DELAWARE ESTUARY SITUATION REPORTS

This series of reports is devoted to discussion of current issues relevant to conservation, use, and development of Delaware Estuary resources, and of concern to managers, decision makers, and the general public.

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Coal Transfer

Can an Environmentally Safe Coal Transfer Operation Be Undertaken In the Lower Delaware Bay?

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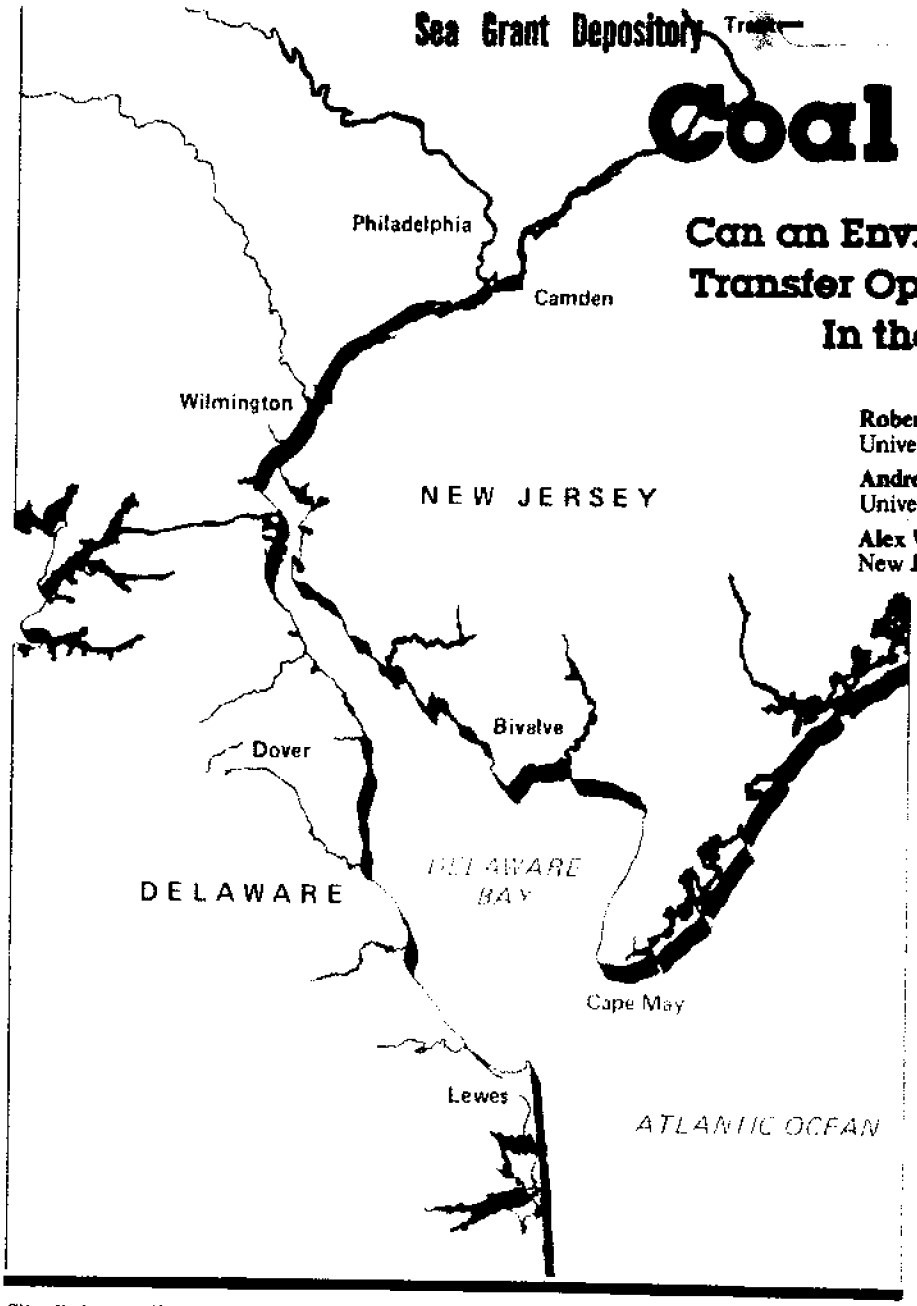

The Delaware Estuary, a multi-purpose bistate resource.

