility siting on bulk commodity shipping costs. Because of the differential in shipping costs between rail and vessel traffic, coal from Montana loaded into Panamax class vessels at Tongue Point (RM 18) would cost approximately $1.40 more per ton F.O.B than at Kalama (RM 72).[7] This figure is based on the assumption that rail shipping costs are only a function of mileage, and that costs are incurred on a ton/mile basis. It costs less to move bulk commodities by water than by rail,[22] and differences in vessel shipping distances generally do not compensate for differences in rail shipping distances (see Table 1).

Table 1 shows that an increase in vessel size by 15,000 dwt (from 40,000 to 55,000 dwt) could make a Tongue Point facility more competitive than the Port of Kalama on a cost per ton delivered to Asia basis.

Table 1

KALAMA-TONGUE POINT COST VS. DWT COMPARISON

PORT	COST FROM MONTANA[7]	DISTANCE TO YOKOHAMA	DWT (x1000)	COST TO YOKAHAMA[7]	TOTAL[8]
Kalama	19.20	4290	40	17.70	36.90
Tongue Point	20.80	4240	40	17.50	38.30
Tongue Point with MCR Project	20.80	4240	55	15.20[7]	36.00

The Columbia River bar and navigation channel at present limit vessel draft to 38 feet, and therefore about 40,000 dwt shipping. The 40 foot loaded draft of 55,000 dwt vessels would require some dredging of the bar and channel to allow year round access to Tongue Point. It is expected that the Corps of Engineers Mouth of the Columbia River Project will allow for a 55 foot entrance and 40 foot navigation channel. The Corps of Engineers standard 2 foot overdredge and judicious use of the tides would allow 55,000 dwt colliers access to Tongue Point or other Estuary ports.

-User Fees

It is considered likely that some form of user fee will be implemented for navigation projects in the future.[23,24] Although the formula has yet to be determined, it appears that legislation creating a "nationally traded trust fund" arrangement may be introduced by Senator Hatfield in the 98th Congress.[25] Under this arrangement, all users of federal navigation projects would be assessed a fee that would be contributed to a trust fund, which in turn would supply federal support for navigation projects.[25] There would probably be a distinction between new work and operations and maintenance (O & M) work. Ports would pay a certain percentage of new work costs, with O & M costs being dispersed nationally through the fee assessments of shippers.

The effect of user fees on shipping costs in the Columbia River Estuary would be determined by the user fee formula in the final legislation. For example, new dredging work for a deepwater channel to the Port of Astoria docks could cost 30 million dollars. If Columbia River ports are required to pay 50% of this cost, and the Port of Astoria is required to pay 75% of that amount as the prime beneficiary, 11.3 million dollars would be added to the Port's deep draft development project costs. Amortizing this cost into coal shipping costs over a ten year period at 10mt/y throughput would add 11¢ per ton to the cost of coal, assuming coal bears the entire cost of navigational improvement. This may not have a significant effect on price competitiveness of coal exported from the Estuary. The effect of user tariffs on coal transportation costs would be irrelevant if the national trust fund option is pursued, as all ports will experience this increase in shipping costs.

- Benefit-Cost Analysis

Benefit-cost analysis of coal transportation facilities and associated federal navigation projects in the Columbia River Estuary is very complex. While it is relatively easy to identify primary beneficiaries and capital costs of such a project, secondary and tertiary beneficiaries and "opportunity costs" of land and capital are much harder to assess. To further complicate benefit-cost analysis, two different viewpoints must be addressed: the federal perspective and the regional perspective. The following discussion of benefit and cost issues is based on a comparison of the benefit-cost analysis methods used by the Army Corp of Engineers that addresses the national perspective,[26] and a method developed by the American Geophysical Union (AGU) for evaluating water projects, addressing both national and regional perspectives.[27]

There are two major differences in the benefit-cost accounting methods used by these two organizations. The first difference is that the AGU method considers the "opportunity cost" of committing land and capital to a proposed use. For example, capital committed to a coal export channel project could preclude other dredging operations that also support marine commerce and have significant social benefits.

The second major difference is that the AGU method examines costs and benefits on a regional scale. From a national perspective, distributional effects are unimportant; the major factor is whether total benefits of a project exceed total costs regardless of the distribution of those benefits and costs. From a regional perspective, distributional aspects are very important. Increases in salaries, benefits, and jobs to local residents as well as costs borne by the city, port, or county are distributional considerations that are closely watched on a regional scale.

The different accounting procedures for benefit-cost analysis of deep draft navigation projects in the Estuary are contained in Table 2 and Table 3.

Table 2

NATIONAL ECONOMIC DEVELOPMENT BENEFIT-COST ANALYSIS FORMAT[26]

BENEFITS:

1. Cost Reduction:
   A. The difference between current and future costs without the project and costs with the proposed improvement for shipping existing commodities.

      1) The reduction in cost due to commerce shifted to the project harbor from alternative harbors.

      2) The reduction in cost associated with shifting commerce to a lower cost mode of transport.

2. Shift of Origin Benefits:
   A. The difference between total delivered cost of commodities with and without the project, assuming commerce is shifted to a new point of origin.

3. Induced Movements:
   A. The benefit for each increment of induced production and consumption as a result of the project, i.e., the difference between the cost of transportation via the proposed project and the maximum cost the shipper is willing to pay.

COSTS:

1. The cost of the project, amortized and projected over a fifty year period at 7-5/8% interest.

2. The cost of maintenance of the project (annual) for the fifty year planning period.

Because the Corp of Engineers will address the national perspective of deep draft port development in their Coal Export Channel study to be released in October, 1983, and because this report addresses regional development issues, the ACU regional benefit-cost analysis format will be used to examine potential deep draft development in the Columbia River Estuary.

The following analysis is based on development of a deep draft coal transshipment facility, exporting 10 mt/y and receiving 285 vessel calls per year at the Port of Astoria docks.

Table 3

AGU BENEFIT-COST ANALYSIS FORMAT[27]

BENEFITS:

1. Savings to local shippers.
2. Increased profits of local tug, lighter, and shipping companies.
3. Increased net incomes of other local businesses.
4. Increases in salaries, benefits, and jobs in the local economy.
5. Increases in local tax revenues.
6. Development of a new transportation infrastructure to support a project, and related enhancement of other rail and shipping commerce.

COSTS:

1. Construction, channel dredging, O & M, and replacement costs borne by the region.
2. Local contributions to project related harbor and port improvements.
3. Opportunity cost of land and capital.
4. Negative impact on present waterfront uses and activities and on businesses near the rail route.
5. Social costs of industrialization, and increased pressure on social services.
6. Environmental impacts.

The benefits and costs of an energy related facility that requires deep draft (greater that 50 feet) access are examined in detail below.

Benefits:

1. Savings to local shippers:

As of this writing, there are no local companies importing or exporting goods from the Estuary that would benefit from a deeper channel.

2. Increased profits of local tug, lighter, and shipping companies:

The local pilot and tug services would profit considerably from a deep draft port development. At an estimated fee of $2,450 for pilotage and tuggage per vessel,[7] a 10mt/y coal facility would generate approximately $700,000 in new business, assuming 285 more vessel calls per year. Induced movement of other bulk commodities such as grain may push gross revenue increases to over one million dollars per year.

Fuel services, both dockside and lightering, (the third largest commodity moved in the Columbia River Estuary from 1968-75 [28]) could also be expected to increase. Vessel calls in the 250-300 per year range would mean an approximate 245% increase in ship traffic at the Port docks over 1979 levels,[6] with a concurrent increase in fuel services.

The Port of Astoria can also expect to benefit from this increased traffic. An increase in moorage fee revenue associated with an increase in traffic would add to the Port's general operating fund, lessening the Port's dependence on tax revenues and bond sales for Port related improvements. Fees from leasing Port property for deep draft shipping facilities would be significant. For example, a coal transshipment facility located at the Port docks could generate up to $750,000 per year income to the Port, increasing Port revenues by approximately 25%.[29]

3. Increased net incomes of other local companies:

The Port of Astoria and local fuel and tug companies depend on local marine supply and maintenance businesses for support services. In 1968, 20% of all Port expenditures were spent locally.[30] Using this figure as a crude estimate of a local support service multiplier, and assuming local tug and fuel companies follow the same pattern of spending, local support services may increase gross revenues by as much as $350,000 per year from a deep draft coal transshipment development.

4. Increases in salaries, benefits, and jobs in the local economy:

A 10mt/y coal transshipment facility is expected to cost approximately 65 million dollars to construct at the Port docks,[31] and employ about 90 people as a long term work force.[29] Initial construction of the facility would require approximately 250-300 workers, and generate an estimated payroll of 700 million dollars overall.[32] Historically, the construction sector in Clatsop County purchases $.63 locally (including labor) for every dollar transacted of project costs.[30] If local construction companies were to garner 10% of the construction activity, a 4.1 million dollar input to the local economy would result. This secondary cycling of money by the local construction companies combined with the total payroll would add short term injection of approximately 11 million dollars to the Clatsop County economy.

Operation of a facility is expected to employ 90 people. Assuming 95% of these employees live in Clatsop County, and draw an average income of $21,500 per employee,[33] this employment would add 1.8 million dollars per year into the economy in the form of wages. Using a secondary job multiplier of 1.4,[33] 126 secondary non-manufacturing jobs would be created with an average income of $14,500 per year.[33] Again assuming 95% of the employees live within Clatsop County, another 1.7 million dollars in wages would be added annually to the local economy. Thus, a five year total for the increase in jobs and wages would be 126 jobs with a combined total payroll of approximately 17.7 million dollars.

When the short term injection of 11 million dollars for construction is factored in, the five year estimate becomes approximately 28.0 million dollars.

5. Increase in local tax revenue:

Property owned by the Port of Astoria is not subjected to property taxes.[29] However, if the Port of Astoria leases Port property to a coal exporting consortium, that property would be listed on the Clatsop County tax rolls. All commercial property is taxed at the same rate within a given taxing district, although this rate changes yearly. Using the assessment procedure and consolidated tax rates in Clatsop County for 1981-82, and an assumed market value of the coal transshipment facility of 65 million dollars, the revenue accruing to the different taxing districts would be as shown in Table 4. These are only approximate values, and are used for illustration only.

Table 4

ESTIMATED TAX REVENUES[34]

Taxing District	Tax per $1000 Assessed Value, 1982	Revenue from Development*
City of Astoria	10.15	556,829
Clatsop County	1.42	77,901
Port of Astoria	.10	5,486
Educational Ser. Dist.	.58	31,819
Astoria School District	7.63	418,582
Clatsop Comm. College	1.12	61,443
Astoria Ambulance Dist.	.14	7,680
Clatsop Care & Rehab. Ctr.	.15	8,229
TOTAL	21.29	1,167,969

Table 4 shows that a coal transshipment facility at the Port docks could add approximately 1.2 million dollars per year in tax revenues to the Astoria area. This would tend to reduce assessed value taxation for all property within the Astoria taxing district. A reduction in taxes is generally seen as a benefit to the taxpayer and to the local economy, where those dollars previously reserved for taxes would presumably be spent. The magnitude of this effect is unknown.

* Assuming a development cost of 65 million dollars.

A coal port development at the Skipanon site or other sites would have similar effects on the local taxing districts, although the total revenue may be slightly more or less, and the distribution of the income would be different.

6. Development of new transportation infrastructure to support a project, and related enhancement of other rail and shipping commerce:

The development of a deep draft coal transshipment facility would require dredging of the mouth and navigation channel of the Columbia River (see Section 3.4). In addition, coal would be supplied to the facility by unit train, and the existing rail line from Portland would have to be upgraded (see Section 3.5). These two actions would produce economic effects beyond allowing movement of bulk shipments of coal. Excavation of a deep draft coal export channel and upgrading the rail line would open the Estuary to shipments of other bulk commodities as well, notably grain. This would certainly benefit the Port of Astoria, because of elevator, land, and dock leasing revenue, as well as an increase in the tax base because of elevator improvements. In addition, the Port expects that an enhanced transportation infrastructure would attract primary manufacturing industries to the area that depend on bulk shipments of imported raw materials.[29] The finished product would then be shipped east on the rail line. The net incomes of these businesses would constitute a project benefit to the region. There would remain constraints on development in the Estuary area, however. For example, without detailed scheduling of traffic and construction of extensive rail sidings, coal train traffic may monopolize the rail route. In addition, it is uncertain whether markets exist that would fully utilize such a development in the Astoria area, or whether more economically efficient locations exist elsewhere for this type of activity.

