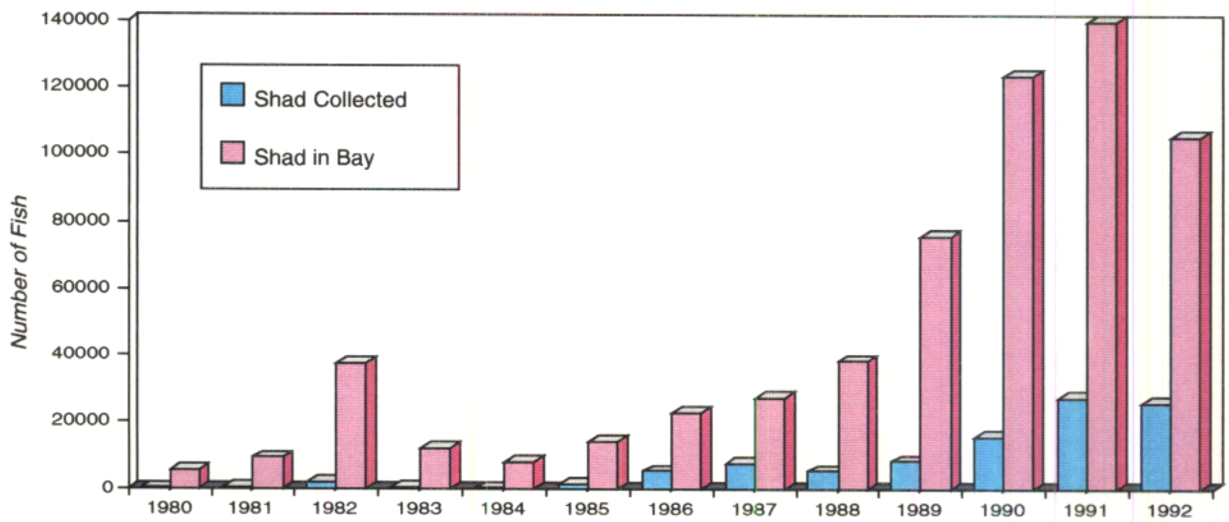
Figure 2-7
Numbers of American Shad



regional aquifers. There are also concerns about potential impacts on ground water quality resulting from chemical leaks and spills, the handling and storage of large quantities of fuel oil and coal, and the generation and landfilling of coal combustion by-products.

Ground Water Quantity Impacts

The impact of withdrawals of ground water by power plants is an issue in southern Maryland and the Eastern Shore, where there is an increasing public awareness of the importance of ground water as a natural and economic resource. Maryland's power plants withdraw ground water from several Coastal Plain aquifers in these two areas. There are large volumes of ground water available in these aquifers, but the aquifers must be protected over the long term to ensure that ground water remains available to current and future users. High-volume ground water withdrawals by power plants, if not managed properly, have the potential to lower the water level in the aquifer and cause intrusion of salt water or water of otherwise poor quality into the aquifer.

Currently, five power plants withdraw ground water from Maryland's Coastal Plain aquifers to provide high-quality water for plant operations: BG&E's Calvert Cliffs nuclear power plant, PEPCO's Chalk Point and Morgantown power plants, DP&L's Vienna power plant, and SMECO's combustion turbine at Chalk Point. Table 2-3 lists the average daily ground water withdrawal rates by these power plants from 1975 to 1991. Because SMECO's withdrawal from the Patapsco Aquifer, which began in 1990, is included under PEPCO's ground water appropriation for the Chalk Point plant, these withdrawals have been combined in Table 2-3. The SMECO turbine required about 0.01 mgd from the Patapsco Aquifer in 1990 and 1991.

Table 2-3
Annual Average Ground Water Withdrawal Rates at Power Plants (million gallons per day)

Year	Calvert Cliffs (Aquia Aquifer)	Morgantown (Patapsco Aquifer)	Vienna (Columbia Group Aquifer)	Chalk Point (Magothy Aquifer)	Chalk Point (Patapsco Aquifer)
			Current Appropriation Limit		
	0.45	0.82	0.05	0.66	0.66
1975	0.23	0.80	0.04	0.75	
1976	0.20	0.80	0.07	0.95	
1977	0.25	0.80	0.06	0.70	
1978	0.23	0.70	0.06	0.70	
1979	0.25	0.80	0.07	0.85	
1980	0.25	0.80	0.04	0.77	0.30
1981	0.27	0.65	0.02	0.69	0.37
1982	0.27	0.60	0.02	0.61	0.39
1983	0.25	0.60	0.03	0.69	0.43
1984	0.28	0.70	0.03	0.62	0.37
1985	0.26	0.61	0.03	0.64	0.26
1986	0.26	0.62	0.02	0.50	0.41
1987	0.38	0.52	0.03	0.42	0.35
1988	0.25	0.67	0.03	0.42	0.37
1989	0.07	0.73	0.04	0.54	0.46
1990	0.09	0.68	0.02	0.59	0.45
1991	0.15	0.57	0.01	0.43	0.47

Table 2-3 highlights several facts regarding the power plant withdrawals:

- *In most cases, the power plants in Maryland historically have withdrawn ground water at rates below their regulatory limits, which are established by the Water Resources Administration of the Maryland Department of Natural Resources (DNR).*
- *Ground water usage at Calvert Cliffs decreased threefold in 1989 and 1990 because the reactors were shut down during that period.*
- *PEPCO has increased its withdrawals from the Patapsco Aquifer at Chalk Point over the last three years to make up for reduced withdrawals from the Magothy Aquifer, and to supply water for four new combustion turbines that began service in 1991 and 1992.*

Overall, studies have shown that the only significant impacts to ground water from power plant withdrawals are in the Aquia Aquifer at Calvert Cliffs and the Magothy Aquifer at Chalk Point. To track and evaluate these impacts, three agencies — the Maryland Geological Survey (MGS), the U.S. Geological Survey (USGS), and PPRP — jointly operate ground water monitoring programs in the Aquia and Magothy Aquifers. Data from the monitoring program at the Aquia are available from 1982 through 1990; at the Magothy, data are available from 1975 to 1990. The monitoring program tracks the **potentiometric surfaces** (water levels) in the aquifers over time and thus indicates the effect of water withdrawals from the aquifer systems.

In the Aquia Aquifer between 1982 and 1990, the monitoring indicated that the potentiometric surface around Calvert Cliffs declined approximately 13 feet. A 20-foot decline was observed between 1982 and 1986, but a partial recovery occurred in late 1988 and 1989, most likely because of the temporary shutdown at Calvert Cliffs. The recovery of the potentiometric surface indicates that the aquifer has the ability to return to pre-pumping levels after ground water withdrawals cease. The monitoring data also show that decreases in the water level around water supply well fields at Lexington Park and Solomon's Island south of Calvert Cliffs are even greater than those observed at the plant. This indicates that withdrawals in these areas have a greater effect on the Aquia's potentiometric surface than even power plant withdrawals. Despite the declines in the Aquia potentiometric surface, approximately 400 feet of water remains in the aquifer.

Monitoring in the Magothy Aquifer in southern Maryland between 1975 and 1990 showed that the potentiometric surface declined approximately 20 feet around the Chalk Point facility and up to 50 feet in the Waldorf area of Charles County, west of the power plant. An eight-foot decline in the Magothy's surface around the Chalk Point facility between 1986 and 1990 is likely the result of higher pumping rates at the power plant in 1989 and 1990. Although the potentiometric surface around Chalk Point has declined, the facility has only a localized effect on the Magothy Aquifer; the decline observed in Waldorf is almost entirely a result of withdrawals for domestic and industrial use in that vicinity.

Impacts to the water levels in the Magothy Aquifer at Chalk Point are not a concern at this time for two reasons. First, PEPCO should soon begin to reduce the amount of ground water withdrawn from the Magothy as it begins to withdraw more ground water from the Patapsco Aquifer. When withdrawals decrease, the Magothy Aquifer should eventually recover its potentiometric surface at Chalk Point. Second, the eight-foot decline measured in the Magothy is small compared to the 400 feet of water remaining in the aquifer.

Maryland's Ground Water Management Program

Ground water is recognized as a renewable natural resource that requires careful development and protection to ensure a long-term water supply of adequate quantity and quality. The purpose of ground water management is to maximize available resources for beneficial uses while simultaneously minimizing adverse impacts that could limit current and future ground water uses. This objective requires balancing the quantity and quality requirements of residential, municipal, agricultural, commercial, and industrial users with the limitations of available ground water resources.