New Jersey Marine Sciences Consortium

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In This Issue: Coal Transfer

Effective August 1983, the U.S. Coast Guard authorized coal transfer between vessels moored in Anchorage Area A, off Big Stone Beach in lower Delaware Bay. Two general methods may be used to transfer coal from shallow-draft barges to deep-draft colliers: auger or conveyor-belt operation and clamshell operation. Although dust emission is inherent in coal transfer, best available data from similar situations indicate dust emission can vary from 0.168 pounds per ton for clamshell to 0.0024 pounds per ton for auger/conveyor transfer. Air quality and bottom water deterioration are the major potential environmental impacts. Because some unknown amount of harmful materials may leach from coal into the water, a prudent management strategy should be developed to minimize, through best available transfer practices, the amount of coal loss into the environment. Air and water quality baseline and monitoring programs should be instituted to audit operator performance and track environmental changes.

The material in this bulletin is condensed from the report *Environmental Effects and Regulatory Options of Coal Transfer Operations in Lower Delaware Bay*, January 1984. For information, contact the Delaware Department of Natural Resources and Environmental Control, Richardson Robbins Building, Dover, DE 19901.

Information related to the hydrography, chemistry, and biology of the Delaware Bay noted in this bulletin is based on the report *The Delaware Estuary: Research as Background for Estuarine Management and Development*, July 1983. For information, contact the Delaware River and Bay Authority, P.O. Box 71, New Castle, DE 19720.

Also referred to is the *Department of Transportation, United States Coast Guard Environmental Assessment No. 16475.3/32-82 for the Proposed Redesignation of Anchorage A (Big Stone), Delaware Bay*, May 1983. For information, contact Third Coast Guard District, Impact Assessment Section, District Planning Office, Governors Island, NY 10004.

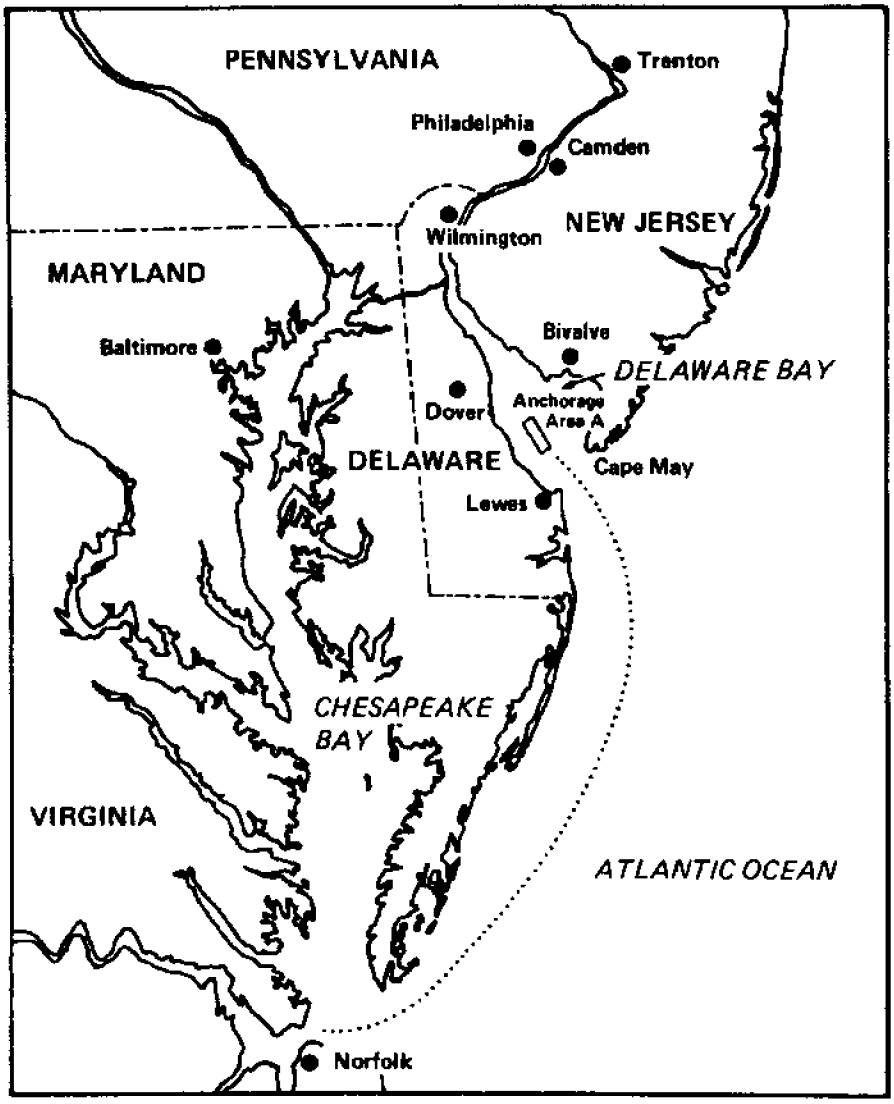


Figure 1. *Shallow-draft barges loaded at coal terminals in Norfolk, Virginia, are moved to Anchorage Area A in the Delaware Estuary where the coal would be transferred to deep-draft colliers.*

The Situation

About 80% of all of the coal exported from the United States passes through the ports of Norfolk, Baltimore, and Philadelphia (Figure 1). Most of this coal is destined for European markets. United States coal is high priced but is desirable because the supply is stable and the quality is high. However, the annual quantity exported is extremely variable, depending on the international value of the dollar, competition from other coal exporting nations, and the price and supply of crude oil. For example, exports from Norfolk, Baltimore, and Philadelphia dropped 35% from 1982 to 1983. It is not possible to predict reliably the future export demand for U.S. coal.