<u>Costs:</u>

1. Construction, channel dredging, O & M, and replacement costs borne by the region:

There is a possibility that the federal government through special deepwater port development legislation would fund the work necessary to develop deep draft access in the Estuary. Nevertheless, since user fee legislation has been proposed, it is necessary to address user fees as potential regional costs (see above, User Fees).

The estimated cost for new work dredging varies with the location of the development site (see Section 3.4). Dredging for deepwater access to the Port docks is estimated to be 38.2 million dollars for new work, and 27.2 million dollars for annual maintenance dredging costs. At the Skipanon site, the cost are 18.5 and 11.7 million dollars, respectively. The new work costs would be amortized over a given period (the Corps of Engineers generally assumes 50 years at 7-5/8% interest), and added to annual maintenance costs to determine overall annual costs of the deep draft channel project.

Construction and site preparation costs would also vary with the site. In the instance of development of Port of Astoria property, these costs would be borne by the coal exporting consortium, with a foreign investor as one of the principles, and therefore it is difficult to determine the actual costs borne by the region. Assuming the development costs are distributed equally among the investors, 66% of the construction costs, or 43 million dollars in the case of the Port docks, would be paid by the region. At the Skipanon site, this figure may be as high as 53 million dollars.

2. Local contributions to harbor and port improvements:

Local contributions to harbor and port development are obtained through the Port of Astoria taxing district. Since the coal exporting consortium would be expected to fund site preparation costs as well as construction costs, local contributions could be considered negligible.

3. Opportunity cost of capital and land:

Use of capital and land for a particular project precludes use of that capital and land for other investments and development opportunities. The rates of return of alternate investments, and the amount of foregone consumption can be taken as the opportunity cost of a project.[35] In this case, the question is whether alternate regional investment of the almost 145 million dollars necessary to make a coal transshipment port operational in the Estuary could yield greater economic and social returns. There exist several possibilities for alternate investments in the Estuary area. For example, 700 million dollars of frozen whitefish fillets, most of which were caught and processed by foreign fishing vessels operating within the U.S. fishery conservation zone, were imported to the U.S. in 1979.[6] Investments in improving the West Coast catch and processing of underutilized species may significantly reduce this large outflow of money to foreign countries. Additional investments of 27 million dollars per year (displaced O & M dredging costs) could assure progress in areas identified as needing improvement. Another example would be the development of new, or consolidation of existing drydock facilities, which could be specifically designed to serve medium and large sized fishing and fish processing vessels used seasonally in Alaska. The Skipanon development site could accommodate such an activity without extensive modification, and enjoys a locational advantage over the Port of Portland for this scale of service. Such a service may capture vessel outfitting and overhaul activity from upriver and Puget Sound areas. A third example, which is not predicated on industrial development, is to develop tourist oriented businesses on some of the existing waterfront areas and to encourage historical and commercial operations to utilize the waterfront. Impetus for this type of option is provided by the ranking of Astoria as preferable to any other West Coast port as a stopover for luxury liner cruises.[36] Activities such as those mentioned above may also generate a greater number of jobs than a bulk transshipment facility, thus creating a greater social benefit.

In the case of coal port activity, the opportunity cost of land committed to the project is difficult to quantify. This type of development does not preclude alternative use of the land in the future, and therefore the opportunity cost of the land would be temporary and probably of little consequence.

4. Negative impact on present waterfront uses and activities and on businesses near the rail route:

Operation of a coal transshipment facility west of Tongue Point would require coal train traffic through several small towns and along the Astoria waterfront. The amount of traffic varies with the output of the facility. At 10 mt/y capacity, three trains per day would be necessary to supply the facility. Since unit trains would pass a given point twice for each trip, areas along the rail line would experience a unit train movement about once every three and one half to four hours. (see Section 3.5) The impact of this activity is examined in Section 4.5.1. Quantification of the cost associated with this disruption is beyond the scope of this study. However, two impacts are likely to be significant. The first is the cost of decreased efficiency associated with temporary obstruction of business operations and access. For example, if a forklift operator paid $8 per hour must wait twenty minutes out of each eight hour work shift for train passage, this amounts to $665 per year for that employee alone. This type of delay would also have a ripple effect through other employees that the forklift operator serves. The second cost is related to the desirability of maintaining a tourism/small business orientation on the Astoria waterfront. Estimating the cost associated with coal facility impacts on waterfront businesses and businesses along the rail route would entail collecting data on the gross receipts generated by these businesses, and estimating a per cent reduction (1%, 5%, etc.) in receipts associated with coal train movements and a general increase in industrial activity.

5. Social cost of industrialization, and increased pressure on social services:

Social costs associated with industrial development are very difficult to quantify, and have been generally ignored in past benefit-cost analysis.[27] Costs to society that fall in this catagory are related to personal value judgments on what is desirable in a community, and what could be seen as a detriment to the quality of life. The number of these impacts, as well as their intensity, are inversely related to distance from a given project.[37] Thus, social costs incurred by coal facility development at the Port docks would be restricted to the immediate area and to cities affected by coal train traffic. These costs may include disruption of existing scenic resources, degradation of local air quality, noise, and a resultant decrease in property values of homes that overlook the new facility. In addition, costs as intangible as changes in the "ambient quality of traditional activities" might be considered, even though it is difficult to attach a dollar value to such costs.[37]

In the construction phase of industrial development, the influx of large numbers of temporary workers (250-300 in the case of coal port construction--see #4, Benefits) can stress social services. The social cost associated with a large influx of workers is discussed in Section 4.4.1.

6. Environmental impacts:

Environmental impacts associated with development and operation of a coal transshipment facility are discussed in Section 4.5.1. Costs involved in mitigating these impacts can be taken as the willingness to pay to protect the resources in the area, both biological and social.

Mitigation of impacts that require standard environmental protection devices (e.g., air sweeps, water treatment facilities, etc.) are estimated to cost one million dollars per year; prevention of toxic runoff, dust, and fires (enclosure of coal piles) may cost up to nine million dollars annually, and railroad grade separations to protect the small towns on the rail route from disturbance is estimated to cost 800,000 dollars annually per separation.[21] Mitigation of adverse impacts to the Estuary (if necessary) may cost 340,000 dollars annually.[21] This combined value (greater than 11.0 million dollars) can be taken as the annual cost of environmental impacts associated with the project.

Over 11.0 million dollars per year for environmental impact avoidance may seem like a large amount, but it accounts for less than 1% of the total delivered cost of coal.[21] Mitigation is estimated to add 3¢ per ton of coal,* or approximately .06% of the total delivered cost.

Environmental controls account for a small portion of the total capital costs of a project. It has been estimated that environmental controls account for approximately 6% of total capital costs of a coal transshipment facility.[21]

3. POTENTIAL ENERGY FACILITY SITES

3.1 INTRODUCTION

The most comprehensive study to date of potential energy related development, impacts, and use conflicts in the Columbia River Estuary, Energy Related Use Conflicts for the Columbia River Estuary,[10] prepared for the U.S. Fish and Wildlife Service (USFWS), identified eight sites for OCS support and three sites for coal export facilities or OCS support below river mile 25. Oregon local comprehensive plans and the Washington shoreline management plan delineate areas available for intensive port development within the Estuary. Natural and jetty-induced sedimentary processes preclude development of major facilities requiring deep water access in Baker Bay.[38] Therefore, large scale energy related development is essentially limited to the Oregon side of the estuary. The Port of Ilwaco and Port of Chinook are discussed as potential sites in terms of small scale OCS support facilities only.

Criteria for high potential sites are the following:

a. Appropriate zoning for water-dependent development.
b. Access to the main navigation channel.
c. Adequate area (80+ acres) of upland to support the aquatic site.
d. Availability of rail and highway access.

Probabilities for particular categories of development that are most likely at a given site over a 20 year time frame are based largely on the USFWS energy related use conflicts report and information contained in Section 2.2, Categories of Potential Energy Related Development.

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* Based on $340,000 annual cost, and 10 mt/y throughput.

Economics of site specific transportation infrastructure upgrading are discussed in Section 3.4, Dredging Estimates and DMD Costs, and Section 3.5, Rail Upgrade costs.

The potential sites are as follows: (See Figure 1)

High potential:
- Tansy Point
- East Bank, Skipanon River
- West Bank, Skipanon River
- Port of Astoria Docks
- North Tongue Point
- South Tongue Point

Low potential:
- Port of Ilwaco
- Port of Chinook

3.2 HIGH POTENTIAL SITES

3.2.1 Tansy Point

The CREST Mediation Agreement identified the Tansy point area for large (80-100 acre) water-dependent development, with the exception of bulk coal or ore facilities, citing "potential conflicts with adjacent and nearby uses"[39] that include residential homes and seafood processing facilities. This does not preclude use for other energy related projects. Tansy Point is an attractive development site for the following reasons:

a. Naturally scoured deep draft vessel access adjacent to the shoreline.
b. Proximity to the river mouth (RM-10).
c. Little or no maintenance dredging of the berthing area would be required due to the high degree of river scour.
d. Potential for 3,600 feet of deep water berthing frontage exists.
e. Fewer biological impacts associated with major development than at most other development sites.
f. Total of 80-100 acres available for development.
g. Access to the longest tidal window of any major development site on the Columbia River.

A possible disadvantage to Tansy Point is the existing use of the area, and deed restrictions on certain parcels. For an 80-100 acre contiguous site to exist, property ownerships would have to be consolidated, 21 homes and businesses would have to be relocated, and improvement of the highway and rail line would be necessary. The cost of remedial measures for these problems is estimated to be similar to project costs at other sites (50-90 million dollars).

Since bulk coal/ore shipments are not allowed under the mediated agreements, and it is unlikely that any LNG or LPG facility would be sited in the Estuary (see Section 2.2.4) the most likely energy related facility at this site would be OCS support services (see Section 2.2.3). This type of activity would not necessarily require consolidation of the whole parcel to operate. Due to the uncertainty of OCS activity on the West Coast and the property consolidation problem, energy related development at Tansy Point over the next 20 years is seen as low.

3.2.2 East Bank, Skipanon River

The East Bank of the Skipanon River is one of the best large acreage water-dependent development sites with deep draft access in the Columbia River Estuary. Reasons for this include proximity to the river mouth, (River Mile 11.5) and access to the main 40 foot navigation channel 2,100 feet to the north.[40] With minimal or no alteration to adjacent estuarine wetlands, up to 200 acres of upland and 1500 feet of Skipanon River frontage would be available for construction of bulk commodity storage and ship berthing.

Dredging requirements are small relative to sites further upriver (see Section 3.4). The Skipanon River channel is federally authorized at 30 feet deep and 200 feet wide,[40] although the present maintained depth is 13-15 feet. To fully develop the deep water characteristics of the site, a 40 foot channel would need to be dredged to the main river channel. Alternately, conveyor galleries could provide access to the channel, thus avoiding the need to dredge the Skipanon River. This may cost up to 15 million dollars[29] for the galleries, but would reduce dredging costs. The combined cost of development at this site is estimated to be less than at other site options further upriver (see Section 3.4 for a discussion of dredging costs).

Highway and rail access are available to the site. Upgrading of the rail line and trestle across Youngs Bay would be necessary for the bulk coal/ore transshipment option.

Probability of an energy related facility on the East Bank of the Skipanon River is estimated at near zero until the late 1980's, when increased demand and more certainty in the energy markets will raise this probability to medium through the 1990's.

3.2.3 West Bank, Skipanon River

This site consists of three non-contiguous parcels of land of approximately 32 acres, 52 acres, and 110 acres in area separated by the City of Warrenton sewage lagoons,[39] at approximately river mile 10.5. Though the present upland configuration makes coal or bulk ore handling infeasible due to unit train loop track requirements, it may be possible to arrange a loop track right of way with the adjacent 110 acre lumber mill and log storage site. Direct access to the Skipanon Waterway or main Columbia River ship channel is limited. Conveyor galleries across the log storage sites and through a "Conservation Aquatic" corridor to the north to a loading pier near the navigation channel would allow deep draft berthing access without significant dredging. This method could also be used to connect the three parcels of land by passing over the sewage lagoons. Rail and highway access is good. Upgrade of the rail and trestle would be necessary for the coal facility option.