The quantity and quality of the state's ground water resources are managed through the coordinated efforts of several state agencies.

- *The Maryland Department of Natural Resources' Water Resources Administration (WRA) has primary responsibility for permitting the use of ground water within the state and protecting this resource from overuse.*
- *The Maryland Geological Survey (MGS) provides technical support by generating a ground water database and investigating ground water resources to provide information for WRA management decisions.*
- *The Maryland Department of the Environment has the task of managing and protecting the quality of ground water sources.*

The impacts of utilities' ground water withdrawals are monitored and evaluated through a joint program of the U.S. Geological Survey/Maryland Geological Survey (USGS/MGS) and PPRP. Because four power plants in Maryland — Calvert Cliffs, Chalk Point, Morgantown, and Vienna — are major users of ground water, USGS/MGS has incorporated observation wells at those plants into its statewide monitoring network, through a cooperative effort with PPRP that began in 1975. This monitoring program allows an evaluation of the long-term impact of ground water withdrawal by power plants.

Ground Water Quality Impacts

There are generally three ways in which power plant operations can affect the quality of local ground water:

- *Chemical constituents of coal stored in piles at power plants can be leached out of the coal and infiltrate into the ground and eventually into the ground water.*
- *Similarly, chemical constituents can leach from ash and other by-products of coal combustion that utilities landfill in the state.*
- *Spills and leaks of liquid petroleum fuels that utilities transfer, store, and use can reach the ground water.*

PPRP recently assessed the potential for coal piles to impact ground water quality at Maryland's seven coal-fired power plants. Coal piles placed on the ground surface are uncovered and exposed to precipitation. As water infiltrates the piles, acidic runoff (**leachate**) is produced. The acidic runoff contains constituents, especially iron and sulfate, that can degrade ground water quality in the vicinity of the piles. All seven of the power plants collect and treat their coal pile runoff to prevent ground water degradation. Although coal pile runoff at PEPCO's Morgantown plant is collected and treated, the runoff may still have some potential to degrade ground water because there are no clay liners beneath either the pile or collection basins to prevent infiltration, and there are no monitoring wells in place to detect a release of leachate constituents to ground water.

PPRP has also evaluated the impacts associated with landfilling coal combustion by-products. In general, these studies indicate that ground water quality can be degraded as constituents are leached from the landfills; however, when degradation does occur, it is localized, minimal, and does not appear to affect ground water users. PEPCO's Faulkner fly ash landfill, located near Zekiah Swamp Run in southern Charles County, is one example where coal combustion by-products have degraded ground water quality. Water quality data obtained during studies there indicate that concentrations of major elements in ground water, including metals such as iron, manganese, nickel, and zinc are higher than expected because constituents in the landfill ash are leaching out and infiltrating into the ground water. The extent of ground water affected by the leachate is limited to the ground water within 1,500 feet of the landfill. The leachate does not appear to have affected surface water quality in Zekiah Swamp Run or ground water users.

Spills and leaks of fuels during transport and storage at power plants also pose a risk to ground water quality. Petroleum fuels generally do not dissolve in water; however, some organic compounds contained in the fuels, such as benzene, are slightly soluble in water and can dissolve in the ground water. Petroleum products have degraded shallow ground water quality at BG&E's Perryman combustion turbine facility in Harford County. Fuel oil was released to the subsurface when an underground pipeline connecting the fuel oil tanks to a combustion turbine failed. Investigations conducted by BG&E indicate that oil is floating on the water table surface, and contamination of the ground water covers an area of approximately five acres. The water table aquifer is not used for water supply downgradient of the site, so impacts to users are not expected. No impacts to surface water have been identified. BG&E has also reported an underground fuel oil leak at its C.P. Crane Plant; however, the environmental impact from this release has not been determined.

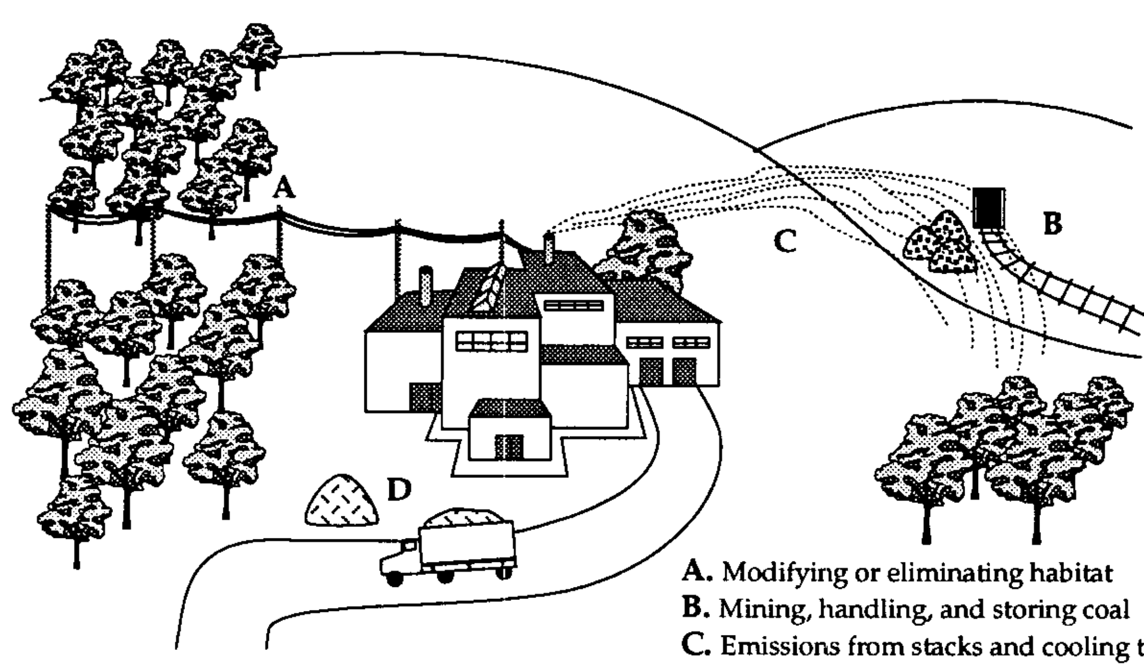
Terrestrial Impacts

The construction and operation of power plants can affect **terrestrial ecosystems** in many ways (see Figure 2-8). Direct impacts result from the construction of the power plant and its transmission lines. Indirect impacts of plant construction and operation are more subtle and may be difficult to distinguish from the effects of other factors. Indirect impacts result from surface water runoff from fly ash storage piles and deposition of air pollutants from the power plants themselves.

Direct Habitat Alteration

The construction and operation of power plants, whether steam electric or hydroelectric, may impact terrestrial resources by physically modifying or destroying existing habitats, and disturbing wildlife. Transmission line corridors and combustion by-product landfills can similarly eliminate or modify habitats. Maryland has valuable nontidal wetlands and is particularly concerned with minimizing impacts to these habitats. Under regulations implementing Maryland's Nontidal Wetlands Protection Act, activities in such areas are regulated under a policy of **no net loss.**

Figure 2-8
Modes of Power Plant Impact on Terrestrial Ecosystems



A. Modifying or eliminating habitat
B. Mining, handling, and storing coal
C. Emissions from stacks and cooling towers
D. Disposal of wastes

Steam Electric Power Plants

There are 14 utility steam electric power plants in Maryland greater than 100 MW in capacity, nine of which are located in rural areas and five of which are in urban, developed areas. The total area of all of the rural power plant sites is approximately 5,500 acres, the majority of which lies within the Coastal Plain province of Maryland. This acreage amounts to less than 0.1 percent of Maryland's total land area (more than six million acres). Facilities located in urban areas do not displace native vegetation and habitats, and thus have little or no direct impact on Maryland's terrestrial ecosystems. Depending on the specific plant site, buildings and structures may occupy only a small percentage of the total acreage. For example, at Chalk Point, less than one-third of the 1,149-acre site is occupied by the power plant and ancillary facilities. At Calvert Cliffs, approximately one-tenth of the 1,140-acre site is occupied by the power plant and ancillary facilities.

Hydroelectric Facilities

There are ten hydroelectric facilities in Maryland. Impoundments created by their dams are located in rural areas and hence have displaced previous terrestrial habitats. Not including the impoundment associated with Conowingo Dam (half of which lies in Pennsylvania), the inundated areas created for or with hydroelectric facilities total 7,790 acres. The habitats inundated by the impoundments, **riparian corridors,** typically support diverse and valuable flora and fauna. This loss of existing terrestrial habitats by inundation has been mitigated to a large degree by the formation of new habitats along new water lines of the impoundments. The impoundments have also provided new open water habitats suitable for a variety of wildlife, including waterfowl.