Coal shipping costs can be reduced by the utilization of large 100,000-150,000-ton colliers, but when loaded, these colliers need greater channel depths than currently exist at any East Coast U.S. port. A deep natural channel extends from the continental shelf into the lower Delaware Bay (Figure 2). In these protected waters of the Bay, designated Anchorage A, crude oil transfer from loaded tankers to barges has been permitted for several decades.

Coal transfer between vessels moored in Anchorage A, off Big Stone Beach in lower Delaware Bay, has been authorized by the U.S. Coast Guard, effective August 1983. The redesignation of the Anchorage from crude oil lightering to general cargo transfer came as a result of a request to the Coast Guard from the Delaware River Port Authority, and after the Coast Guard conducted an environmental assessment resulting in a finding of no significant impact (see box at left). Several coal transfer companies have expressed potential interest in use of Anchorage A.

The environmental impact of coal transfer activity would affect Delaware Bay waters shared by Delaware and New Jersey. However, Anchorage A is wholly within the boundary of the State of Delaware. With uneasiness about the Coast Guard assessment, and relying on the estuarine research experience of the University of Delaware College of Marine Studies and the New Jersey Marine Sciences Consortium, the Delaware Department of Natural Resources and Environmental Control contracted an independent environmental assessment (see box at left).

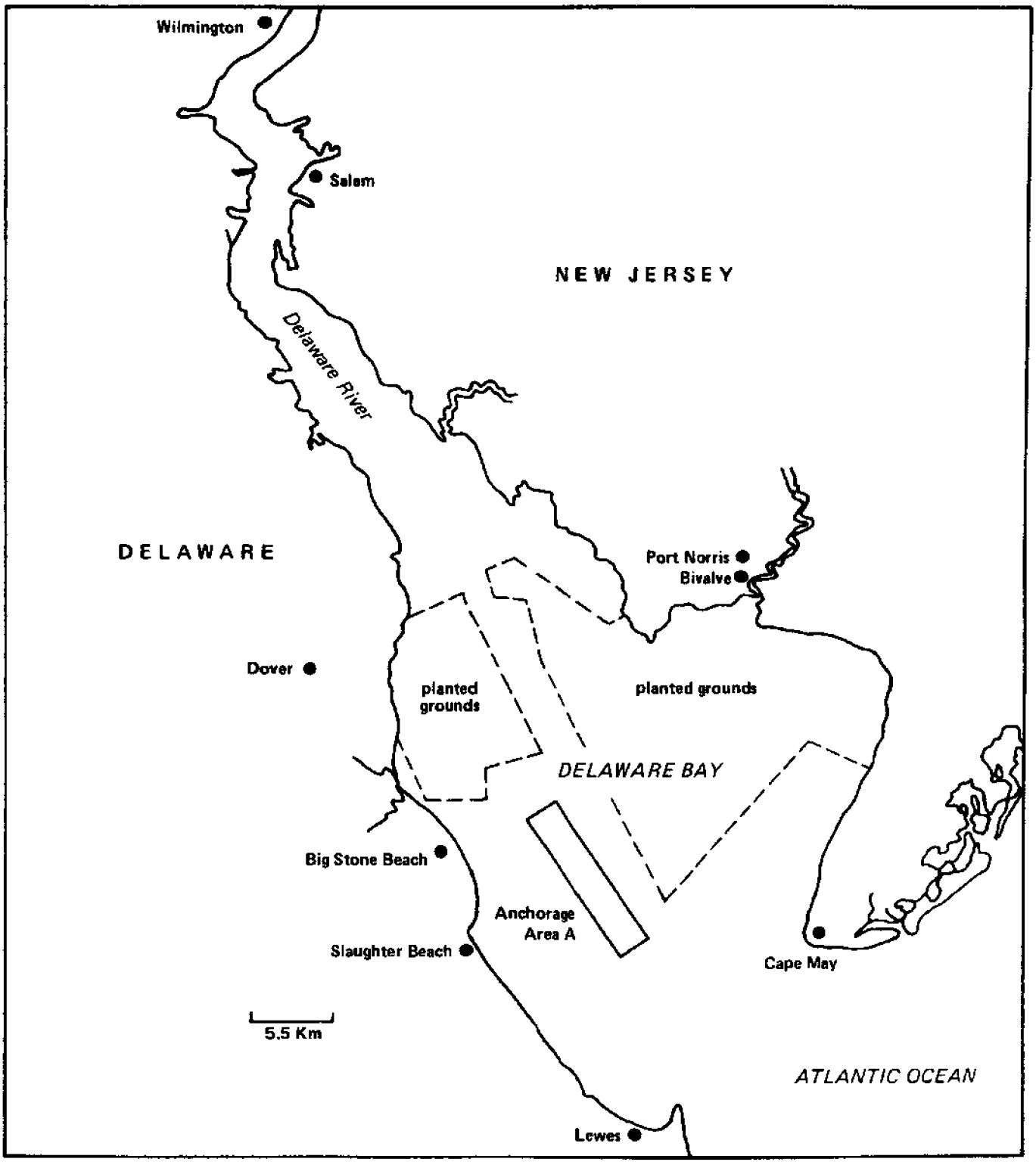


Figure 2. *Anchorage Area A relative to oyster planting grounds in the Delaware Estuary.*

Coal and Its Transfer

Coal is a fossil fuel used principally for industrial manufacturing and electric power generation. Coal use was once heavy, then declined. In recent years, coal use has resurged as oil prices have escalated. With increased environmental awareness and with significant potential magnitude of the environmental effects of man's activities, coal use is now seen as a potential environmental hazard.

Coal is a complex substance formed by the accumulation and subsequent modification of plant materials over long periods of time. It contains a number of inorganic substances including some trace metals (such as lead, arsenic, cadmium, and selenium) and complex organic substances including some carcinogenic and toxic compounds. Coal is generally thought to be relatively inert in the natural environment; however, it is known that trace metals and organic compounds will slowly leach from wet coal over time. Very little accurate information is available on the rates and amounts of these toxins that can leach from coal spilled in the estuarine or oceanic environment.

To assess the amount of coal that could be lost into the lower Delaware Bay and its potential impact, it is necessary to consider the method of transfer. In any operation, coal would be carried from the export site by shallow-draft barge to the anchorage area for transfer to a deep-draft collier. Two general classes of transfer technologies are available today. These are discontinuous methods such as clamshell-bucket operations and continuous methods such as auger machinery or belt-conveyor operations. The clamshell discontinuous method is commonly used for bulk cargo transfer and is being considered for coal transfer in the Delaware Bay.

In clamshell transfer, a crane is used to load the coal from the barge to the collier (Figure 3). Each clamshell bucket load of coal is exposed to the wind, and is dropped into the collier's hold, creating dust.

A continuous-loading operation generally uses equipment which by design is enclosed and less exposed to wind. It is thus less liable to have large dust losses compared with discontinuous operations. A typical design might have a conveyor going from the barge hold into the collier hold (Figure 4).