Due to the three-parcel configuration and limited access to deep water berthing, only energy facilities designed for shipments of bulk energy commodities (e.g., LNG, oil, coal) would be able to efficiently utilize this site, using pipeline or conveyor to reach deep draft ships in the main channel. Because LNG or oil energy facility development in the Columbia River Estuary is expected to be virtually non-existent over the next 20 years (see Section 2.2.4) and because there are less restrictive coal facility sites nearby, the probability of energy related development on West Bank, Skipanon River is estimated to be very low over the next 20 years.

3.2.4 Port of Astoria Docks

The Port of Astoria Docks is also a feasible location for energy related development. The Port has expressed special interest in a bulk coal handling facility.[41] The Port has direct access to the 40 foot main navigation channel, and is located at River Mile 13. Through the mediated agreements, 2,340 feet of continuous berthing area could be made available with direct access to approximately 85 acres of upland, 52 acres of which is already levelled and surfaced. This would require filling between Pier 2 and Pier 3, demolition of an existing warehouse, and construction of a thirteen acre, 1,280 foot pier to the west of the existing facility. This total area would be sufficiently large to accommodate a 100-car coal loop track, bulk storage area, and loading/unloading machinery. There is good highway and rail access to the site. Additionally, development of a coal handling facility at the Port of Astoria

Docks would eliminate the need for upgrading of the Youngs Bay trestle, and double crossing of Highway 101. The rail upgrade costs from Portland to Astoria would be less than at the Skipanon or Tansy Point sites. However, this advantage may be offset by the greater dredging costs of being further upriver (see Section 3.4). Another possible constraint to coal port development at the Port docks is local resistance to the effects of large scale transshipment of coal, particularly wind blown coal dust. Probability of development of an energy related facility at the Port of Astoria docks is seen to be low until 1990, medium to the year 2000.

3.2.5 North Tongue Point

Tongue Point, at River Mile 18.5, has been extensively studied for potential use as a coal handling facility, and as a result a great deal of site planning has already been completed.[7,42] The mediation agreement allows for filling between the existing south edge of the "North Tongue Point" site to midway between pier five and six. This would create roughly 80 acres of new upland, for a total upland area of approximately 120 acres. Also contained in the agreement is a provision for access channel and turning basin dredging, rail routing on site, and pile supported rail access structures.[39] The main advantage to the North Tongue Point site for energy development is the proximity to rail service necessary for efficient operation. Estimates for the rail upgrade between Portland and Tongue Point are about half of the rail upgrade costs to the Skipanon and Tansy Point sites.[8] In addition, the North Tongue Point option would eliminate the need for coal train traffic through downtown Astoria. The Tongue Point sites are somewhat more protected from the strong western winds that blow most of the year in the Columbia River Estuary, and this may serve to lessen the impact on air quality caused by fugitive coal dust. A major drawback to the North and South Tongue Point sites is the high cost of new work and maintenance dredging of the Columbia River navigation channel to accommodate large colliers. This may offset all of the above advantages, and force development further down river (see Section 3.6) Probability of development of an energy related facility at North Tongue Point is estimated to be low through 1990, and medium to 2000.

3.2.6 South Tongue Point

The South Tongue Point site consists of 100 acres of upland with immediate rail and highway access. Development of South Tongue Point for an energy-related facility is directly related to the North Tongue Point development site. Under the mediated agreement, a pile-supported access corridor between the two sites is provided for, and a navigation channel of up to 25 feet deep and 500 feet wide is allowed to the eastern side of the site.[39] Development of South Tongue Point would add approximately 2,500 feet of shallow draft pile supported berthing and 100 acres of upland to potential Tongue Point development. Development of North Tongue Point is a prerequisite to development of South Tongue Point for water-dependent use. Therefore, the probability of energy related development at South Tongue Point is the same for North Tongue Point, low through 1990, and medium through 2000.

3.3 LOW POTENTIAL SITES

3.3.1 Port of Ilwaco

The Port of Ilwaco's main constraint to energy facility development is space, with only approximately 26 acres available on a peninsula of dredge spoils surrounding the boat basin. The area designated as "Development" is bordered by extensive marsh and mudflats to the east, and by Fort Canby State Park and more marsh to the west. The brackish marsh areas have been designated "Natural" in the Columbia River Estuary element of the Pacific County Shoreline Master Program,[43] and therefore may not be available for large scale development. Channel access is limited, with severe shoaling problems.[38] The boat basin is located approximately 3.5 miles from the main Columbia River navigation channel, and is maintained at 10 feet.[40] The access channel is federally authorized at 10 feet deep by 150 feet wide.

Dredging and maintaining the long access channel 30 to 40 feet deeper than present conditions would be very costly. There is no rail access to the site. Thus, aside from a potential support role consisting mainly of transportation for outer continental shelf activities, the probability of energy related development at the Port of Ilwaco is perceived to be near zero for the next 20 years.

3.3.2 Port of Chinook

The Port of Chinook has development constraints similar to those cited above for the Port of Ilwaco. Shoaling threatens to shut off the access channel entirely,[38] and 2.8 miles of very extensive new work and maintenance dredging would be required to modify the present 10 foot channel to 40 feet, with the same difficulties mentioned above for the Port of Ilwaco. Although development land exists away from the water, no extensive piers or water related facilities exist of the size necessary for energy-related development. No rail line serves Pacific or Wahkiakum Counties along the Columbia River, and this eliminates the possibility of bulk energy commodities being shipped in or out of the Port of Chinook or the Port of Ilwaco. There remains, however, the possibility of the Port of Chinook providing small scale outer continental shelf support services. Given the above constraints, the probability of energy related development at the Port of Chinook is estimated to be near zero for the next 20 years.

3.4 DREDGING ESTIMATES AND DMD COSTS

The amount of material dredged to provide navigational access to each potential development site depends on the shoal that must be removed and the vessel draft to be accommodated. This discussion begins with estimating this amount of material, and calculating the cost of disposal of that material at the closest available DMD site. The estimates for individual shoals are based on the percentage of the total channel dredging to Tongue Point that is presently performed on a particular shoal over a five year period with the bar dredged to 48 feet. The percentages are then multiplied by total estimated dredging quantities to estimate new quantities for particular shoals. For the purpose of this analysis, the following assumptions are made: 1) the MCR Project has been completed, with the bar dredged to 55 feet and the channel maintained at 40 feet, 2) the percentages of total dredging required per shoal will remain the same at the new depths. Due to higher energy costs in the future, both on site dredging costs and spoil transportation costs will be greater than at present. Assuming that all dredging can be accomplished using a new 6,000 cy hopper dredge and the older 3,600 cy hopper dredge Biddle, it is estimated that on-site dredging costs will be approximately $1.07/cy.* Columbia River clean sand and water weigh approximately 1.5 tons per cubic yard.[44] Assuming a

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*Includes $.07 amortized cost of new dredge at 7-5/8% interest over 50 years assuming 50 mcy/y capacity.

transportation cost of $.04/ton mile, this yields an average dredge and disposal cost of about $1.70/cy (see Appendix A). This is considered a conservative estimate, as some estimates have ranged as high as $2 to $4/cy.

Mouth and channel configuration will be as follows:

Mouth: 660' wide @ 55' depth (inbound lane)
660' wide @ 65' depth (outbound lane)**

Channel: 300' wide @ 40' depth (inbound lane)
400' wide @ 55' depth (outbound lane)**

All estimates of new work dredging quantities are based on existing Corps of Engineers data,[45] previously published estimates,[7] and conversations with the Corps of Engineers and other experts. By October 1983, the Corp of Engineers Waterway Experiment Station using a physical model will make available new dredging estimates that can be compared to these estimates. The accuracy of the physical and numerical models now being used has been questioned by several physical oceanographers.[46,47] Table 5 contains the individual shoal new work dredging quantities expressed as a per cent of the total volume, and the estimated cost of dredging each shoal. Cost calculations are contained in Appendix A. Potential disposal sites used for cost of disposal calculations include those sites presently in use or identified for future use by the Corps of Engineers, and those contained in the Columbia River Estuary Regional Management Plan.[38] Transportation costs of the material are calculated by using the nearest, and thus most cost efficient sites. Two of the sites used in this analysis (36-E, 39-E) are self scouring deepwater areas in or near the navigation channel that are under study as possible estuarine in-water disposal sites.[48] These have been included under the assumption that these sites will be available for new work dredged material placement. Cost estimates assume that estuary in-water sites will be used to their estimated capacities, and no land sites are used due to restricted availability of upland sites. Due to the large quantities of materials also involved in operations and maintenance (O&M) dredging on a yearly basis, it is assumed that the present disposal areas at the mouth, E, B, A, and F will be utilized, with an average haul distance of approximately 4 miles past RM-0.

**Depth sufficient to accommodate 150,000 DWT colliers in loaded condition.

Although the economic viability of a deep draft port development project is not predicated solely on dredging costs, new work dredging and DMD costs may be a significant portion of project costs. These costs may be amortized over several decades, and therefore are not a prime determinate of project viability. A more important factor is whether the project can absorb the cost of maintenance dredging and still maintain a net benefit.

Estimates for mouth and channel operations and maintenance dredging requirements are based on extrapolations of unpublished Corps of Engineers data contained in the Feasibility Study for Coal Export Facility at Tongue Point.[7] Obtaining accurate estimates of maintenance dredging quantities is difficult without extensive numerical modeling.

Table 5

NEW WORK DREDGING ESTIMATES*

Shoal	River Mile[40]	% Total Dredging[40]	Estimated Volumes (mcy)	Estimated Cost Total**	Estimated Cost per cy
Mouth	-2 to +3	100	12.0	17.2	1.43
******************					
Desdemona	5.0 to 9.4	5	.7	1.3	1.79
Flavel	11.0 to 13.4	81	11.3	19.7	1.74
Upper Sands	16.3 to 16.8	14	2.0	2.3	1.15***
TOTAL		100	26.0	40.5	

* Projections based on a 65' mouth and 55' channel, assuming a 55' mouth and 40' channel base project.

** Costs in millions of dollars.

*** Upper Sands shoal is very near the Harrington Sump; therefore transportation costs are considerably less.

Therefore, the following discussion of possible annual maintenance dredging quantities and costs for the mouth and the main navigation channel relies on the assumption that the percentage of material removed from different shoals for a 55 foot channel will be the same as for the current 40 foot channel.

Swan-Wooster (1981), assumed exponential increases in shoaling rates for linear increases in depth of O&M dredging. Using the same method, this study extrapolated those numbers for a two foot greater channel depth, yielding an average shoaling rate at 55 feet of 5.75 feet per year, or 10,900,000 cy per year in channel maintenance dredging requirements. Spoil disposal for maintenance dredging will not be able to follow the same pattern as new work disposal, because the sites available for in-water O&M dredged material disposal may fill up in a matter of a few years.[5] This may restrict a larger proportion of the spoils to open ocean dumping, raising the cost/unit of material transported. Using the same dredging and transportation costs and transportation distances as developed above, O&M dredging volumes and costs are shown in Table 6, and cost calculations are found in Appendix A. Discussions with the Corp of Engineers and other sources indicate that these cost estimates are conservative, and may increase substantially over the next two decades. Estimates have usually fallen near the $2-3/cy range, with some as high as $5/cy by 1990. It should also be noted that continued use of some of the proposed new sites may not be possible, due to rapid movement of the placed materials back to the channel, or conversely, mounding at rates high enough to restrict continued placement of materials at the disposal site. Continued use of the Harrington Point Sump/Rice Island system at the magnitude described above may lead to an accelerated increase in estuarine shoaling, which conflicts with stated local, state and federal management objectives. If alternate environmentally sound in-estuary sites cannot be identified, O&M dredge spoils will be disposed of in the open ocean in ever increasing proportions, with a steadily increasing cost associated with that method.