The existing facilities cannot be considered to have eliminated a significant portion of Maryland's total riparian habitat. However, the variable flow downstream from a hydroelectric dam, especially at an intermittently used peaking facility, can harm the riparian corridor by eroding streambank vegetation during high-flow periods.

Combustion By-product Landfills

There are six coal ash landfills in Maryland occupying approximately 1,200 acres, and more than 30 inactive, smaller ash sites. The land area required by conventional pulverized coal-fired power plants for ash disposal depends largely on the type and amount of coal used. Over a 40-year period, Maryland's coal-fired plants could require between 1,140 and 2,300 acres of land for ash disposal. At the higher end of this range, additional landfill acreage beyond the 1,200 acres currently in active use will have to be identified.

There are a number of potential terrestrial impacts associated with the development and operation of a combustion by-product landfill. Site clearing and subsequent landfilling can destroy vegetation and wetlands; modify habitats of rare, threatened, or endangered species; displace wildlife; and lead to the direct loss of smaller animals unable to migrate out of the disturbed areas. Leachate from ash landfills can have terrestrial impacts, in addition to the ground water impacts discussed previously, although such terrestrial effects from leachate are insignificant. For example, PPRP studies indicate trees immediately adjacent to PEPCO's Faulkner ash landfill had higher levels of arsenic and manganese in plant tissues than trees from control sites, but the concentrations were still within the natural ranges for these elements. The potential for a terrestrial community's eventual recovery at an abandoned landfill site and the site's long-term impact on the community have not been evaluated.

Transmission Line Rights-of-way

Transmission line **rights-of-way (ROWs)** are distributed throughout the state, connecting sources of power and distribution centers to consumers. Transmission line corridors require 12 to 24 acres of land per mile and traverse more than 3,000 miles in Maryland. The amount of land in Maryland potentially affected by transmission lines is considerably larger than all the acreage devoted to power plants, hydroelectric dam impoundments, and ash landfills combined.

The ecological impacts of power line construction and maintenance are very site-specific and may be either temporary or permanent. Land must be cleared of vegetation to construct transmission line corridors. The corridors must be maintained in grass or brush; hence, impacts to trees in forested areas will be permanent. However, with proper construction techniques, even sensitive wetlands (excluding trees) can recover in about two years after construction. Since January 1991, when Maryland DNR assumed responsibility for permitting activities in nontidal wetlands, the construction of new ROWs has affected less than one-half acre of nontidal wetlands permanently. This loss constitutes 0.03 percent of the total permanent impacts associated with permitting activities in nontidal wetlands between January 1991 and June 1992. To achieve "no net loss" of wetlands, the state requires that permanent impacts to nontidal wetlands be **mitigated**. Wetlands mitigation means that new wetlands are built to replace any acreage of wetland lost because of construction activities. Under certain circumstances, the state can require that twice as many acres of new wetlands be created to replace the loss of existing wetlands.

Utilities employ a variety of right-of-way management techniques, such as mowing, selective clearing, and herbicide application. When herbicides are part of right-of-way management, only U.S. EPA-approved herbicides are used by utilities. Only those herbicides approved for use in wetlands and surface waters are used in these areas. When these herbicides are used as approved by the U.S. EPA, studies have shown that they have little environmental impact. Use of herbicides may actually improve habitat quality within a right-of-way by promoting the development of mixed shrub/scrub and herbaceous vegetation, which is typically better quality habitat for most birds and wildlife than a grassy mowed right-of-way. Use of herbicides can also provide a more stable habitat, because the right-of-way does not have to be disturbed routinely for mowing.

When transmission line corridors are created in forested areas, considerable **edge habitat** is created, through the conversion of forested areas to grasses or shrubs. In cases where the transmission line corridor is located on the outer edge of a wooded area, the clearing and conversion of wooded areas to grass or shrub habitat can result in an increase in the number of species present in the total corridor and forest area. However, when the transmission corridor traverses the center of a large wooded area, essentially fragmenting the large wooded area with a swath of grass or shrub habitat, species that depend on forest interior habitat are adversely affected. The cumulative effects of landscape fragmentation on Maryland's wildlife have not been explored.

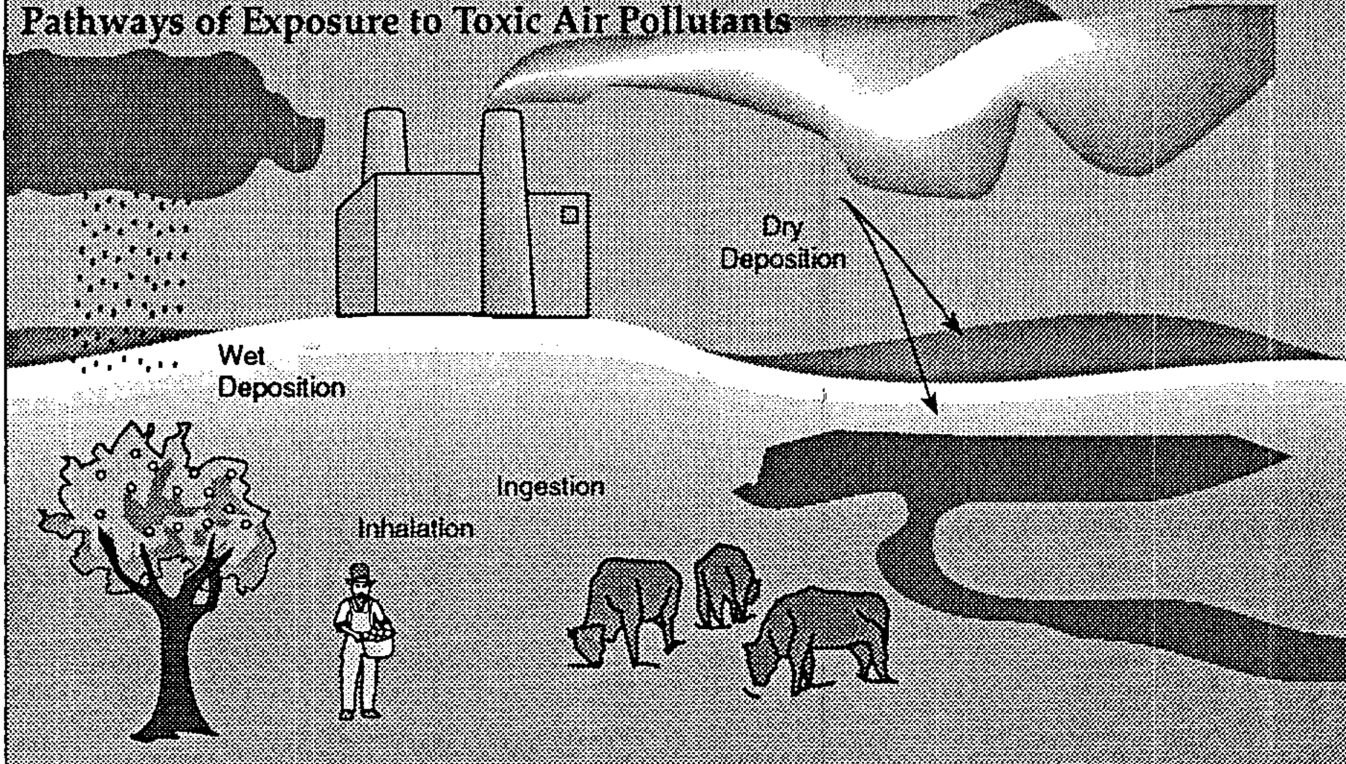
In addition to impacts associated with the construction and maintenance of ROWs, there is the potential for bird mortality resulting from collisions with the transmission lines. Studies have documented that mortalities can be large, especially for waterfowl, when lines are located near lakes or wetlands where birds concentrate. These types of impacts can be minimized, however, by siting new lines to avoid these areas, positioning towers and lines near visible screening objects to cause birds to fly over transmission lines, or making habitat modifications that result in changes in flight paths. Although no studies have investigated the magnitude of collision-related mortalities in Maryland, there have been no reported incidents of massive avian deaths associated with transmission lines. Generally, collision mortalities associated with transmission lines have not significantly affected bird populations.