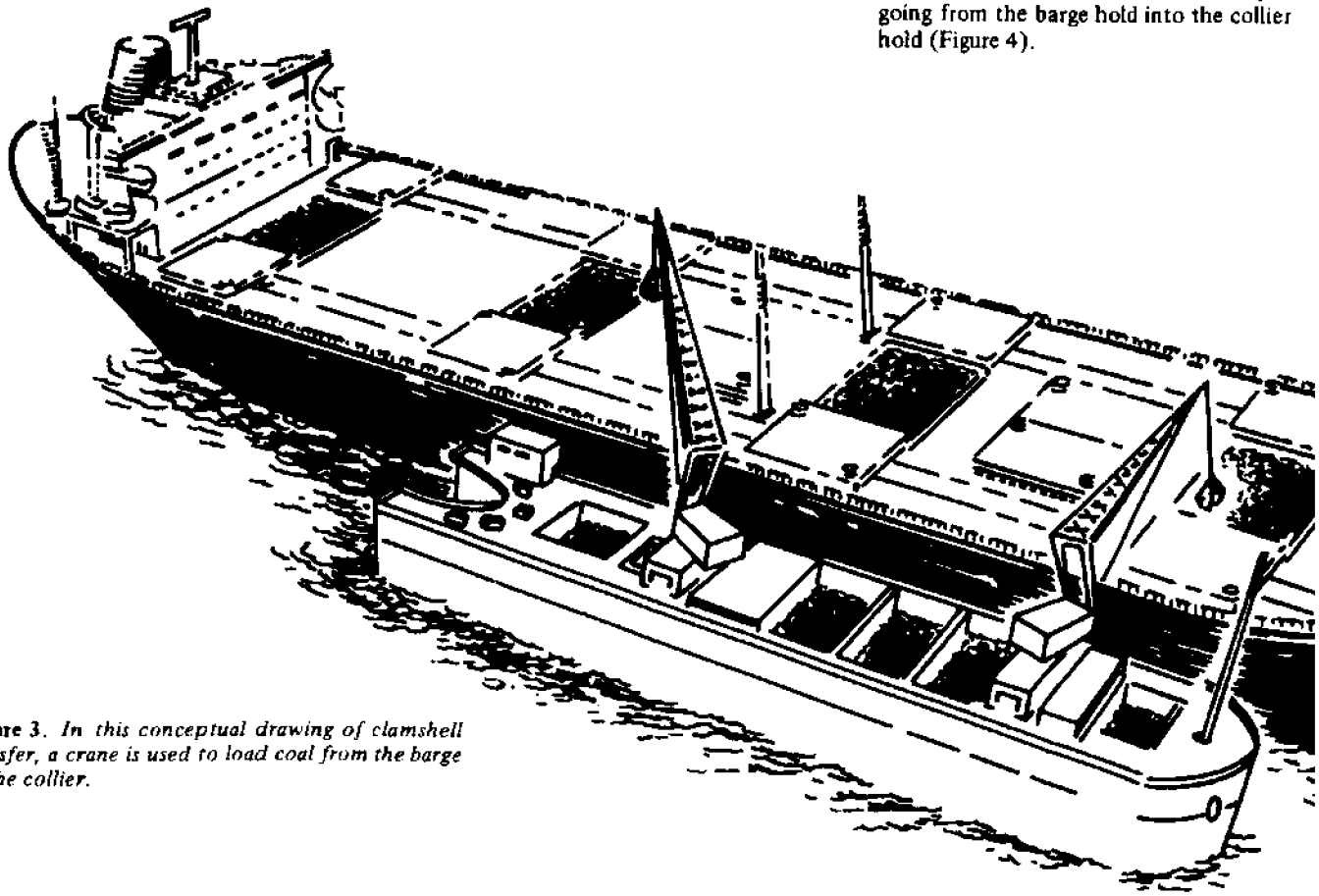


Figure 3. *In this conceptual drawing of clamshell transfer, a crane is used to load coal from the barge to the collier.*

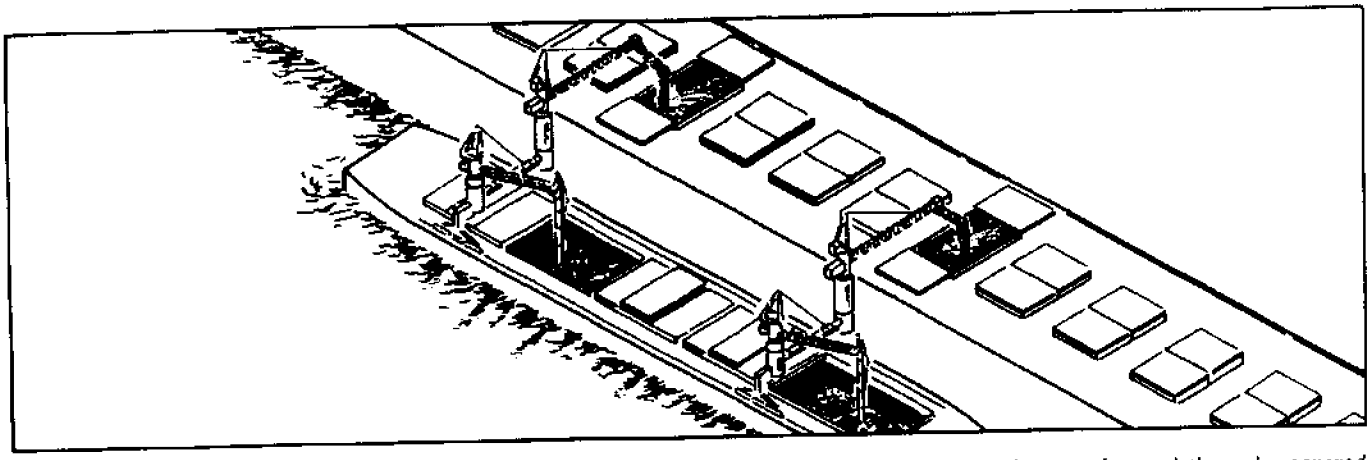
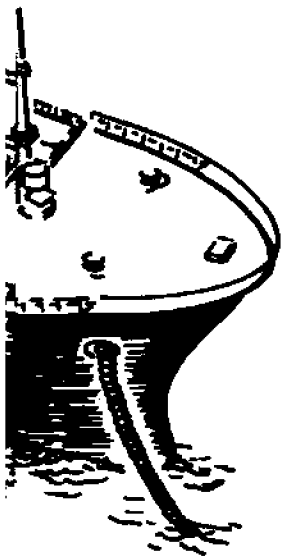


Figure 4. *In this conceptual drawing of conveyor-belt transfer, coal is drawn from the hold of the barge and passed through a covered transit into the hold of the collier.*

Dust Emissions and Other Losses

Dust is generated during the handling and transfer of coal between the barges and colliers. The most important factors that affect the quantity of dust generated are the moisture content of the coal, the size distribution of coal dust already in the barges, wind speed, the height from which the coal is dropped, and the method of transfer (clamshell, auger, or conveyor).