3.5 RAIL UPGRADE COSTS

For the purpose of this analysis, the Burlington Northern rail line from Portland to Tansy Point has been divided into the following segments:

- Portland to Tongue Point
- Tongue Point to Port of Astoria Docks
- Youngs Bay Trestle and Track to Warrenton (East Skipanon)
- Warrenton (East Skipanon) to Tansy Point

Table 6

ANNUAL OPERATIONS AND MAINTENANCE DREDGING ESTIMATES*

Shoal	River Mile[40]	% Total Dredging[40]	Estimated volumes (mcy)	Estimated Cost Total**	Estimated Cost per cy
Mouth	-2 to +3	100	7.5	10.7	1.43
**					
Desdemona	5.0 to 9.4	5	.55	1.0	1.79
Flavel	11.0 to 13.4	81	8.8	15.5	1.76***
Upper Sands	16.3 to 16.8	14	1.5	2.1	1.40***
TOTAL		100	18.4	29.3	

* Projections based on a 65' mouth, and 55' channel, assuming a 55' mouth and 40' channel base project

** Costs in millions of dollars.

*** O & M costs for these shoals are greater than for new work costs because of assumed unavailability of disposal sites 36-E and 39-E.

The cost of rail upgrade at any of the potential development sites is the cumulative cost of all segments between the site and Portland. Information on rail upgrade costs for particular rail segments in the Astoria and Warrenton area were obtained from the Department of Transportation, based on Oregon PUC and Burlington Northern estimates. These estimates will be used to determine over-all rail costs to a given development site. For the purposes of this report, published estimates of certain segments,[6,7,15] information from Oregon PUC[49] and Burlington Northern,[50] and calculations based on estimated per mile upgrade costs of 350,000 dollars per mile[49] are used to construct Table 7.

Several rail factors that are common to more than one site include:

1. Unit train movement west of Astoria would cross Highway 101 at two locations approximately 1.6 miles apart. This would create delays of 10-15 minutes at each crossing for highway traffic. Burlington Northern has imposed an embargo on rail traffic crossing Youngs Bay beginning October 1, 1982, with eventual plans to replace the entire trestle.[50] This replacement may involve attempting to move the trestle north of the highway to eliminate the multiple crossing of the highway. This replacement is estimated to cost approximately 13 million dollars.[49] Sites west of Youngs Bay must include this amount into project costs, and hence into commodity throughput costs. Locating upriver from Youngs Bay will lower dockside costs of commodities compared to sites west of Youngs Bay by eliminating the need to rebuild the rail trestle.

2. Though the existing track between Tongue Point and Portland will support coal unit train traffic in its present condition, it is expected that the tracks would deteriorate rapidly under such heavy usage.[50] Cost estimates for strengthening the rail line range from 27 to 55 million dollars,[6,7,15] with Burlington Northern estimating around 33 million dollars.[49] This would add a surcharge of approximately 55¢/ton F.O.B. to the price of coal over the amortization period.[7]

3. Use of sites west of Tongue Point must address potential public and business resistence to coal train movement through downtown Astoria. For a 10 million tons/year facility, train traffic is estimated to be between three and five 100-car unit trains moving through the town twice daily (once in, once out), 350 days per year.[8,51] That is equivalent to one train passing a given point every two and one-half to four hours. For a 15 million tons/year facility, the frequency increases to one train passing a given point every one and one-half to three hours.

Table 7

RAIL SEGMENT UPGRADE COST ESTIMATES[6,7,15,48,]

Segment	Estimated Length (miles)	Segment Cost*	Total Cost From Portland*
Portland to Tongue Point	92.0	33.0	33.0
Tongue Point to Port of Astoria Docks	4.8	2.0	35.0
Port of Astoria Docks to East Skipanon			
-rail	1.8	1.0	-
-trestle**	1.5	13.0**	49.0
East Skipanon to Tansy Point	1.8	1.0	50.0

* Costs in millions of dollars.

** Assuming complete replacement of the existing trestle is necessary for unit train movement.

3.6 RAIL VS DREDGING COSTS IN SITE SELECTION

There are essentially four factors involved with determining economically optimal site development in the Columbia River Estuary: cost of the facility, railroad upgrade costs to the site, dredging costs to the site, and maintenance dredging costs over time at each site. Table 8 contains estimates of the above criteria for four sites, using data from Tables 4, 5, and 6, along with facility cost estimates from the Port of Astoria[29,52] and other sources.[7] Maintenance dredging cost estimates should be considered accurate for the first five years of maintenance dredging only, as it is expected that costs will increase in the future at an unknown rate. The twenty year estimate is for comparison only. The data presented in Table 8 suggest that over time maintenance dredging is the most important factor in the profitability of a given site. Development sites downriver from Flavel Shoal (Skipanon, Tansy Point) have a distinct cost advantage over sites that must dredge Flavel Shoal to operate.

Table 8

SITE SELECTION ECONOMIC DATA*

ite	RM	Coal Facility Costs	Rail Upgrade Costs	New Work Dredging Costs**	Maintenance Dredging Costs	Total Estimated Cost 1 year	5 year	20 yea
ansy Point	10.0	N.A.	50.0	17.2	10.7	N.A.	N.A.	N.A.
ast Skipanon	10.5	80.0	49.0	18.5	11.7	159.2	206.0	396.0
ort of Astoria Docks	13.0	65.0	35.0	38.2	27.2	165.4	274.2	682.2
orth Tongue Point	18.5	100.5***	33.0	40.5	29.3	203.3	320.5	760.0

* Costs in millions of dollars.
** Assuming a 65' mouth and 55' channel.
** Adjusted to 1982 dollars.

4. POTENTIAL IMPACTS OF ENERGY RELATED DEVELOPMENT

4.1 DREDGING AND DREDGED MATERIAL DISPOSAL

4.1.1 Salinity Changes From Channel Deepening

Salinity exerts a major role in determining the composition and distribution of communities within the Estuary, and changes in salinity patterns are likely to redistribute both species and areas of productivity. The amount of salt water intrusion and salinity change resulting from deepening the entrance and navigation channels is difficult to predict. Salinity changes resulting from previous channel deepening efforts are masked by lack of data and the natural variability of the system.[53] Moreover, data on increases in salinity associated with incremental increases in channel depth are not available. However, it is possible to make general statements regarding potential effects of channel deepening on the Estuary.[2] Increased channelization of the river may affect the Estuary in two ways. First, deepening the channel would increase the volume of the salt water wedge, and thus salinity intrusion into the Estuary. Second, increased channelization might cause a reduction in overall river currents within the Estuary, allowing greater salinity distribution into the peripheral bays.[53]

The most significant impact to biota will be at the upriver end of the affected area, where a former freshwater zone will become a brackish zone. This will eliminate saline intolerant freshwater biota from the area. Cathlamet Bay may be the area of greatest impact. The main effect would be changes in abundance and distribution of many species. Assessing this impact requires information on species abundance, distribution, functional relationships, and relationships between organisms and physical factors. This information is not available at the present time.[53]

The Columbia River Estuary Data Development Program (CREDDP) has produced a large data base that can potentially address many of the channel deepening impacts. Preliminary review of the CREDDP data suggests that the following impacts to the biota from deepening the channel to 50-60 feet need to be addressed.[53]

-Primary productivity

The distribution and productivity of emergent plant, water column, and benthic primary producers can be estimated and mapped, and for the most part, information will be adequate to ascertain changes brought about by higher salinities. In order to rigorously define emergent plant associations in

Cathlamet Bay and other parts of the Estuary and to show the relationships between these associations and such physical factors as salinity, a great deal of statistical analysis must be performed on existing data. This analysis should be intensified to generate results of sufficient resolution.

-Benthic diatoms

At present, the Corp of Engineers is funding a study to determine the existing upstream limit of salinity intrusion using diatom species as indicators. This will be useful as a supplement to the physical studies of salinity intrusion and will also be beneficial in determining changes in the benthic diatom community after the channel deepening.

-Phytoplankton

Phytoplankton productivity may also be altered if salinity intrusion is increased. The first step in determining the effects is a characterization of the species composition of phytoplankton assemblages on each side of the freshwater/brackish water interface. Then, knowledge of the productivity levels common to each community, combined with the already developed model of phytoplankton productivity, can be used to predict the new productivity levels after the channel deepening. The quality of this evaluation can be increased by further refining existing models of phytoplankton productivity. Most importantly, the link between primary producers and higher trophic levels must be determined so that the effects of altering primary productivity patterns can be assessed.

-Secondary production (zooplankton)

The effect of channel deepening on zooplankton has not been identified as an area of concern by resource agencies. CREDDP has many stored zooplankton samples taken from the mouth of the estuary to the extreme western part of Cathlamet Bay, in or near the navigation channel. Sample processing to date has been limited to spring and summer collections only. Therefore, to produce a complete annual picture of zooplankton abundance or to characterize the tidal/diel/depth distribution of the important zooplankter Eurytemora, some additional processing must be done. The freshwater community has not been adequately sampled, and it will be the community most affected by an upriver shift in salinity. It will require a full annual series of zooplankton samples to adequately describe communities in this area. It is preferable that fish be sampled at the same time to establish trophic linkages between the zooplankton and fish.

-Benthic infauna

The effect on benthic infauna are mainly related to changes in distribution and abundance brought on by the salinity increase. CREDDP intends to analyze field data using various multivariate techniques to determine relationships between infauna and salinity. Knowledge of these relationships can be used to formulate predictions of changes in the benthic infaunal communities in response to an upriver shift in salinity intrusion.

-Epibenthic fauna

According to many resource agencies, the most important epibenthic organism to examine is Dungeness crab because of its commercial value. The link between this organism and its prey has not been studied in the Columbia River Estuary. This trophic link can be examined by processing crab stomach samples already collected by CREDDP. Resource management agencies have expressed interest in determining the use of the Estuary by juvenile Dungeness crab, including their abundance and migration routes. A synthesis of existing data collected by NMFS, CREDDP, and other resources may suffice in ascertaining use of the Estuary by juvenile Dungeness crabs.

-Fish

State and federal resource management agency concerns about fisheries are mainly focused on juvenile salmon distribution, migration routes and timing, and utilization of Cathlamet Bay. In order to examine trophic linkages between salmon and their prey, fish stomachs must be analyzed. CREDDP has several thousand stored samples, but can only process a few hundred at the present time. Additional processing would increase the knowledge of fish feeding requirements in the Estuary.

A tremendous amount of data have been collected by CREDDP, NMFS, and other researchers, and these data have never been synthesized. Therefore, the first and possibly the most important step in assessing impacts on fish would be to fund a fisheries biologist/estuarine ecologist to synthesize existing data into a comprehensive report on fish ecology in the Columbia River Estuary. Once this is completed, studies to develop lacking data can be initiated.

-Higher trophic levels

Other organisms which should be included in an impact assessment are birds, wildlife, and marine mammals. The effect on birds and wildlife will most likely be minor. However, marine mammal food requirements and activity patterns should be examined because any change in their abundance and distribution may have adverse impacts on the commercial salmon industry.

Physical characteristics and biological interrelationships in an estuary are very complex and may never be fully described and quantified. However, new investigations such as those described above are all steps toward a more complete characterization of the estuarine ecosystem, and are necessary to fully delineate impacts related to navigation channel deepening. Table 9 contains a summary of study recommendations to reach this goal.

Table 9

SUMMARY OF STUDY RECOMMENDATIONS

1) Describe the present vertical mixing processes and salinity intrusion patterns.

2) Modify and refine the two-dimensional vertical model to be produced by CREDDP in order to predict the extent of salinity intrusion after channel deepening.

3) Calculate suspended sediment fluxes using CREDDP data.

4) Use the WES sediment transport model along with the results of #3 and the CREDDP two-dimensional horizontal model to predict future shoaling patterns.

5) Fund a fisheries biologist/estuarine ecologist to synthesize Columbia River Estuary fisheries data.

6) Assess the need for further field work to fill the gaps revealed by #5.

7) Assess the need for field work concerning juvenile salmonid use of Cathlamet Bay tidal marshes.

8) Conduct further stomach analysis on fish to determine their food requirements. Emphasis should be placed on Cathlamet Bay samples.

9) Call a meeting of "crab authorities" to discuss current information on Dungeness crab use of the estuary before considering new field work. Synthesize existing data on Dungeness crab in the Estuary.

10) Conduct further analysis of zooplankton data to better define their abundance and distribution in time and space.

11) Describe the emergent plant communities of the Estuary and their relationships to salinity levels.

12) Conduct a further processing and analysis of CREDDP phytoplankton samples in order to ascertain post-channel deepening changes in phytoplankton productivity.

13) Examine marine mammal activity patterns and food requirements of marine mammals in the Estuary.