Indirect Impacts

Air Emissions Impacts

Coal-fired power plants can affect terrestrial ecosystems through the deposition of gaseous and particulate air pollutants from stacks and coal-handling activities. The primary concern with power plant air pollution emissions is in its effect on ambient levels of those pollutants. However, as airborne pollutants from power plants are dispersed, some are eventually deposited on land and surface waters. These pollutants may pose ecological risks such as acidification of soils and waters, or they may be directly toxic to plants or wildlife. Pollutants in surface waters can be absorbed by aquatic life and may be incorporated into aquatic food chains of terrestrial wildlife. Similarly, pollutants deposited onto land can be

Figure 2-9
Pathways of Exposure to Toxic Air Pollutants



incorporated directly into terrestrial food chains from uptake by crops and farm animals (Figure 2-9).

Particulate matter may be introduced into the atmosphere during the loading, transport, unloading, and storage of coal on-site, and from the plant's stacks. Particulates in the air, in sufficient quantities, can negatively impact vegetation and terrestrial invertebrates and vertebrates.

Cooling tower emissions include some solid salts dissolved in the cooling water. When the steam from the cooling tower disperses in the atmosphere, these solids may fall out and adversely affect terrestrial ecosystems. In general, these impacts are believed to be localized and limited to an area within about 2,000 yards of the cooling tower. At the Chalk Point plant, a measurable effect on plant tissue and soil salt concentrations has been found due to emissions from the cooling towers. Although immediate negative impacts to vegetation in the area are unlikely, accumulation of elevated salts in soils could have long-term effects.

Power plant stacks also emit SO_2 and NO_x. As with particulates, damage to terrestrial resources from SO_2 and NO_x emissions has not been evident, and actual concentrations of pollutants appear to be too low to cause long-term effects (effects of acid deposition, formed when SO_2 and NO_x chemically react in the atmosphere, are discussed earlier in this report). Power plants can also emit additional potentially toxic substances, such as gaseous fluoride, arsenic, and mercury. In general, however, coal-fired power plants appear to be a minor source of heavy metals compared to other pollution sources, such as smelters and automobiles. Toxic chemical studies are discussed further in Section 4 of this report.

Climate Impacts

Many power plant impacts are local in nature; however, emissions of gases to the atmosphere may have long-range or even global ecological impacts. The mechanism involved is the greenhouse effect in which the accumulation of CO_2 and other gases in the atmosphere raises the temperature at the earth's surface. Refer to Section 4 for additional information on global climate issues.

Additional Impacts

In addition to the previously discussed potential impacts to air, water, and land, power plant operations can also produce other impacts. Among them are:

- *Radiological*
- *Noise*
- *Social and cultural*

Radiological Impacts

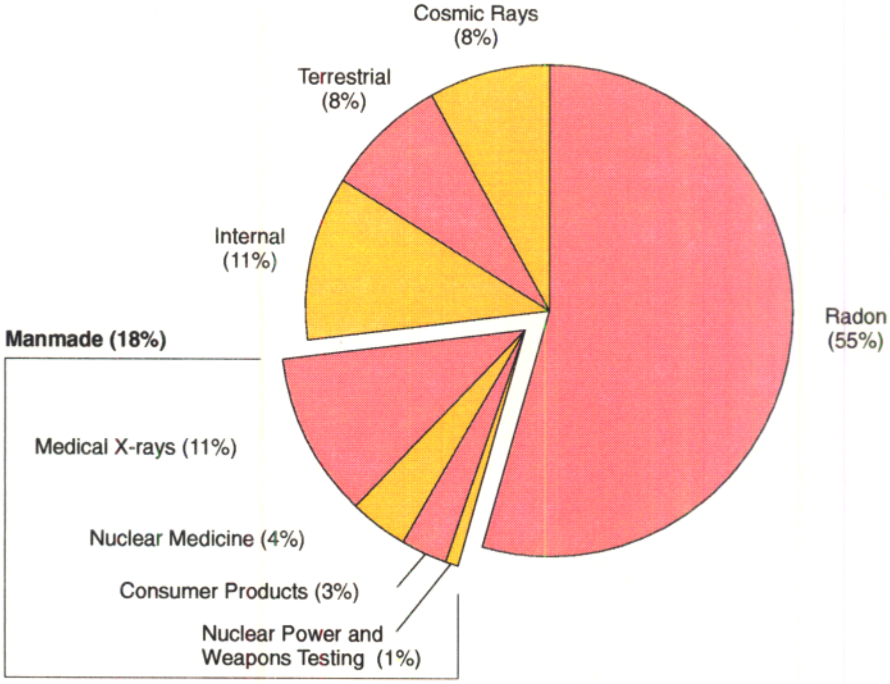
Nuclear power production in the United States is licensed, monitored, and regulated by the U.S. Nuclear Regulatory Commission (USNRC). Conditions that are imposed in the operating licenses of each plant allow utilities to discharge low levels of radioactivity to the environment. These releases are strictly regulated and must fall within limits defined in federal law. The limits are designed to keep environmental releases and radiation doses **as low as reasonably achievable (ALARA)**.

Pathways for exposure to radioactivity introduced into the environment are similar to those of other pollutants. Water doses, known as the aqueous pathway, are received through the ingestion of radioactivity contained in water and seafood and by exposure to contaminated sediments and water. Atmospheric pathway doses result from the direct inhalation of gaseous and airborne particulate radioactivity, exposure to radioactivity in a passing plume, or the ingestion of radionuclides that have been deposited on or assimilated by terrestrial vegetation and animals.

Nuclear power plants are minor contributors to radiation exposure in the United States. Natural radiation sources account for more than 80 percent of the average radiation dose. Of the approximately 18 percent of radiation dose provided by manmade sources, less than one percent is attributed to nuclear power plants (Figure 2-10).

There are three nuclear power stations that are regarded as potential sources of environmental impact to the State of Maryland. Of these plants, only the Calvert Cliffs Nuclear Power Plant is located within Maryland. The Peach Bottom Atomic Power Station is located along the Susquehanna River north of the Pennsylvania/Maryland state line. The third power plant, Three Mile Island nuclear station, is located on the Susquehanna River just south of Harrisburg, Pennsylvania. Normal operations at Calvert Cliffs and Peach Bottom routinely

Figure 2-10
Estimated Effective Radiation Dose from Natural and Manmade Sources



produce detectable radioactivity in Maryland; however, PPRP studies have indicated that except for the accident in 1979, radioactivity from Three Mile Island has not been detectable in Maryland.

Both Calvert Cliffs and Peach Bottom make controlled releases of low-level radioactive gaseous and liquid effluents, in accordance with their operating licenses. Prior to or at the time of release, radioactivity levels are monitored and quantified by the utility to ensure compliance with license restrictions. Levels of radioactivity in the Susquehanna River and Chesapeake Bay, the air, and the surrounding land areas are monitored by the utilities as well as the state. The results of these monitoring programs allow an assessment of the environmental and human health impacts of radioactivity released by each plant.

Calvert Cliffs Nuclear Power Plant

The Calvert Cliffs Nuclear Power Plant, owned and operated by BG&E, is located on the western shoreline of the Chesapeake Bay in Calvert County, Maryland. Each of its two units is a **pressurized water reactor** with a capacity of 860 MW per reactor. The two units entered into service in 1975 and 1977, respectively.

The Calvert Cliffs plant routinely releases low-level gaseous and liquid radioactive effluents into the atmosphere and the Chesapeake Bay. The quantities of radioactivity that are contained in these effluents at any given time depend upon many factors, such as plant operating conditions and conditions of the nuclear fuel. Since Calvert Cliffs has been in operation, all releases of radioactivity to the environment have been well within regulatory limits.

Radioactive noble gases, primarily argon, krypton, and xenon, comprise nearly all of the radioactivity released to the atmosphere from Calvert Cliffs. These particular **radionuclides** are chemically inert and therefore are of little environmental concern. They are readily dispersed in the atmosphere and have short half-lives, permitting them to decay rapidly to stable forms.