Water binds the dust particles together and the higher the water content, the less dust emitted. But the moisture content of any barge-load of coal depends on the coal seam from which it originated, weather conditions during transport, and the preparation and handling procedures. The quantity of dust mixed with the coal in the barge when it arrives at Anchorage A depends on the character of the original coal and the number of times the coal has been handled in route to the ship. The combined effect of the height from which the coal is dropped into the collier's hold and the wind speed is an important phenomenon. On calm days and when coal is discharged below deck level, the quantity of dust generated will be small. Conversely, on windy days and when the coal is dropped above deck level, the quantity of dust generated may be considerable. Finally, the method of transfer, whether clamshell, auger, or conveyor, affects the quantity of dust generated because it can affect drop height and exposure to wind.

In the U.S. Coast Guard Environmental Assessment, the dust emission rate is 0.04 pounds per ton of coal transferred. The State of Delaware independent assessment found that dust emission rates vary, depending on the transfer method. Best available data indicate that such emissions can range from 0.168 pounds per ton for clamshell transfer to 0.0024 pounds per ton for either auger or conveyor transfer. Obviously, the technology employed is a major factor as far as dust emissions are concerned. For example, if 3 million tons of coal per year are transferred at the Anchorage, then the Coast Guard estimates 60 tons per year of dust emitted, while the State study estimates 252 tons per year of dust emitted for clamshell transfer and 3.6 tons per year for either auger or conveyor transfer. It is important to note here that no actual measurement data are available on dust emissions from coal transfer operations like the ones envisioned for the Anchorage area and thus estimates are made based upon the most similar situations available. Until such measurements are taken, there probably will continue to be a difference of opinion on the amount of dust generated. However, with moisture, wind speed, and the quantity of dust held constant, the State study estimates 70 times more dust will be generated by clamshell transfer than by either auger or conveyor transfer.

What mitigating measures may be taken to reduce the dust emissions from the clamshell transfer process? The nature of the operation precludes enclosing the process or confining the dust. Water sprays add unwanted weight to the coal and increase the potential for explosion in the collier. The height from which the coal is dropped is operator dependent and can be minimized.

In addition to the generation of dust in the transfer process, a certain amount of coal lump spillage may occur. No data exist on the rate of routine spillage of coal lumps from clamshell or auger/conveyor systems. The U.S. Coast Guard Environmental Assessment made no estimate of coal spillage. Based on standard texts on the transfer of materials and assuming a 10-foot fendered distance between vessels, it was estimated in the State study that between 6.4 and 1500 tons of coal will spill overboard for each 3 million tons transferred.