14) Perform laboratory activity experiments on patterns and food requirements of organisms found in the Estuary.

15) Conduct stable carbon isotope analysis to assess the relative contribution of each primary food source to the food web.

4.1.2 Ecological Effects of Sediment Removal and Relocation

Water quality impacts related to mouth and channel dredging are expected to be slight. Sediments in the lower Columbia River are "clean", that is, there are no significant concentrations of organic material or contaminants present.[38] Increases in turbidity are a localized, temporary occurrence. Due to the large volume and flow of the river, turbid water is rapidly diluted and flushed from the Estuary. The Estuary historically experiences high turbidty conditions during the spring freshet, and channel dredging impacts are seen as small in comparison.[54] Dredging impacts to benthic fauna will be severe in the short term, as large numbers of organisms will be removed from the channel. However, as it is not possible to dredge the entire channel at once, it is not likely that entire bottom communities would be eliminated. Surviving organisms and recolonization from the rest of the Estuary would provide a source of juveniles to recolonize the newly disturbed sediments.[55] The rate of recovery to previous conditions depends on the successional stage of the community at the time of dredging. Recovery to a previous "mature" community condition would take longer than recovery to an intermediate, "colonizer" community condition. This concept is borne out by previous studies in which mature, stable communities took a year or longer to recover,[56,57] while colonizer communities subjected to frequent disturbances required less than a month to recover to previous levels.[58]

It is probable that benthic communities found in the Columbia River channel are of the latter type, being subjected to periodic dredging and frequent disturbance from large vessel propwash. Thus, it is expected that damage to that part of secondary production in the Estuary represented by benthic invertebrate communities in the navigation channel would be small.

The above discussion indicates that on-site impacts from dredging would be very small, and that the focus of estuarine impact analysis should be on the impacts of salinity intrusion, as disscused above in Section 4.1.1. It is anticipated that dredging for deep draft access to potential energy related development sites will utilize both open ocean and estuarine in-water disposal sites, at least in the short term.

Disposal of dredged materials off the mouth of the Columbia River has been the subject of several studies.[59,60] Impacts to benthic and epibenthic organisms from the deposition of large quantities of spoils can be expected. The main affect of deposition of material on macrofaunal communities at disposal sites is a significant reduction in densities and a concurrent rise in diversity.[60] The diversity increase may be ascribed to "successional stage" non-equilibrium communities,[61,62] temporary removal of predators or competitors, juveniles imported with the sediment or river plume,[60] or simply cropping of the most abundant species. Whatever the mechanism, diversity increases are relatively short term, usually lasting less than one year.

Decreases in densities were caused by smothering of the fauna present. Some species are able to burrow up through sediments rapidly enough that the spoil deposition does not eliminate them.[60] Densities remain low for 10 months to a year after deposition.[60,62]

The selection of areas that are considered to be less critical habitat than others would lessen impacts on fisheries and organisms that utilize these areas. Area E is presently the preferred site, being a source of beach nourishment for Peacock Spit.[40] However, large quantities of material placed in this area may impact crab populations near shore.[38] In contrast, sediments placed at site D tend to move down channel and upchannel, with upchannel movement dominant, probably moving mainly into the north channel and on to Desdemona Sands. This is supported both by radioactive tracer studies and bedform analysis.[63] Bedforms on Flavel Bar indicate that this reach of the river is an area of convergence of bedload transport, receiving bedload sediments from landward in the spring and seaward in the fall.[63] It also is approximately midway between the excursion limits of the turbidity maximum in the Estuary, and thus also receives significant deposition of suspended sediments.[63]

Two methods of disposal may partially alleviate the problem of dredge spoil disposal:

1) Increase haul distance to deeper water;

2) Disperse the spoils over a wider area.

The first method has the disadvantage of considerably increasing the hauling time and costs of disposing of the material, and possibly causing greater impacts to dense offshore benthic communities. The second method may increase total impacts on benthic communities by affecting a larger area, though the impacts per unit area would be lessened compared to the present method. This may lead to more rapid recovery of the affected communities.

Washington State Parks has expressed interest in locating a sump where the North Jetty meets Cape Disappointment, and rehandling the material by pipeline dredge onto Peacock Spit for Washington State beach nourishment.[64] This method, if approved by resource agencies, would provide an almost unlimited disposal site for future project spoils.

Clatsop Spit is also a likely candidate for this method of disposal. Questions regarding this method center around the cost of double handling of spoils, the physical constraints of sump siting, and effects on razor clam populations on Benson Beach. This method, compared to ocean hauling, may be more attractive in the future when fuel prices again rise.

Open ocean dredged material disposal associated with a deep draft channel is expected to occur constantly. It is expected that due to the restricted area used for placing dredge spoils, benthic and epibenthic communities would be impacted at least semiannually, and this may permanently alter community structures in the disposal areas off shore from the Estuary.

4.2 ELECTRIC GENERATING FACILITIES.

Thermalelectric

With the possibility of coal transshipments from the Lower Columbia River comes the possibility of locating relatively small coal fired electrical generating facilities along the transportation route. Environmental impacts of coal fired electrical generation are well documented.[37] Construction impacts in the Estuary would be limited to excavation of water intake and outfall channels, and possibly runoff from the construction site. This would be a temporary, localized impact, and probably insignificant compared to normal estuary disturbances and turbidity levels. Much more significant are the long term impacts from stack emissions and thermal effluents.

Stack emmissions include fly ash, unburned hydrocarbons, carbon monoxide, nitric oxides, and oxides of sulphur. Sulphur dioxide in particular has been linked to decreases in crop and timber production, corrosion of metal and stone buildings, and lowering of property values.[37] In addition, areas of high precipitation such as the lower Columbia River are susceptible to acid rain conditions.

Acid rain can lower the pH of lakes and small rivers, and affects soil pH.[10] It is unlikely that acid rain could significantly affect the large volume of water in the Columbia River, but it may affect quiet, shallow water areas in the Estuary.

The need for large amounts of cooling water for thermalelectric power plants makes large sources of water such as the Columbia River economically attractive for plant siting. Cooling water intake structures have been shown to be extremely destructive of estuarine planktonic organisms and fish that use the estuary.[65] A generating plant on the Hudson River in New York killed almost 1½ million fish during a two month period in 1969, and 80% of all planktonic forms are killed passing through the cooling system of a Connecticut plant.[65]

Salmon in the Columbia River would be especially vulnerable to entrapment at power plant cooling water intakes, as they are known to feed and migrate near shore where intakes would be located.[65] Appropriate project design may significantly ameliorate this impact.

The effects of thermal effluents in the Columbia River are very well studied, mainly in conjunction with operations at the Hanford Nuclear Reservation in Eastern Washington, and hydroelectric dams along the river's entire route.[66,67,68] Due to the large volume of the lower Columbia River, it is unlikely that a moderate sized coal fired thermalelectric plant would appreciably raise the temperature of the entire river. Localized impacts would be unavoidable, and it is likely that salmon and other cold water fish would be excluded from the area.[37] The localized increase in temperature at the outfall may increase predation of juvenile salmon even temporarily exposed to the elevated temperatures, decrease their resistance to disease and pollutants, and interfere with migration.[65] All marine and estuarine species in the area exposed to even periodic warm water eddies may experience interference with reproductive patterns.[65]

Changes in the structure of local primary production communities would be expected if temperature changes are constant, as warm water species replace cold water species. This usually means the replacement of benthic diatoms and macroalgae with blue-green algae.[64]

Wet scrubber systems for the control of fly ash collect very fine particulates that do not settle out in waste water treatment ponds and would otherwise would be passed into the river. Potential constituents of this waste water may include substances such as dilute acids, boron, and radioactivity, which also have negative impacts on the aquatic ecosystem.

Hydroelectric

Three sites are being considered for low-head hydroelectric generation in the Columbia River Estuary area, although none have been proposed for the Estuary itself. Two of the sites, Big Creek and Youngs River, are on the Oregon side of the Estuary, and the third, Grays River, is on the Washington side. Air impacts from construction would be considered small, and impacts related to operation would be virtually nonexistent although some increase in air moisture content near the sites is possible in drier months.

Water quality impacts include turbidity and hydrocarbon pollution during construction, and temperature and nitrogen supersaturation increases during operation. Coffer dam and falsework construction is usually necessary during placement of the main containment structure. Equipment in, over, and adjacent to the stream bed during dam and falsework construction may introduce hydrocarbons, cement, and other wastes into the river,[37] with potential adverse impacts on emergent vegetation, phytoplankton, diatoms, and fish spawning grounds.

In addition to direct damage to the river bed by heavy equipment, silts released from gravel washings and coffer dam demolition may cause down river turbidity and fine sediment deposition to rise to unacceptable levels.[37] This could inhibit primary production in the river, and render salmon spawning gravels unsuitable for use.

Water passing through generator turbines and over spillways tends to become supersaturated with nitrogen.[65] High nitrogen supersaturation greatly reduces salmon tolerance to temperature increases. At 110% nitrogen supersaturation, a one degree celsius rise in temperature can cause gas embolism and death, while at higher levels temperature increase is not necessary to cause gas embolism.[69]

Considering the cumulative impacts of existing dams on the Columbia River, new low-head hydroelectric dams at the three proposed sites will have little effect on the Columbia River Estuary. They may, however, have considerable effect on the particular tributaries suggested for impoundment. Impoundment tends to raise water temperatures by slowing movement and increasing the surface area of the river exposed to insolation.[70,71] A moderate rise in temperature associated with smaller hydroelectric projects probably would not prevent adult salmon from migrating or spawning.[66,67] There is a possibility that such an increase in temperature may decrease or eliminate reproductive success of downstream spawners by increasing metabolic rates and stress on eggs and juveniles,[68] and making them more susceptible to other physical and chemical stresses.[66,69]

4.2.3 Economic Impacts

Economic impacts from electrical generating facilities have historically been considered to be positive. Electrical generation is a "major act of production" and, like all production, increases income.[37] Typical construction operations last about five years, with wages and salaries starting low, rising to a peak after the first 2-2½ years, then tapering off to previous low levels.[37] This is because it takes many more workers to construct a facility than to operate one. Since the employment impacts are temporary, so are the impacts to social services, although these impacts may be severe during the construction phase.

Long term growth stimulated by a new source of energy may cause significant impacts to the environment, social services, and tax structures. In many cases, "revenue is added with the first boom, but then the county can be left holding the bag for all the added infrastructure costs".[72] To make up for added costs of police and fire protection, education facilities, water and other utilities brought on by the influx of activity that an increase in power availability brings, and which the new utilities tax input does not cover, counties may have to raise tax rates or assess homes and properties at higher rates. This can have a negative impact on people and businesses not economically connected with the new power plant.

Given the overall effect of the "boom and bust" cycle of construction and long term costs of development, some county officials in other areas have come to the conclusion that "the bottom line here is that it doesn't pay to be developed."[73]

4.3 FUEL PROCESSING FACILITIES

The probability of fuel processing facilities locating in the Columbia River Estuary is near zero (see Section 2.2.2). In addition to associated water dependent development construction impacts, there are many air, water, and solid waste emmissions associated with operation of the four types of fuel processing facilities addressed in this report, many of which have been identified as potential carcinogens.[74]

Two very good treatments of fuel processing facility operational impacts (with bibliographies) are contained in <u>Energy Related Use Conflicts for the Columbia River Estuary</u>,[10] and <u>Evaluation of Power Facilities: A Reviewers Handbook</u>.[37]

4.4 GAS AND OIL EXPLORATION

It is likely that gas exploration in the Columbia River Estuary area and oil exploration offshore will take place in the next five to ten years (see Section 2.2.3). Impacts related to these two activities are quite different in nature, and will be addressed separately.

Exploratory drilling for gas will not take place in the Estuary itself because of laws designed to protect sensitive aquatic areas. Directional drilling techniques can be utilized from upland sites to tap reserves underlying estuarine aquatic areas. Problems encountered with removal of gas reserves include reduction in subsurface pressure, which may lead to subsidence of estuarine areas above the gas pocket. This could radically change estuarine community distributions. Preventive measures require pumping water into the gas resevoir, both to reduce subsidence and maintain well head pressure. Measures to prevent contamination and reduction of groundwater supplies may be very important in some areas.