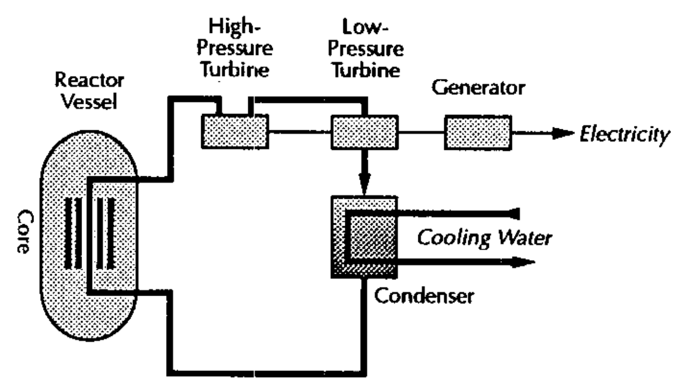
The principal environmentally significant radionuclides that have been released to the Chesapeake Bay are forms of radioactive cobalt ("radiocobalt"), radiozinc,

Nuclear Reactors

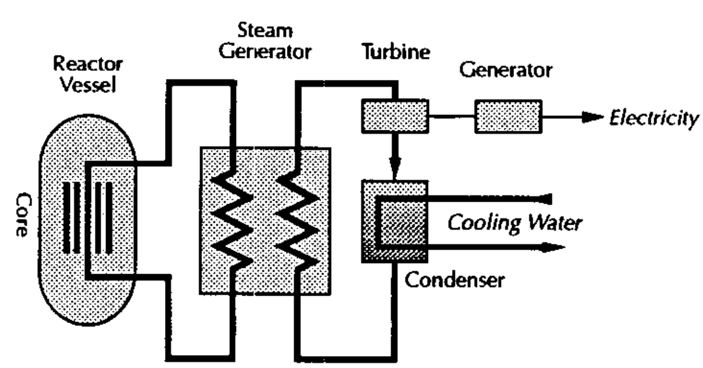
All currently operating commercial nuclear power reactors in the United States are one of two types — **boiling water reactors (BWRs)** or **pressurized water reactors (PWRs).**

In each, steam directly or indirectly created by heating water in the nuclear reactor core drives a turbine. In a BWR, water circulated through the core is heated to produce steam. In a PWR, water under pressure and super-heated in the reactor core provides the heat to convert a secondary loop of water to steam.

Boiling Water Reactor



Pressurized Water Reactor



Radioactive Fallout

A small percentage of the total radiation exposure received by humans is derived from radioactive fallout from atomic weapons tests. While most of the world's governments halted their open air nuclear weapons tests in the mid-1960s, the People's Republic of China conducted occasional aboveground atomic tests until October 1980. The open air testing of atomic weapons introduces a multitude of radionuclides into the environment. Because of atmospheric circulation patterns, these nuclides are distributed throughout the world. As a result, detectable amounts of long-lived radionuclides directly attributable to weapons test fallout have been measured in Maryland's environment. Among the most significant of the test-derived radionuclides are cesium-137 and strontium-90.

and radiosilver. These radionuclides are notable because they are readily accumulated by plants and animals, such as oysters and blue crabs. They can also become trapped in sediments at the bottom of the Bay. Through the food chain, these radionuclides in sediments may ultimately contribute a radiation dose to human populations. However, the quantities of environmentally significant radionuclides released and subsequently detected in fish and Bay sediments are quite small. Released quantities of a form of radiocobalt known as cobalt-60 were slightly higher in 1990 than they had been in recent years, but this did not result in a significant increase in detected concentrations of cobalt-60 in the Chesapeake Bay.

Results of the most recent environmental monitoring (from 1989 through 1991) indicate that releases of radioactivity to the atmosphere by the Calvert Cliffs plant were not detectable in air, precipitation, or vegetation. Liquid releases of radioactivity produced detectable concentrations of radiocobalt, radiozinc, and radiosilver in Chesapeake Bay aquatic life and sediments. Several radionuclides originating from natural sources and atmospheric nuclear weapons tests were also detected.

Bay oysters are ideal indicators of environmental radionuclide concentrations because they do not move and they readily ingest and concentrate metals. Oysters are commercially harvested in the vicinity of Calvert Cliffs, and they have the greatest potential for providing a human radiation dose through seafood consumption. On a quarterly basis, PPRP immerses oysters in trays in the vicinity of the Calvert Cliffs liquid effluent discharge, then collects them for tissue analysis of radionuclide content. Radiosilver continues to be the principal plant-related radionuclide accumulated by oysters; it has consistently been detected in test oysters as well as oysters located on natural beds. Recent monitoring data revealed low concentrations of radiosilver in other Bay organisms, including blue crabs, grass shrimp, and algae.

Aquatic sediments are also useful indicators of environmental radionuclide concentrations because they serve as natural sinks for both stable and radioactive metals. Sediment samples are collected seasonally by PPRP from eight transects extending bayward north and south of the Calvert Cliffs plant. Cobalt-60 was the plant-related radionuclide detected most frequently in Bay sediments during the 1989-1991 period. Detection of another form of radiocobalt, cobalt-58, declined in frequency and in concentration compared to previous years, owing largely to the decrease of releases in Calvert Cliffs liquid effluent. Radiosilver was also detected sporadically during this period at concentrations similar to levels detected in previous years.

As part of the surveillance program, PPRP estimates doses of radiation to individuals consuming seafood. The doses are calculated based on maximum or worst-case estimates of the amount of plant-related radioactive materials potentially available. Results indicate that radiation doses attributable to operations at Calvert Cliffs are well below federally mandated limits.

A comparison of radionuclide concentrations in aquatic and sediment samples collected between 1989 and 1991 with levels detected since 1978 indicates that:

- *In general, the levels of plant-related radionuclides detected in the 1989-1991 period are similar to the range of concentrations detected over the previous decade.*
- *Although radionuclide concentrations do fluctuate seasonally and annually, no long-term accumulation of plant-related radioactivity in Bay aquatic life and sediments is apparent.*
- *The quantities of radioactivity that are introduced into the environment by Calvert Cliffs are small when compared to background radioactivity from natural sources and weapons test fallout.*
- *Atmospheric and aqueous releases, as well as radiation doses to humans, are well within regulatory limits.*
- *Environmental, biological, and human health impacts resulting from the operation of Calvert Cliffs are insignificant.*

Peach Bottom Atomic Power Station

The Peach Bottom station is owned jointly by PECO, Public Service Electric and Gas Company, DP&L, and Atlantic Electric Company, and is operated by PECO. The power plant is located in Pennsylvania approximately three miles north of the Pennsylvania-Maryland border on the western shore of the Susquehanna River (Conowingo Pond). Each of its two operating units is a **boiling water reactor** with a maximum capacity of 1,098 MW (gross).

Like Calvert Cliffs, the Peach Bottom plant routinely releases low-level gaseous and liquid radioactive effluents into the atmosphere and the Susquehanna River. Since the plant has been in operation, all liquid and atmospheric releases of radioactivity have been well within regulatory limits.

Three Mile Island Nuclear Station

The Three Mile Island (TMI) Nuclear Station is located on the Susquehanna River just south of Harrisburg, Pennsylvania, approximately 30 miles from the Maryland border. Each of its two original units were pressurized water reactors with maximum capacities of 840 MW. Unit 1, placed in service in 1974, has been one of the nation's most dependable commercial nuclear power reactors and remains in service today. Unit 2, crippled in the widely publicized accident on March 29, 1979, has been defueled and decontaminated and awaits final decommissioning concurrent with Unit 1. The operating license for Unit 1 expires in 2014.

PPRP has played an important role in collecting and assessing information related to the environmental, social, and economic consequences of the March 1979 accident and communicating that information to Maryland citizens and decisionmakers. These activities continued for several years during the cleanup, focusing on corrective actions taken by the operator and the U.S. Nuclear Regulatory Commission (USNRC). While the immediate concern following the accident was related to reactor core damage and potential releases of radioactivity to the air, the greatest environmental significance to Maryland was the issue of radioactive discharges to the Susquehanna River — and ultimately the Chesapeake Bay.

During the accident, the reactor containment building and the auxiliary and fuel handling buildings were flooded by over 1.5 million gallons of radioactive water. Early on in the accident sequence, much of this water was discharged to the Susquehanna River. PPRP staff, aware of the ongoing condition, arrived at the site on Friday, March 30, 1979. Through the USNRC, PPRP was provided samples of all water discharges to conduct independent analysis at its radioecology laboratory in Baltimore. Results of these measurements, which PPRP provided daily to the utility and the USNRC during the first two weeks of the incident, permitted the quantification of radioactivity released during the event. When discharges to the Susquehanna were finally terminated, subsequent analyses by PPRP of Susquehanna River and Upper Chesapeake Bay sediments and finfish provided the information necessary to assess the accident's environmental and public health impact.