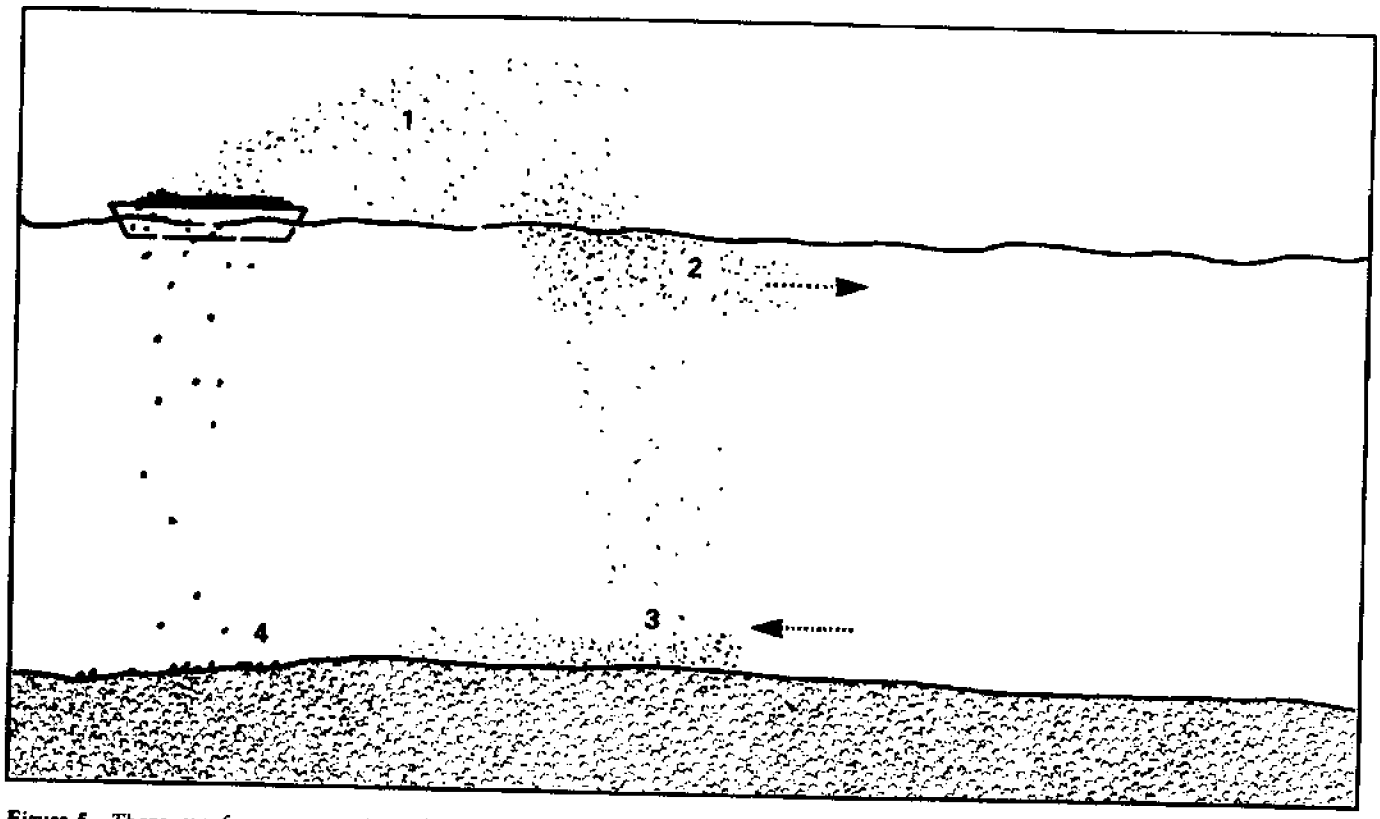


Figure 5. *There are four avenues into the environment for potential coal losses: (1) Dust from the transfer activity carried by the wind would result in dust in the atmosphere immediately adjacent to the transfer. (2) From dust falling into the water, the finest particles would be carried down bay in the surface waters. (3) Heavier dust particles would settle and be carried up bay in the immediate bottom waters. (4) Larger chunks of coal could fall overboard and quickly become incorporated in the bottom sediment.*

Environmental Impact of Coal Losses

Coal losses from a routine transfer operation in the lower Delaware Bay could follow any of four different avenues (Figure 5). The wind-borne dust would go into the air temporarily, giving rise to concern for air quality. Most of the dust in the air would fall fairly quickly on the water and would have an impact on the surface water layer or the immediate bottom water layer. Therefore, it is necessary to consider the impact of the fugitive dust on the air, surface waters, and bottom waters. The fourth avenue for coal losses is spillage of chunks of coal from the barge or ship directly into the water; these coal particles as well as the coal dust will eventually end up in the bottom sediment.

The concentration of coal dust in the air near a transfer activity could be calculated and compared with air quality standards. Regulations exist that would allow the State of Delaware to issue and to condition permits for specific coal transfer operations. Operations contributing dust emissions that exceed specific criteria would have to be brought into compliance. This is particulary important since the Anchorage area is used for commercial and sportfishing activities as well as shipping (Figure 6).

The U.S. Coast Guard in its environmental assessment calculated that the dust particles that are 1 to 100 microns (0.001 to 0.1 millimeters) would fall into the water within 2 kilometers of the transfer operation. The State study modeled this dispersal by using a water surface area with one dimension of 2 kilometers and the second dimension of 4 kilometers (the average surface water net drift is 4 kilometers per day). Since the surface water net drift applies to approximately 4 meters depth, the volume of the surface water that would receive the coal dust can be calculated. This was done and, with a worst case estimate of fugitive dust losses, the amount of coal that would fall

in the surface waters was calculated. Since the majority of the coal dust would sink through the surface waters in less than one day, the residual buildup of coal dust in the surface waters is small. By assuming that this residual coal dust behaved as fine suspended sediment and comparing it to the natural suspended sediment concentration, no significant increase would occur from a worst case coal loss. Since there would be no significant particle increase from the coal dust, it is unlikely that there would be any significant environmental impact in surface waters.