Exploratory drilling produces cuttings, surplus drilling muds, chemicals, and various fugitive gases from the wellhead.[10] The standard procedure is to collect these fine grained solids and soluble materials into waste pits, allow them to dewater, and then reuse or dispose of them offsite. Waste quantities generated are on the order of one cubic yard for every 9-14 meters depth, and 20-40 kilograms of chemical additives per day.[10] Safety, location, and maintenance of waste pits and "mud sumps" is imperative. A waste sump leak occurring on an unnamed tributary to the Walluski River (Clatsop County) introduced significant amounts of drilling muds to the river, causing a serious turbidity problem.[75] Nearly a month passed before the suspended material was discharged and the river approached normal clarity.[75] Impacts from exploratory drilling and minor production within the Columbia River Estuary area are expected to be small.

A potential threat to the Estuary from offshore oil exploration and production is related to oil spills and wellhead blowouts. Depending on the proximity to the mouth of the Columbia River, and other physical factors such as tides, weather, and river flow, impacts could range from air and water quality degradation to losses of marine mammal and important fishery populations. Under certain conditions (e.g., low river flow, flood tide), suspended sediments, drilling muds and cuttings, and hydrocarbons may also impact the Estuary, although this is not considered likely. Available literature on oil drilling and related impacts to the marine environment include Managing Oil and Gas Activities in Coastal Environments,[76] Oil Spills and the Marine Environment,[77] Oil Spills and Spills of Hazardous Substances,[78] and "Effects of Oil on Marine Ecosystems: A Review for Administrators and Policy Makers".[79]

A greater potential for impacts to the Estuary comes from construction and support of offshore facilities. Onshore activity generally occurs in three phases: development, production, and decline.[80] The prime activity during the development stage is construction. Construction is very labor intensive, so local areas undergo the greatest stress in housing and services during this time. Construction of drilling rigs requires large acreages with deep water access. A proposed steel structure fabrication yard on the Skipanon River near Warrenton, Oregon was estimated to require approximately 2.5 mcy of dredging and 344 acres of upland,[81] although project redesign reduced this requirement somewhat. In addition to drilling rig construction, there is a need for temporary and permanent shore services.[80,82] Impacts to social services are also greatest during this period. Estimates of workers drawn from outside the county to work in the steel structure fabricators yard range from 600 to 1500 individuals, not counting families.[81] It may take several years for state and local government revenues generated by oil production to catch up to costs of providing the necessary infrastructure and social services for a large influx of people. States such as Texas, Louisiana, and Oklahoma that supply these workers also experience disruption in tax bases and social services. This phase may last seven to ten years.[80,82] A major problem facing communities dealing with an oil boom is the inequity in pay between oil workers and the local workforce.[80] Pay scales for oil workers are quite high, an influx of large amounts of disposable income into a community increases consumption of local goods and services and therefore drives up prices. Residents not financially connected with oil money suffer from these higher prices, and this tends to increase the social dichotomy between "locals" and "oil people." Hostilities generated by this social dichotomy have led to vandalism against oil facilities in Scotland.[80] Other problems associated with rapid growth are discussed in Section 4.2.3, Economic Impacts of Generating Facilities.

The next phase, production, may last 5 to 10 years, depending on the size of the exploited fields. Oil fields off Oregon's shores are expected to be of small to moderate size,[13] and thus production will be on the lower end of the time scale. Activities in the Estuary are mainly transportation oriented, with personnel, supplies, and materials being shuttled between the shore bases and the drilling rigs.

Impacts associated with increased ship traffic in the Estuary are discussed in Section 4.6. The production phase of activity brings a decrease in employment opportunities, as it takes fewer workers to maintain the facilities than it takes to build them. This means there is less stress on infrastructure, but increased unemployment is likely to increase the pressure on economic social services. A recurring theme in previously published reports on onshore impacts related to offshore oil development is the need for rigorous planning at the earliest onset on activity to prevent the boom town-ghost town scenario.

4.5 TRANSPORTATION AND TRANSPORTATION FACILITIES

As discussed in Section 2.2.4, it is highly probable that no LNG, LPG, or oil transshipment facilities will be located in the Columbia River Estuary. Impacts from these types of facilities may be very great. Potential impacts from LNG and LPG facilities and transshipment activities are described in detail in "LNG and LPG Hazards Management in Washington State"[83] and an extensive bibliography on this subject is contained in LNG and LPG Hazards Management: A Bibliography.[84]

Oil spills and hazards of oil transshipment are probably the best studied of all pollution problems. A small sample of the available literature on oil spill hazards, impacts to marine environments, policy and cleanup technology are contained in Oil Spills and the Marine Environment,[77] Oil Spills and Spills of Hazardous Substances,[78] and "Effects of Oil on Marine Ecosystems: A Review for Administrators and Policy Makers"[79]. The oil spill cleanup capacity in the Columbia River Basin, an oil spill protection plan for the Lower Columbia River, and a case study of an oil spill on the Columbia River are contained in Oil Spill Cleanup Capacity on the Columbia River Basin,[85] Oil Spill Protection Plan for the Natural Resources of the Lower Columbia and Willamette Rivers,[86] and Columbia River Oil Spill Study,[87] respectively. One factor of note in these studies is that oil tanker traffic is responsible for a very small amount of the oil spilled into the Columbia River, and that the majority of oil comes from general cargo and passenger traffic.[85]

One of the more interesting, efficient, and economical methods of oil spill cleanup was recently tested on the Lower Mississippi River. "Antipollution pillows" were thrown onto the spill, and each 8 oz, standard chicken feather pillow quickly soaked up 8 lbs of oil sludge, not including the weight of water.[88] Use of this method in conjunction with oil containment booms may be applicable to the Columbia River.

The Marine Resource Damage Assesment Program developed by the Washington Department of Ecology[89] outlines methods for evaluating the economic impacts of an oil spill, and compensating parties suffering losses caused by a spill. This program is discussed in Section 5.4.4.

4.5.1 Coal Transshipment

It is likely that a coal transshipment facility will be operational in the Columbia River Estuary within 10-15 years. Impacts associated with coal export facilities fall mainly into five catagories:

1. Water Quality
2. Air Quality
3. Noise
4. Adjacent and nearby use
5. Hazards

-Water Quality

Water quality impacts would be related to direct settling of coal dust on the Estuary surface, and storm water runoff from the development site. The problem of direct coal dust input to the Estuary varies with the different site options. Sites such as the Port of Astoria Docks or East Skipanon may deposit coal dust in the relatively calm Youngs Bay area, while the Tongue Point site would impact Cathlamet Bay.

Low current velocities allow the dust to settle through the water column and become incorporated into the sediments. This is a very gradual process, and as yet, there is no evidence that this process inhibits the normal functioning of estuarine ecosystems.[90] However, if prevailing winds consistently deposit dust in a particular area of the Bay over an extended time period, coal buildup in the sediments could cause significant problems. Shiploading facilities at the Superior Midwest Energy Terminal have been shown to spill an estimated 10-20 tons of coal per year into the adjacent shipping channel.[91]

A potentially more severe water quality impact may occur from polluted precipitation runoff from the coal handling site. This wastewater would contain coal dust and other waste matter such as dilute acids, hydrocarbons, dissolved solids, and suspended fines. An average of 66-80 inches of rain per year falls on the Columbia River Estuary area,[92,93] often at very heavy rates. One inch of rain falling on a 100 acre site assuming 90% runoff [33] creates approximately 2.7 million gallons of water. Rainstorms in Astoria periodically drop three to three and one-half inches of rain over a 24 hour period. This would generate an average of approximately 6560 gallons per minute of wastewater flow over the 12 hour period for the 100 acre site that must be treated. Greater flow rates can be expected for the 100 year storm. Flow equalizer ponds, large capacity settling ponds, and overload filter systems would be necessary to handle high pulses of site wastewater runoff associated with storm fronts in the Columbia River Estuary area.

-Air Quality

Air quality is impacted from fugitive dust originating from dumping, stacking, reclaiming and loading, or merely wind blowing over stacked coal. Though this is a problem at any site, fugitive coal dust in Astoria proper may be more of a problem than at more rural sites. Even with state of the art washing and coating equipment, significant amounts of coal dust do escape during handling,[90] and the strong prevailing west winds common to the Astoria area could cause problems.

The Draft EIS for the proposed Port of Kalama facility estimates coal dust emissions from a 15 mty facility using state of the art emission controls would average 115.3 tons per year.[33] Adjusted for a 10 mty facility, this may equal 76 tons per year for a facility located in the CRE area. Seventy-six tons per year does not approach the threshold for a prevention of serious deterioration analysis, set at 250 tons per year.[33] However, considerable local citizen opposition to 76 tons per year of fugitive coal dust is possible. Near the 4 mt/y Neptune facility in Vancouver, B.C., which has sprinkler dust control and curtails operation during periods of high winds, residents on a hillside up to three miles from the coal yard complain that outside patios and furniture are "covered with coal dust," and that "you have to wipe it off constantly."[94] Intensive use of baghouses and sprinkler dust control systems may alleviate this problem to a considerable degree, but some coal dust deposition on Astoria and nearby communities would be unavoidable.

Coal dust emissions are of concern because of possible impacts to cities and persons exposed for a continued period of time. These problems are mainly in the form of human health impacts, although economic effects have also been noted.[91] The following discussion on human health impacts is drawn from a presentation by Robert Halstead, Energy Facilities Analyst for the Wisconsin Coastal Management Program, to the Symposium on Coal Ports and Environmental Considerations held in Seattle on June 4, 1982.[91]

> Although the human nose filters out 99% of airborne particulates, the smallest, called respirable particulates, are deposited in the aveoli of the lung. This slows down the exchange of oxygen in the blood, causing

shortness of breath and heart strain. People with respiratory problems such as asthma or emphysema are most sensitive, as are the elderly and the very young.

The particles themselves may be poisonous if inhaled or absorbed, causing damage to the kidneys and liver. Particulates may also absorb sulfur dioxide and form sulfates. In the presence of moisture (as in the lung), sulfuric acid is formed, irritating membranes and reducing the body's ability to remove harmful bacteria, increasing the possibility of infection.

Adverse health effects from particulate matter are not always seen immediately. Particulates can accumulate in the lungs over time, causing respiratory distress and other health problems.

The Wisconsin Department of Natural Resources estimated that the Superior Midwest Energy Terminal operating at approximately 4 mt/y throughput (one-third full capacity) emitted over 1,000 tons of coal dust in 1980, three times the level predicted for full capacity operations.[95] Thus, actual emissions were nine times the predicted levels. Because of this disparity, Mr. Halstead has suggested caution in accepting total suspended particulate emission estimates contained in environmental impact statements prepared for Pacific Northwest coal ports,[91] and stresses the importance of proper site selection to reduce adverse impacts.[95] See Section 3.2 for a discussion on siting alternatives.

-Noise

Noise problems would generally be a problem only at the Port of Astoria Docks site. The Tongue Point and Skipanon sites are relatively removed from population centers, and thus noise generation is less of a problem. Noise from coal handling equipment can be expected to be about 70-dBA 100 feet from the source,[33] slightly louder than the sound of aircraft overflights at 68 dBA.[74] Noise levels of less than 70 dBA are not likely to be bothersome during the day due to the general din of activity within the city. However, at night the city is quiet and the sounds emanating from the coal facility would be easily discernible, and possibly a source of irritation for nearby residents.

Noise from rail traffic would impact many homes along the rail line between Portland and Astoria. The coal unit trains would move through or near the towns of St. Helens, Scappoose, Rainier, and Astoria. Rail road traffic generates approximately 75 dBA of noise, and these towns may be affected by the high rate of traffic generated by coal transportation (see Section 3.5).

-Adjacent and Nearby Uses

Coal port activity in the Columbia River Estuary is likely to impact adjacent and nearby uses, especially for the Skipanon and Port of Astoria Docks option. The largest impact expected is on waterfront business in downtown Astoria from coal train movements. As noted in Section 3.5, 100 car coal trains would be moving slowly along the waterfront rail line every 2½ to 4 hours to supply a 10 mt/y facility. For example, Ocean Foods' processing facilities are traversed by the rail line. At present, low train traffic has not made this arrangement a problem. It may take a coal unit train six to ten minutes to pass a given point,[96] which could significantly inconvenience the fish packing operations.