During the cleanup, PPRP reviewed results of utility and USNRC evaluations and studies, providing comments and perspectives to USNRC regulators and citizens through public briefings and media. A significant concern was related to disposal of the more than 2 million gallons of radioactive water generated during the accident, which was stored on the TMI site. PPRP interacted with the utility and the USNRC extensively over several years to resolve this disposal issue. In fact, throughout the more than 10 year cleanup, PPRP was engaged in numerous research projects and conducted several independent studies. These included, for example, the deployment of appropriate air monitors along the Maryland-Pennsylvania border to assess a potential radiation dose associated with the purge of radioactive gases from the reactor containment building.

The Unit 2 reactor has been defueled, and decontamination of that portion of the TMI site is complete. The site is securely maintained and monitored, and awaits full dismantlement as part of decommissioning in the next century. While no lives were lost, and the radiological impacts to natural resources were minuscule, the potential for both was great. This knowledge — the Three Mile Island legacy — resulted in extensive regulatory and industry changes to improve the safety of commercial nuclear power reactors in the United States and abroad.

The Chernobyl Accident

On April 26, 1986, Unit 4 of the four-reactor Chernobyl plant in the Ukraine region of the former Soviet Union exploded as a result of a rapid rise in **fuel element criticality.** Steam pressure from the explosion lifted a 1,000-ton cover plate from the uncontrolled reactor, exposing it to the environment. Large quantities of radioactivity (more than one million times the amount released at the Three Mile Island accident in 1979) were released over a period of about 10 days. Most of the accident-related radioactivity was deposited in northeastern Europe and Scandinavia, but gaseous and particulate radioactivity was detected in a matter of two weeks throughout North America as well. A number of fission-related radionuclides were detected in the Maryland/Pennsylvania area in the atmosphere, vegetation, milk, precipitation, soil, and aquatic biota. The Chernobyl-related fallout in Maryland consisted mainly of iodine-131 and radiocesium. Owing to the short half-life of radioiodine and deposition and dispersion patterns, with the exception of very low levels of radiocesium, Chernobyl-related radioactivity was not detectable in the region after two months.

Information from monitoring programs indicates that in recent years radionuclides of xenon and krypton accounted for nearly all of the radioactivity released to the atmosphere by the Peach Bottom plant. These particular radionuclides are chemically inert and, therefore, are of little environmental concern. Based on environmental monitoring from 1989 to 1991, no radioactivity attributable to the atmospheric releases of the Peach Bottom plant was detected in air samples collected from the plant site and distant locations.

Of the radionuclides released by Peach Bottom to the Susquehanna River from 1989 to 1991, nearly 100 percent was tritium (a radioactive form of hydrogen) in a form that is not bioaccumulated and is of limited environmental concern. Very small quantities of radioactive cobalt, iron, zinc, and cesium accounted for most of the remainder of the radioactivity released as liquid effluent. These particular radionuclides are environmentally significant because they can be readily accumulated by aquatic life such as mussels and finfish.

Finfish collected from the Conowingo area (including the Conowingo Pond and Conowingo Dam tailrace) contained both plant-related and fallout-related radionuclides. As with the plant and animal samples, Peach Bottom plant-related radioactivity was also detected in sediments collected down-river of the plant, similar to previous years. Concentrations of radiocobalt and radiocesium were highest in the Conowingo Reservoir area, as they have been in previous years. It is estimated that less than 20 percent of the radioactivity released by Peach Bottom is found in surface sediments of the Conowingo Reservoir. The remaining radionuclides appear to be transported downstream to the Chesapeake Bay.

Estimates of radiation to individuals consuming fish were calculated using the maximum plant-related radionuclide concentrations, similar to the studies at Calvert Cliffs; however, because the Susquehanna River is a source of drinking water, its ingestion, in addition to fish consumption, may potentially contribute to a human radiation dose. The annual total body dose associated with the consumption of finfish and drinking water are well below federal limits.

Comparing PPRP's radiological monitoring of Peach Bottom plant-related radioactivity in aquatic life and sediments collected from 1989 to 1991 with monitoring results since 1978 indicates that:

- *The low levels of plant-related radioactivity detected in aquatic life and sediments represent a small increment to the Susquehanna River-Chesapeake Bay system relative to natural and weapons test radioactivity levels.*
- *No long-term accumulation of plant-related radioactivity in river biota is evident.*
- *Atmospheric and aqueous releases as well as radiation doses to humans are well within regulatory limits.*

- *Environmental, biological, and human health impacts resulting from the operation of Peach Bottom are regarded as insignificant.*

Noise Impacts

The noise created by power plants is unlike other environmental impacts because it does not involve emissions of physical substances such as air pollutants or wastewater. Rather, noise consists of vibrations in the air that gradually decrease, or attenuate, the longer they travel. For people who live or work near a power plant, the noise impacts, along with visual and traffic impacts, can be the most significant type of effect caused by the facility.

Noise is made up of many components of different frequency (pitch) and loudness. One **decibel** (dB) is a measure of loudness and is approximately the smallest change in sound intensity that can be detected by the human ear. A tenfold increase in the intensity of sound is expressed by an additional 10 units on the decibel scale; a 100-fold increase by an additional 20 dB. The sensitivity of the human ear also varies according to the frequency of sound; consequently, a weighted noise scale is used to determine reactions of people to noise. This **A-weighted decibel (dBA)** scale weights the various components of noise based on the response of the human ear. For example, the ear perceives middle frequencies better than low or high frequencies; therefore, noise composed predominantly of the middle frequencies is assigned a higher loudness value on the dBA scale.

The sound level measured at a particular location cannot be determined by directly adding all the individual noise sources. Rather, the total noise is primarily a result of the source of highest intensity. For example, two sources of 50 dBA each will together emit 53 dBA; a source of 65 dBA combined with a source of 85 dBA will result in a noise level of 85.1 dBA. As the intensity difference between the two noise sources increases, the effects of the lower sound sources become negligible.

Structures such as berms and walls may be constructed solely to provide noise control and have been along highways for many years. Vegetative buffers may be used in conjunction with these structures for additional noise abatement. Sound waves decrease in strength as they travel, and each doubling of distance from a noise source results in a decrease of 6 dBA in the measured sound level.

In Maryland, noise surveys have recently been performed at two power plant sites — Chalk Point and Dickerson. Both of these surveys were done by PEPCO to support its proposals to construct new generating units at these locations. PPRP's analyses, based on the data collected by PEPCO at both sites, determined that the proposed new units would cause

Typical A-Weighted Sound Levels for Various Common Noise Sources

Noise Source	Typical Level (dBA)
Lowest sound audible to human ear	0-1
Soft whisper in quiet library	30-40
Light traffic, gentle breeze	50
Air conditioner at 6 meters, conversation	60
Busy traffic, noisy restaurant, freight train moving 30 mph at 30 meters	70
Subway, heavy city traffic, factory	80
Truck traffic, boiler room, lawn mower	90
Chain saw, pneumatic drill	100
Rock concert in front of speakers, sand blasting, thunderclap	120
Gunshot, jet plane	140
Rocket launch pad	180

insignificant increases in noise levels around these facilities compared to existing noise levels. However, both surveys performed by PEPCO suggest that state and local noise standards are being exceeded slightly at certain times at both sites already. The combined effect of the existing power plants, road traffic, motorboats, trains, planes, and even insects is believed to be responsible for these periodic exceedances. At Dickerson, PPRP recommended that PEPCO construct walls to decrease noise levels at adjacent properties resulting from the proposed combustion turbines. The licenses granted to PEPCO also require the utility to monitor the noise created by the new units being added at both these locations.

Social and Cultural Impacts

Power plants in Maryland have influenced more than the physical environment. Power plants have integrated themselves into local economies as employers, as purchasers of goods and services, and as taxpayers. These facilities have also imposed social costs on their neighbors in the forms of increased traffic, compromised viewsheds, and various aesthetic and nuisance impacts. In recognition of this, PPRP's environmental assessments of utility power plants and transmission lines include the analysis and consideration of social impacts.

Social impacts encompass a number of concepts. In general, there are potential economic impacts, expressed in terms of employment and income; demographic impacts, such as population and housing; fiscal impacts, both in terms of revenues and expenditures; transportation and land use impacts; cultural impacts; and aesthetic impacts. This section concentrates primarily on three social impact categories that are relevant to several recent power plant siting projects: cultural resources, aesthetic impacts, and fiscal impacts.

Cultural Resources

Although utility structures occupy only a small fraction of the lands in which generation facilities are located, power plants generally preempt large tracts of land from other uses. In fact, assembling and developing large tracts of land for power plants or other uses can lead to the loss of potentially significant cultural resources in the form of **archaeological** and **historical sites**. To protect the state's cultural resources, utilities must conduct detailed inventories both on- and off-site as part of the power plant licensing process, and must propose mitigation measures, where necessary, to ensure the preservation of these resources.