Since the majority of the dust particles would sink fairly rapidly, they would reach the bottom waters before they were swept away. The bay bottom in the area of the Anchorage has mainly coarse-grained sediments indicating that fine sediment particles do not accumulate there. Also this area is characterized by a cloud of suspended sediments in the 2 meters directly above the bottom. These bottom waters slowly move up the bay and toward the shore. With a modeling exercise similar to that used for the surface waters, it is possible to demonstrate that the majority of the coal dust lost from transfer would accumulate in this bottom water cloud. Comparing the coal particle concentration to the natural bottom-water suspended-sediment concentration, worst case calculations show a detectable increase caused by the coal. It is not possible to accurately predict the rate at which toxic metals and organic substances might leach from the coal dust. However, sufficient coal dust in this narrow bottom-water zone to cause a significant increase in suspended sediment concentration is reason for concern. Concentration estimates could be in error by a factor of ±2.

The same narrow bottom water zone is the primary location of the mysid shrimp which are a major food source for larval and juvenile weakfish. The bottom waters in the Anchorage and nearby are primary locations of crab, flounder, and oyster feeding. Thus, it is likely that the worst case coal accumulation in the bottom waters could threaten major fishery species in the lower Delaware Bay. Eventually, the coal dust will be distributed widely in the lower Bay and will accumulate in the muddy bottom sediments. The discussion here deals with the environmental impact of coal dust and spillage for a one-year period only. No data exist that detail the cumulative impacts of coal dust and spillage in the marine environment over time. This is a legitimate concern that should be addressed when any applicants propose to transfer coal in the Delaware Bay.

Figure 6. *Recreational boats in the area of Anchorage A.*

In the coal transfer operation, some coal could also be lost routinely as direct spillage of chunks of coal over the side. Dust consists of fine coal particles carried by the wind; larger particles (chunks) too heavy for wind transport would fall into the water and sink to the bottom in less than an hour. Discontinuous transfer would have the largest routine losses of both fine particles and chunks. Calculations of routine spillage of coal chunks indicate that no significant buildup would occur in the bottom sediments.

In summarizing environmental impacts of the four avenues for coal losses, air quality and bottom water deterioration are the major concerns. In both areas worst possible case losses potentially could pose problems. Thus, controlled transfer operations would minimize the potential for serious environmental problems through coal loss. With smaller losses, larger amounts of coal could be transferred without environmental impact.

Regulatory Concerns

As previously noted a major concern regarding a routine coal transfer operation is determining whether the activity will cause a deleterious environmental effect on the Anchorage area in the lower Bay and its immediate environs. This concern coupled with the complexity of the other variables associated with coal export, such as economic viability, the volatile nature of the world coal market, and the limited anchorages available to support this activity, makes the decision about regulating and/or permitting a coal transfer operation in Delaware Bay a difficult one.

On the Federal side of the issue, coal transfer between vessels moored in Anchorage Area A off Big Stone Beach was authorized by the U.S. Coast Guard effective August 1983. The Coast Guard did this after soliciting public comment concerning redesignation and after completing an environmental assessment on this activity. In its environmental assessment, the Coast Guard determined that a coal transfer operation would pose no significant environmental impact to the Delaware Bay. Subsequent to this action the applicability of this assessment has been questioned by both the Delaware Department of Natural Resources and Environmental Control and the Delaware General Assembly.

The U.S. Coast Guard's authority in this matter of a coal transfer operation is primarily that of being responsible for navigational safety. This includes those aspects of traffic control and anchoring authority as well as promulgating rules related to vessel signals, maneuvering, aids to navigation, and safety equipment. The U.S. Coast Guard has no authority related to the environmental consequences of a coal transfer operation. Hence, the responsibility for control of the proposed coal transfer operation lies with the State of Delaware. It is within this context that the State must define its role and exercise what it deems its regulatory responsibility.

In applying regulations to the control of a coal transfer operation it is important to understand the nature of the coal handling technology employed. Inherent in any coal transfer operation are fugitive dust emissions and spillage losses. It is the rate of such losses that is of concern in determining impacts on the State's air and water resources. The regulatory and management challenge to the State might then become one of devising a suitable strategy that ensures the maintenance of environmental quality while permitting maximum amounts of coal to be safely and profitably transferred.

How much regulation will be required is a difficult question to answer. But having examined the potential environmental impacts of a coal transfer operation, several observations can be made with respect to regulatory strategy. Any prudent regulatory strategy should consider these important elements: 1) the development of specific best-available coal transfer practices aimed at minimizing environmental impacts, and 2) both air and water quality baseline and monitoring programs to environmentally audit whether an operator's transfer system is performing as promised. Only by considering both of these elements can potential coal transfer operators and State officials begin to achieve a balance between environmental protection and economic development tempered by mutually agreeable safeguards.

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