Tourist related businesses would also be impacted by coal train activity. Noise, vibration, dust and restriction of access due to passage of the trains would impact the Pier 11 operation, and possibly cause a loss of revenue due to forgone tourist trade. The rail line forms the southern boundary of the parking lot for the Thunderbird Motel, Astoria's largest motel. Coal train passage so near to the building may prevent continued economic returns to the owners of the motel. This may be a moot point, as the lease on the motel property is held by the Port of Astoria, and that lease expires in 1985.[29] These impacts are addressed in Section 2.2.5, Benefit Cost Analysis.

-Hazards

There are two primary hazards related to handling and shipping coal. The main concern is fire. Coal that has been stored and loaded in the rain has a tendency to spontaneously combust when confined in ship holds. Over 20 incidents of elevated temperatures requiring immediate fire fighting action have been reported, and there have even been reports of coal barges arriving at Gulf ports on fire.[97]

The other problem is apparently also related to damp, confined coal. An Indonesian bulk carrier in the Port of Los Angeles/Long Beach reached temperatures of 130 degrees in the hold. Aside from fire problems, high heat released sulphuric acid from the coal, threatening the structural integrity of the hold of the ship.[97] The Coast Guard is expected to release regulations banning loading coal in heavy rains.[97] Coal port facility operators in the Columbia River Estuary would need to plan for eliminating the hazards of damp coal.

4.6 COAL PORT DEVELOPMENT UPRIVER

The Port of Portland is actively pursuing coal port activity. Because of its relative advantage of quality rail infrastructure and shorter rail haul distances compared to Astoria, this port is able to economically ship coal in 45,000 dwt colliers, thus eliminating the need for extensive and costly dredging. The lack of dredging requirements removes a very time consuming obstacle to coal facility completion. It is expected that the first coal export facility operating in the Pacific Northwest will be able to capture some portion of the export market and hold it even in the face of more competitive prices from other ports in the future (see Section 2.2.4). Thus, at least one upriver port is expected to be in operation in the next five years.

The only known impact to the Columbia River Estuary from coal export facilities upriver would be related to increased ship traffic. An increase in ship traffic has two main effects; an increase in the occurence of oil pollution and an increase in ship wake erosion. At design capacity of 15 mt/y, one Port facility shipping coal in 45,000 dwt colliers could potentially receive 330 colliers per year.[33] Assuming that this port is functioning at 80% capacity (12 mty) this translates to 264 ship calls per year on upriver coal ports. This is a 10% increase over 1979 levels of shipping in the Columbia River.[1]

The quantity of oil spilled into the Columbia River is a function of vessel trips. Also, 78% of all spills occurring below Bonneville Dam (during the period 1973 to 1978) occurred in the Portland/Vancouver area.[85] This is because spills occur more often at transfer points than at transit points. Of all spills on the river, 42% (by volume) were in the "dry cargo/passenger" category.[85] 77% of the spills in this category were less than 100 gallons.[85] Therefore, it is unlikely that increases in Columbia River shipping traffic from coal port activity at Kalama or Portland pose a significant increased threat of a major oil spill. Though very difficult to quantify, it should be noted that incremental increases in ship traffic mean incremental increases in oil pollution on the Columbia River, mainly from bunkering and deballasting.

Increased ship traffic in the Columbia River is expected to impact shorelines by increasing erosion caused by ship wakes. The periodic saturation and dewatering of shore or dike material by tidal action combined with waves generated by passing ships tends to undermine dike facing material. This material then slumps, exposing the upper portion of dikes to erosive action from waves.[98] Determining the extent that ship wakes are responsible for erosion at a given site is very difficult. In addition to ship wakes, many factors such as river currents, wind generated waves, stage of tide, navigation channel maintenance dredging, and dredged material disposal practices are responsible for shoreline erosion. As ship traffic is expected to increase approximately 10%, it can be assumed that there will be an incremental increase in shoreline erosion associated with ship wakes.

Ship wakes also have been shown to be responsible for fish strandings.[99] Juvenile fish may be swept ashore by ship generated waves and stranded on sandbars. The estimated ship wake stranding mortality measured between the Cowlitz and Willamette Rivers between February and July of 1975 was 145,003 chinook, 1,359 coho, 4,771 chum, and 537 steelhead trout, all juveniles.[99] Stranding of juvenile salmonids by ship wakes has been called "the most serious form of juvenile stranding on the Columbia River at this time."[99]

An increase in ship traffic moving to an upriver port would increase the amount of fish strandings, but the extent of this increase would be difficult to assess.

5. MITIGATION STRATEGIES FOR POTENTIAL ENERGY RELATED DEVELOPMENT

5.1 LOCAL, STATE, AND FEDERAL MITIGATION POLICY ANALYSIS

5.1.1 Definitions

Energy related development in the Columbia River Estuary area will create unavoidable impacts to natural (air, water) and human (economic, social) resources. Mitigation is defined in this application as the means by which these adverse impacts to natural and human resources are minimized. A concurrent study being conducted by CREST addresses mitigation for site specific impacts to the estuary (e.g. habitat compensation), and therefore compensation for site specific impacts will not be contained in this report.

5.1.2 Mitigation by Federal and Washington State Agencies

The following discussion draws heavily from information contained in the CREST Mitigation Policy Paper.[100] At the federal level, USFWS has taken the lead in developing mitigation policies, resulting from their broad mandate to protect fish and wildlife resources. Their mitigation policies are based on HEP, the Habitat Evaluation Procedure (102 ESM). This is a system for evaluating the habitat for a selected species, and has broad applicability to wildlife management. The USFWS use "mitigation" to cover the entire permit review process including aspects such as modifying project design, and as such, has applicability to potential energy related development impacts to the Columbia River Estuary area. A recent statement of USFWS mitigation policy is presented in the Federal Register, Vol. 4C. No. 15 (1981). The USFWS objective for the Columbia River Estuary can probably be summarized as "no net loss of in-kind habitat value", using compensation for lost resources to achieve this goal. Application of this concept may be difficult when considering impacts such as particulate emissions or economic impacts to adjacent use, but certainly this concept is pertinent to impacts to the ecosystem from project construction (e.g., dredge and fill) and from project operation (e.g., wastewater runoff). In Washington State law, there is no specific requirement for mitigation. State resource agencies can, however, request mitigation as part of the federal Section 404 permit process and the state shoreline permit process. The acceptability of a mitigation proposal would therefore depend on the priorities of the Washington Department of Game and and the Washington Department of Fisheries, and whether they would require mitigation to be ecosystem and habitat based (e.g., reduction in fugitive coal dust) or specifically aimed at increasing populations of economically important species through artificial means (e.g., hatcheries to mitigate for hydroelectric impacts). The kind of mitigation required in the past has included examples of both these categories, so that mitigation in Washington is a very flexible and somewhat unpredictable process. Such a case-by-case approach to mitigation without appropriate guidelines makes mitigation planning difficult. Mitigation is usually determined during project planning and permit review phases of development instead of during comprehensive estuary-wide mitigation planning and implementation, and therefore it is more difficult to delineate cumulative impacts.

The CREST Plan, adopted now as parts of Pacific and Wahkiakum County Shoreline Master Programs, encourages mitigation for dredge and fill activities in Washington's intertidal and marsh areas of the Estuary. In addition, mitigation of unavoidable impacts is an integral part of the decision making process for major energy proposals undergoing review by the Washington Energy Facility Site Evaluation Council.

There are obviously advantages to mitigation on a case-by-case basis. For every development, resource losses and mitigation are carefully evaluated by resource agencies. There are disadvantages for developers, however, since the type and amount of mitigation cannot be accurately predicted, causing delays and problems with development cost analysis. As the case history of Washington mitigation actions broadens, the scope of future mitigation actions will become more predictable. Many impacts from energy related development must be mitigated on a case-by-case basis, since magnitudes of impacts vary with project design, location, size, and function. Thus, the mitigation process used in Washington State can best be applied to impacts not directly related to aquatic habitat or species of concern.

5.1.3 Oregon and Local Mitigation Policy

Oregon's mitigation policy is currently undergoing extensive review and therefore will not be addressed in this report. The Oregon Division of State Lands is scheduled to issue administrative rules for mitigation in Oregon estuaries in February or March, 1983.

Local mitigation policy is set forth in the Columbia River Estuary Mitigation Policy Paper: Final Draft.[100] CREST has developed a mitigation policy based on habitat types that addresses direct impacts to the aquatic ecosystem from dredge and fill activities.[100] This method will be applied to site specific dredge and fill impacts from energy related development in the Columbia River Estuary in a forthcoming report for the Oregon Department of Energy.

5.2 DREDGE AND FILL IMPACTS

Salinity changes

Mitigation planning for salinity changes in the Columbia River Estuary caused by dredging a channel sufficient to accommodate deep draft colliers (or any 55 foot draft vessel) would be difficult for three reasons. First, there are no data on how great the salinity change would be. Physical and numerical modeling of the proposed Coal Export Channel is underway at the U.S. Army Corps of Engineers Waterway Experiment Station to attempt to delineate the extent of salinity intrusion caused by the proposed channel. This information will not be available until late 1983. Second, there is no consensus on what magnitude of impact a given change in salinity would have on the Estuary, or even if expected impacts would be positive or negative in scope. Given that a significant salinity change would occur, it could take years of monitoring and study to quantify that effect. Lastly, it does not appear possible to mitigate for salinity changes within the Estuary if the impact affects the Estuary as a whole.

Given the above constraints, mitigation actions compensating for increased salinity within the Estuary caused by an increase in mouth and channel depth would need to be negotiated by state and federal resource agencies, port authorities, the Corp of Engineers, and other interested parties.

5.2.2 Destruction of benthic communities

It is not possible to completely avoid impacting benthic communities during dredging operations. However, it may be possible to mitigate the effects of removal of large portions of the populations present by restricting dredging to late winter and early spring. This is based on the hypothesis that large numbers of juveniles entering the disturbed area in early spring would quickly colonize the exposed sediments.[55] A potential problem with dredging later in this time period is that juvenile chinook and coho salmon are passing through the Estuary from March through May, and use the navigation channel extensively.[101]

5.2.3 Loss of shallow water and intertidal habitat

A detailed mechanism for mitigating loss of shallow water and intertidal habitat is described in the CREST Mitigation Policy Paper[100], and is applicable to this type of impact.

5.2.4 Increased Shoreline erosion

The amount of shoreline erosion caused by channel dredging has been an issue of debate since 1958, especially along the Hammond-Warrenton waterfront (RM 7-10). Residents contend that channel dredging alters the current flow such that shoreline erosion is inevitable. Erosion experts indicate slumping of the shoreward side of the navigation channel may contribute to bank erosion of adjacent shoreline areas, and that dredging exacerbates this condition.[98]

Mitigation strategies for increased shoreline erosion could consist of two parts. The first part would consist of the Corp of Engineers Waterway Experiment Station conducting experiments on numerical and physical models to determine what magnitude of effect dredging would have on erosion. Alternately, differencing studies using old photos may be used to determine pre-project erosion rates, and monitoring programs could determine if dredging the deeper channel had led to an increase in erosion rates. If studies turned up positive evidence of increased erosion, the second part would be some sort of erosion control initiated by the Corp of Engineers (e.g., riprap, pile dikes, etc.) in areas indicated by the model.

5.3 SPOIL DISPOSAL IMPACTS

5.3.1 Impacts to in-estuary shallow benthic communities

Partial destruction of shallow benthic communities within the estuary from in-estuary disposal of spoils would be unavoidable if that option is pursued. Mitigation possibilities include timing disposal activities as discussed under dredging mitigation above, and dispersing material over a wider area to lessen the impact per unit area. The best mitigation for estuarine impacts is to use the designated ocean disposal sites, thus eliminating the in-estuarine impact altogether.

5.3.2 Impacts to ocean benthic communities

Impacts to ocean benthic and epibenthic communities from placement of up to 18 million cubic yards of dredge spoils each year will be significant (see Section 4.1.2). Potential mitigation strategies may take three forms. The first option would be to disperse the spoils over a much wider area, thus reducing the amount of spoil deposition per unit area. This would lessen the impact per unit area, but increase the area affected, and it is not known if there would be a net decrease in impacts. The second option is to increase the haul distance to deeper waters, and identify more sites. Thus, the frequency of deposition at any one site would be reduced. The third option calls for placing a sump at one or both sides of the mouth, and rehandling sediments onto either Peacock Spit or Clatsop Spit. This may, however, impact intertidal and onshore communities that inhabit the beaches and nearshore areas behind these spits.