Recent applications by Maryland utilities for new power plant construction have included two levels of archaeological assessments, known as **Phase I** and **Phase II** assessments. The Phase I reconnaissance of PEPCO's Dickerson property in Montgomery County for the construction of new capacity there, for example, identified two historic sites considered potentially significant. Subsequent examinations of the sites determined that both were eligible for nomination to the National Register of Historic Places. As a result of these investigations, PEPCO committed to protecting these resources from construction and operations activities by restricting access to the sites.

At BG&E's Perryman site in Harford County, a Phase I reconnaissance of the property identified six prehistoric and nine historic sites of potential cultural significance. Of these, two prehistoric and two historic sites were subject to additional examinations because they were situated on terrain that could be disturbed by construction activities. Although neither prehistoric site was sufficiently intact nor contained a significant content of archaeological materials to be considered eligible for nomination to the National Register, one of the two historic sites was determined eligible. On the basis of this information, BG&E agreed to fence and restrict access to the site to ensure that cultural deposits are not affected by construction and operation of the proposed facility. BG&E also re-routed a utility corridor that originally encroached upon the historic site boundary to avoid disturbing any archaeological deposits that may be buried in the area.

Aesthetic Impacts

Impacts on cultural resources often extend beyond the boundaries of the property in which the facility is situated. Utility structures, for example, can visually intrude upon landscapes. Increased traffic volumes generated by the facility can also affect the aesthetic values of cultural resources. In some cases, these impacts are unavoidable and cannot be mitigated effectively. In other situations, impacts may be temporary, such as nuisance impacts from construction traffic, and are tolerated. Finally, some impacts can be mitigated to protect the aesthetic values of cultural and other resources.

In general, aesthetic impacts are minimized by evaluating potential impacts in the context of the characteristics and value of the resource, the nature and duration of the impact upon the resource, and the feasibility of mitigating the impacts.

For example, during licensing of PEPCO's expansion at its Dickerson plant, visual impacts of various structures on the surrounding countryside were acknowledged. However, in the context of the existing power plant on-site, which includes a 700-foot stack and two 400-foot stacks, it was determined that the additional structures would not be prominent. Furthermore, views of the site from the surrounding countryside were expected to be largely obstructed by terrain and vegetation, reducing visual impacts from selected locations. Despite the presence of many cultural and recreational resources in the Dickerson area, no measures were recommended to mitigate visual impacts because the marginal impacts were small and largely buffered by natural features. Similarly, no mitigation measures were recommended for PEPCO's expansion at its Chalk Point facility because the marginal visual impacts from the proposed combustion turbines, relative to existing structures on-site, were expected to be insignificant from most perspectives.

Visual impacts from BG&E's proposed expansion at its Perryman plant are expected to significantly "industrialize" the horizon from some perspectives because no prominent structures are currently located on the property. However, vegetation will screen the new facility structures from most viewpoints. BG&E has agreed to mitigate visual impacts on an adjacent community by planting a buffer of trees across the sight line between the community and the facility.

Archaeological Investigations

Environmental assessments of cultural resources must satisfy minimum standards of fieldwork, analysis, and data reporting. The requirements are outlined in a document entitled *Guidelines for Archaeological Investigations in Maryland,* published by the Maryland Historical Trust. These assessments generally involve background research into the prehistoric and historic knowledge of the area, and include a **Phase I reconnaissance study.** The purpose of a Phase I reconnaissance is to locate and describe potentially significant sites through surface and subsurface examinations, assessing the nature and number of archaeological resources present. Sites identified as having potential significance undergo a **Phase II preliminary site examination** to provide sufficient information to determine whether the site is eligible for inclusion into the National Register of Historic Places. A **Phase III full-scale excavation** of significant archaeological sites is considered a mitigation alternative prior to the destruction of the site.

Fiscal Impacts

Even though the construction and operation of power plants impose social costs on the host communities, utilities have generated much more in tax revenues than they have required in public expenditures. There are several reasons for low public expenditures:

- *Construction and operation labor demands have been relatively modest due to the nature of generating capacity that has been installed and because construction activities have been staged over several years.*
- *The existence of an adequate supply of labor within commuting distance of new power plant sites has helped to avoid most of the costs associated with an in-migrating labor force.*
- *The existing economic, social, and public infrastructure has generally been adequate to meet facility demands, including workers commuting to construction sites even during peak construction periods. Modest public expenditures have been required to fund transportation improvements to accommodate increased traffic.*

On the revenue side of the ledger, Maryland utilities contribute indirect tax revenues in the form of income taxes on their employees plus sales and other taxes on the purchases they make, as well as corporate tax revenues from suppliers of goods and services to utilities. However, direct tax revenues are far greater contributors to state and local budgets. For example, the first stage of PEPCO's new capacity at the Dickerson plant is expected to add more than $5 million annually to Montgomery County's tax revenues and more than $500,000 each year to state revenues when all four combustion turbines are operational. Additionally, PEPCO will contribute other taxes and one-time payments to other governments including a transit tax to fund the metropolitan Washington, D.C., public transportation system, a tax to the Upper Montgomery County Fire District, and miscellaneous payments for recreational facilities.

BG&E's Perryman facility is projected to add more than $10 million annually to Harford County's total tax revenues when fully operational and more than $1 million in annual state tax revenues. No significant fiscal impacts on municipal budgets are anticipated because all new electric generation facilities in the state, either planned or under construction, are located outside of incorporated areas.

The timing, nature, and duration of fiscal impacts associated with the construction and operation of power plants in Maryland that have been evaluated recently are similar. Public expenditure impacts, where they have occurred, have primarily consisted of up-front outlays by county and state governments to reduce construction-induced impacts on the local transportation systems around proposed sites. Tax revenues during facility construction have mainly been collected by the State of Maryland in the form of personal income and state sales taxes. Government outlays to mitigate facility-induced impacts during the construction period sometimes exceed tax revenues collected in the same period. The payback to county and state governments, however, occurs after the facilities have become operational, primarily in the form of annual streams of property tax revenues. Invariably, the fiscal impacts from new generating capacity licensed in the past five years have been or are projected to be largely positive because of the difference between property tax revenues and government expenditures needed to accommodate the facilities.

Trends and Developments Affecting Power Generation

Several trends and developments in regulatory programs and energy issues have and will continue to affect how power plants generate electricity. Some of the developments are local, such as changes in power plant operations resulting from efforts to protect the Bay. Other developments come from outside Maryland, such as advances in power generation technologies and new federal licensing requirements for nuclear power plants. PPRP monitors and evaluates these issues as they develop. In this section, we report on a few of the more important trends and developments.

Chesapeake Bay Program

In some respects, the creation of the Power Plant Siting Program, precursor to the current PPRP, foretold the later development and implementation of the Chesapeake Bay Program (CBP). As mentioned in the introduction to this report, the Power Plant Siting Program was created in 1971 as a result of public concern over the proposed Calvert Cliffs Nuclear Power Plant. Calvert Cliffs became the focus of many of the initial environmental studies conducted by PPRP as well as by the facility's owner, BG&E.

In the early 1980s, after the health of the Bay and its living resources had declined significantly due to a variety of anthropogenic factors, increasing public concern led to the development and implementation of the Chesapeake Bay Program in 1983. Twenty years after the initiation of the Power Plant Siting Program, data from many of the long-term, scientifically rigorous studies conducted at Calvert Cliffs continue to be used in Bay research. Thus, the motivations and forces that created and sustained PPRP are very similar to those that foster the Chesapeake Bay Program.

The Role of Power Plants as Sources of Impact to the Bay

The Chesapeake Bay Program, a cooperative state and federal effort, has identified several environmental factors that have contributed significantly to the degradation of the Bay and the decline of its living resources. Key among them is excessive loading of nutrients (phosphorus and nitrogen), which results in excessive production of algae, choking of submerged aquatic vegetation, and decreasing dissolved oxygen levels in deeper portions of the Bay due to decomposition of dead algae. Major sources of nutrient loading to the Bay include sewage treatment plants, runoff from farmland, and deposition of nitrogen from the atmosphere. The introduction of toxics into the Bay has also been a major concern for the CBP because of the effects of toxics on organisms in all links of the Bay's food chain and the potential human health risk that toxics pose. Primary sources of toxics include industrial discharges and runoff from the Bay watershed, some of which results from atmospheric deposition. Overexploitation of the Bay's fish and shellfish resources and degradation of critical habitats for commercial, recreational, and ecologically important fish species are also important concerns for the CBP. One important CBP objective is to remove obstacles to upstream migration of **anadromous fish** that use Bay tributaries as spawning and nursery areas.