The best overall mitigation strategy may be a combination of all three options, thus reducing the total amount placed in ocean sites (option 3) and decreasing both the frequency and amount of deposition at a given site (options 2 and 1).

5.3.3 Impacts to fisheries

Impacts to fisheries, with the exception of crabs, are expected to be slight. Pelagic and demersal fish that feed in the disposal areas are able to avoid the actual deposition of spoils. There appears to be some evidence that deposition of clean dredge spoils may increase the productivity of benthic communities by keeping them in a high production, "early successional" stage.[102] This would help ameliorate any impacts inherent in temporarily excluding these fish from their primary feeding grounds.

Impacts to crab fisheries may be difficult to mitigate. Crab do not possess the mobility of pelagic and demersal fish, and therefore will not be able to avoid being covered by spoils. Even if the wide dispersal of spoils option is taken, fine suspended particles tend to clog crab gill structures. Mitigation of impacts to crab populations by artificial propogation of crab to increase population numbers is, at present, not economically or technologically feasible.

Because a commercially available crab is three to four years old,[103] it is likely that a site would be impacted at least once during the life cycle of a crab. Possible mitigation goals may include funding of research to increase survival rates of eggs and juveniles, and therefore partially offset losses due to dredged material disposal.

5.4 DEVELOPMENT SPECIFIC IMPACTS

5.4.1. Electric Generating Facilities

-Hydroelectric

Impacts to fish and wildlife from construction and operation of hydroelectric facilities have been studied extensively on the Columbia River ever since Bonneville and Grand Coulee Dam construction began in the early thirties. Very good discussions of these impacts and their mitigation are contained in The Snake River Salmon and Steelhead Crisis. Its Relation to Dams and the National Energy Crisis,[104] and the Northwest Power Council's Draft Fish and Wildlife Program.[105]

-Thermalelectric

Extensive literature exists on impacts and mitigation[104,105,106] concerning operation of thermalelectric generating facilities. Discussions of these impacts and possible mitigative actions are contained in Evaluation of Power Facilities: A Reviewers Handbook,[37] "Impact of Cooling Waters on the Aquatic Resources of the Pacific Northwest",[65] and Environmental Quality -1979.[74]

5.4.2. Fuel Processing Facilities

Mitigation of impacts related to all forms of fuel processing facilities center on best conventional pollution control technology. Standards (1979) for emissions from fuel processing facilities may be found in Environmental Quality -1979,[74] and other potential mitigative actions may be found in Energy Related Use Conflicts for the Columbia River Estuary.[10]

5.4.3. Gas and Oil Exploration

Identified impacts:

- Drilling and subsidence.
- Dredge and fill
- Increased ship movement, oil spills
- Economic and social

Drilling activities in the Columbia River Estuary are expected to cause minimal impacts. Potential impacts are related mainly to possible rupture of drill mud collection basins and potential subsidence from reduction of subsurface pressures. Mitigation to reduce the possibility of drilling mud contamination of streams would be based mainly on requiring reinforcement of existing collection pond design. Location of ponds below river grade and pumping up to the river may also be a possible technique.

Subsidence due to reduced subsurface pressure is usually mitigated for by pumping water into the gas or oil reservoir, thus preventing collapse of the reservoir walls. This creates an additional problem of consuming significant quantities of water.

A good summation of mitigation techniques for oil and gas drilling is contained in Managing Oil and Gas Activities in Coastal Environments.[76]

Mitigation techniques for dredging impacts are contained in Section 5.2.

Mitigation techniques for dealing with increased ship traffic and associated oil pollution are contained in Section 5.4.6.

Mitigation of economic and social impacts may take many forms. Impacts to be considered include:

1) Added infrastructure costs (fire and police protection, water supply, etc)
2) Increase in economic social service demand (unemployment, etc.)
3) Inequitable tax structure
4) Change in property values, increase in housing demand
5) Increase in prices for goods and services
6) Increase in crime.

The main method of mitigating for economic and social impacts is to make the developer financially responsible for added infrastructure and social services costs. This could probably be attained by the county and/or city negotiating realistic tax structures based on expected impacts, such that the local government entity is relieved of large infrastructure and social service bills. Stabilization of property values and decreases in temporary housing demand may be attained by the developer providing housing for workers involved in the construction phase of development.

Increase in crime may be partially mitigated by the development interest's financial responsibility for increased infrastructure costs, e.g., police and fire protection.

5.4.4. Transportation and Transportation Facilities

Mitigation strategies for impacts related to oil transshipment are well developed. References for specific mitigation plans for the Columbia River, as well as cleanup capacity and a Columbia River case study are contained in Section 4.5. The State of Washington has developed a coordinated approach to determining damage to marine resources caused by major oil spills. The Marine Resource Damage Assessment Program organizes the scientific expertise of state resource management agencies into a damage assessment response task force.[89] This task force responds to oil spill reports, compiles data, and prepares a resource damage assessment. A damage claim is then issued to the responsible party pursuant to Washington State law.[89]

Potential for siting LNG or LPG transshipment facilities in the Columbia River Estuary area is seen as near zero. Mitigation of LNG or LPG transshipment impacts are contained in references 83 and 84.

5.4.5 Coal transshipment

Identified impacts:

- -Dredging and dredged material disposal; coal export channel
- -Water quality
- -Air quality
- -Noise
- -Adjacent and nearby uses
- -Hazards

Project site and coal export channel dredging and disposal impact mitigation strategies are described in Section 5.2 and Section 5.3.

Water quality impact mitigation is relatively simple, and contains two parts. The first part is to reduce the amount of fugitive dust from the handling site. This in turn would reduce the amount of dust entering the aquatic ecosystem, mitigating impacts to water quality from coal particle deposition on the water's surface. The second part involves treatment of site wastewater runoff. The use of settling ponds, flow regulators, filter systems, and periodic sampling of wastewater runnoff would mitigate water quality impacts from wastewater runoff.

Air quality impact mitigation is a little more complex. Fugitive coal dust is the main concern, and control must take place at several points. 90% of all fugitive dust from a coal facility occurs at three transfer points: unit car dumping, loading out from storage piles, and loading into ships.[33] Mitigation for fugitive dust from unit car dumping may be achieved by the use of "baghouses" in conjunction with an enclosed air sweep system surrounding the dumping area, and water jet systems to wet the coal and reduce the generation of dust.

Dust control at storage pile transfer points is more difficult. The rotary scoop that picks up the coal generates most of the dust. Water jets can be used, but are inadequate to suppress the dust due to the large quantities moved. This is the main area of dust control requiring improvement. It is likely that an air sweep attachment could be constructed for the rotary scoop.

Dust control at the ship loading transfer point may be the easiest to achieve. Chute extensions attached to the coal conveyer channel could reduce the amount of free fall for the coal to the surface of the pile in the ship's hold. Air sweeps could draw off dust from the tube and filter it. Alternately, "caps" could be placed over the top of the hold to draw off and capture fugitive dust.

The most cost efficient method of noise mitigation is to berm the perimeter of the facility and plant shrubs and trees to absorb most of the sound energy. This would probably not protect residential areas on the hillside of Astoria if a terminal operated at the Port Docks. There is no effective mitigation strategy for reducing noise from unit train traffic through towns along the rail route, except possibly through installation of noise barriers to dampen noise generated by rail cars.

Impacts to adjacent and nearby uses are related to visual and noise impacts, and coal train movement through downtown Astoria. Visual and noise impacts are mitigated in the same way, and are addressed above. Coal train movement is an unavoidable impact. Relocating the rail line does not solve the problem, but merely shifts the impacts to another location. With the high frequency of train movement and single track capacity between Portland and Astoria, there is no way to schedule train traffic for non-business hours.

Mitigation for disruption of waterfront businesses could involve:

1) noise dampening structures along the track
2) pedestrian overpasses
3) financial aid for relocation of businesses
4) locating the coal terminal east of Astoria

It is not believed possible to substantially mitigate for coal train traffic through cities along the route from Portland to Astoria other than relocating the tracks outside of the urban areas.

Mitigation for hazards associated with shipping damp coal centers on keeping the coal relatively dry. It is not possible to keep the coal totally dry, as wetting is a primary means of dust control. However, large sheds over the coal storage piles would prevent the coal from being saturated by the heavy rains in Astoria. Covers over loading galleries would also reduce this problem. Voiding oxygen from ships, holds with nitrogen gas or drying the coal as it is loaded are not economically or technologically feasible options.

A strict schedule of "first in-first out" rotation of the coal to reduce the likelihood of spontaneous combustion, and monitors for heat and acid detection both in the coal storage piles and in the ship holds would provide early detection of potential problems.

5.4.6 Coal Port Development Upriver

Impacts identified with coal port development upriver from the Columbia River Estuary are incremental increases in oil pollution, and increases in shoreline erosion and fish strandings from ship wakes. Oil pollution is addressed in Section 4.5 and Section 5.4.4.

Mitigation for stranding of fish caused by ship wakes could include the imposition of channel speed limits for vessels over a certain tonnage. It has been determined that several factors relate to juvenile strandings from ship wakes, including stage of river flow, vessel size, vessel draft, and the time of day or year.[99] Mitigation for increased fish strandings caused by ship wakes, based on findings by the Washington State Department of Fisheries,[99] would consist of imposing a 14 knot speed limit for all vessels with a draft of 25 feet or greater during the period of March through June of each year, when juveniles are moving downriver. Such speed limits do not now exist. Speed limits could be enforced by the U.S. Coast Guard.

If the imposition of speed limits on shipping vessels is not possible, maintaining the stage of the river through manipulation of release amounts from dams on the Columbia River at seven to nine feet at Rainier, Oregon, during this critical period would ensure that all of the potential stranding areas would be inundated, eliminating the problem of strandings.[99]

Mitigation for shoreline erosion caused by ship wakes could consist of two parts. Photo comparisons of pre-development erosion rates and post development erosion rates could be used to determine what (if any) amount of erosion increase can be attributed to ship wakes. Second, if this amount is determined significant, shoreline protective measures funded in part by the coal shipping consortium could be instigated. This could include riprapping, or some structure to lessen the wave energy striking the shoreline. Dredge spoiling on existing dike structures is also considered a good method of mitigating erosion and disposing of dredged material.

APPENDIX A: DREDGING AND DMD COST CALCULATIONS

New Work:

Mouth:

12 mcy x $1.07/cy dredging cost
12 mcy x $0.36/cy transportation cost to ocean
12 mcy x $1.43 =$17.2 million

Desdemona Shoals:

.7 mcy x $1.07/cy dredging cost
.7 mcy x $0.72/cy transportation cost to ocean
.7 mcy x $1.79/cy = $1.3 million

Flavel/Astoria Shoal:

11.3 mcy x $1.07/cy dredging cost
3.2 mcy x $0.40/cy transportation to area D
2.0 mcy x $0.10/cy transportation to area 36-E
6.0 mcy x $1.02/cy transportation cost to ocean
*8.0 mcy x $1.02/cy transportation cost to ocean
= $19.7 million

* $21.5 million dollars if area 36-E unavailable.

Upper Sands Shoals:

2.0 mcy x $1.07/cy dredging costs
2.0 mcy x $1.07/cy transportation to 39-E
*2.0 mcy x $0.30/cy transportation to Harrington Sump
2.0 mcy x $1.37/cy = $2.3 million

* $2.8 million dollars if area 39-E unavailable

Operations and Maintenance:

Mouth:

7.5 mcy x $1.07/cy dredging cost
7.5 mcy x $0.35/cy transportation cost to ocean
7.5 mcy x $1.42/cy = $10.7 million

Desdemona Shoals:

.55 mcy x $1.07/cy dredging cost
.55 mcy x $0.72/cy transportation cost to ocean
.55 mcy x $1.79/cy = $1.0 million

Flavel/Astoria Shoal:

8.8 mcy x $1.07/cy dredging cost
3.5 mcy x $0.40/cy transportation cost to area D
.8 mcy x $0.10/cy transportation cost to area 36-E
4.5 mcy x $1.02/cy transportation cost to open ocean
=$15.5 million

Upper Sands Shoals:

1.5 mcy x $1.07 dredging cost
1.5 mcy x $0.30 transportation to Harrington Sump
1.5 mcy x $1.37 =$2.1 million

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