The potential effects of power plants on the Chesapeake Bay and its aquatic resources were discussed in Section 2. It is clear that power plant construction and operation have the potential to contribute to most of the key impact factors being addressed within the CBP. For example, power plant emissions may contribute to atmospheric nitrogen loading to the Bay's watersheds. A variety of toxics, including mercury, are released from power plant sites through atmospheric emissions and runoff. Power plants that use Bay water for cooling also reduce fish and crab stocks by entraining larvae and impinging juveniles and adults. In addition, the Conowingo Hydroelectric Facility and other hydroelectric plants on the Susquehanna River have been obstacles to upstream migration of anadromous fish into the largest tributary of the Bay. Providing fish passage facilities at those dams plays a key part in meeting the CBP's goal of anadromous fish restoration.

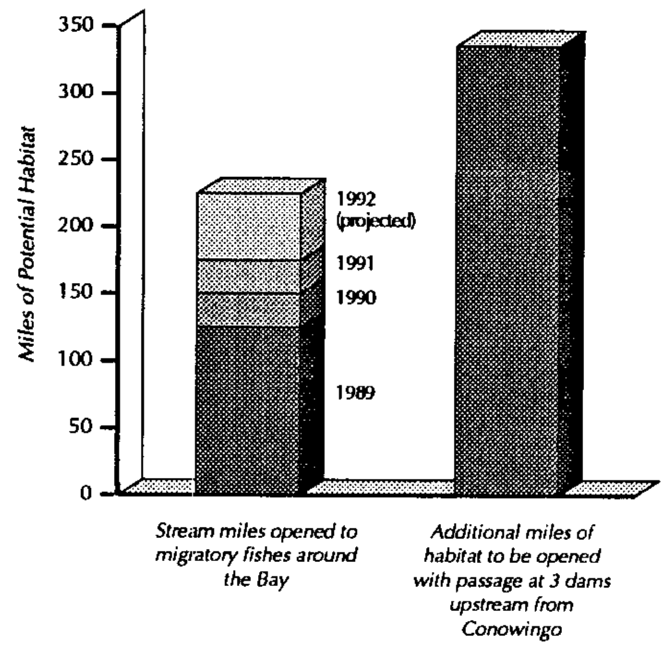
Relationship of PPRP to CBP Programs and Objectives

Many environmental studies of the effects of power plants sponsored by PPRP have contributed significantly to Chesapeake Bay Program accomplishments. One of the most notable is Maryland's current **Long-term Benthic Monitoring Program (LTB)**, which originated from benthic studies at Calvert Cliffs in 1971. Studies conducted originally by the University of Maryland and consultants to BG&E provided a basis for PPRP-funded studies that began in 1976. The objective of the PPRP studies was to determine the extent to which power plant operations produced long-term, cumulative effects on benthic communities in the Bay. By 1989, the studies indicated no evidence of adverse cumulative effects. However, the LTB had evolved into a major element of the CBP's comprehensive effort to monitor status and changes in the Bay ecosystem, and primary responsibility for funding the program was assumed by the Maryland Department of the Environment as part of the Bay monitoring effort. Maryland's benthic monitoring program and coordinated studies being conducted in Virginia's portion of the Bay constitute major tools currently being used to track changes in the status of the Bay ecosystem in response to ongoing management activities.

Another major area of focus within the CBP to which PPRP studies have contributed significantly is management of the major exploited species in the Bay, particularly striped bass. When large-scale PPRP studies began in the early 1970s, Douglas Point, located on the Potomac River midway between Washington, D.C., and the Potomac's confluence with the Bay, was identified as the potential location for construction of a large nuclear power plant. Because Douglas Point was located in the center of the primary striped bass spawning area in the Potomac, the potential effects of the proposed plant on striped bass populations were of great concern.

To address this concern, PPRP initiated the **Potomac River Fisheries Program**, which included multi-year studies of all life stages of striped bass, investigations of the hydrodynamics of the Potomac River, and statistical and modeling studies to examine how environmental changes affect striped bass populations. PPRP also sponsored studies on striped bass during the 1970s on stocks spawning in the upper Bay and the Chesapeake & Delaware Canal. These studies were implemented in response to concerns about potential impacts of a proposed nuclear power plant at the Summit site located on the Canal. Both sets of studies provided critical life history information for characterizing the population dynamics of striped bass, an essential step in developing the interstate striped bass plan that presently guides management along the entire East Coast.

Miles of Potential Habitat for Migratory Fish



The Chesapeake Bay Program anticipates by 1992 opening approximately 225 miles of potential habitat around the Bay as a result of its fish passage efforts. PPRP is playing a major role in opening an additional 336 miles of habitat on the Susquehanna River alone as a result of the 1992 agreement between state and federal agencies and the utilities operating hydroelectric facilities on the Susquehanna.

Recent and ongoing PPRP toxics studies augment CBP efforts to assess sources, consequences, and means of mitigating the effects of toxics introduced into the Bay. Extensive work funded by the Power Plant Topical Research Program division of PPRP has been devoted to characterizing atmospheric deposition of trace elements, including organic and inorganic toxics, to the Bay and its watershed. A one-year PPRP field program that monitored atmospheric trace element loadings to the Bay has been continued for two more years under CBP funding. PPRP has examined the role of sediments as a source of methylmercury in the Bay, and has assessed how the size of airborne particles affects the amounts of trace elements transported in and deposited from the atmosphere. Studies currently underway are assessing the levels of mercury present in fish in inland waters (ponds and reservoirs) in Maryland, estimating the magnitude of atmospheric deposition of trace elements to watersheds, and evaluating mathematical models for predicting dry deposition of trace elements to both land and water. In all of these studies, means of determining the sources of toxics will be developed to assess the magnitude of power plant contributions to toxics and to identify potential means of reducing or eliminating those loadings.

Alternative Generation Technologies and Fuels

Concern about the environmental impacts of generating electricity has spurred research and development into "cleaner" technologies. The following discussion highlights some of the important considerations that go into a selection of generating technology.

On a large scale, electricity is produced from the conversion of stored energy to mechanical energy. Stored energy can be in the form of chemical energy found in fossil fuel resources, nuclear energy found in uranium, or potential energy of water stored behind dams. On a smaller scale, electricity can be produced from the direct conversion of chemical or solar energy into electrical energy.

The development and choice of electrical generation technologies are influenced by the energy content of the fuel or other energy resource, the environmental impacts associated with the use of the resource, and the availability of the resource. A constraint on the choice of employed technologies is that the demand for electrical energy is not constant — it varies with season, time of day, and day of week. However, utilities are expected to meet this demand at all times.

The ability to meet the demand requires a utility to have the capacity available or the ability to rapidly increase capacity in excess of the average demand. Many of the available generation technologies do not respond rapidly to changes in demand or operate inefficiently at partial load. As a result, utilities own and operate a wide variety of equipment to meet the demand.

The technologies presently employed by Maryland power producers are conventional for the industry and typical of much of the United States. Oil-fired and pulverized coal-fired boilers comprise most of the steam-generating capacity while natural gas and distillate fuel oil are more commonly used in combustion turbines. For the most part, Maryland power producers plan to incorporate the latest commercially available technologies into their plans for added capacity.

New commercial technologies introduced into Maryland over the next 10 years will be primarily based on the use of fossil fuels. Capacity additions will be typically smaller than large stations built in the past, or constructed in a staged manner to increase capacity as demand grows. Utilities are planning to build advanced combustion turbine facilities supplied with natural gas and/or distillate fuel oil. Several of the combustion turbine facilities planned for Maryland will be operated in a combined cycle mode.

Combustion turbine combined cycle facilities allow the utilities to stage construction and meet the increase in demand in a cost-effective manner. The combustion turbines can be constructed initially to meet peak capacity needs and then, with the addition of heat recovery steam generators, meet baseload demand. Some time after the year 2000, PEPCO's new combined cycle facility, presently under construction at its Dickerson site, may be modified to include **coal gasification**. Coal gasification is a conversion technology that produces a low or medium Btu gas from the partial combustion of coal.

Panda Energy, a non-utility generator, plans to install a combined cycle facility in Prince Georges County. The facility is designed to use either liquefied natural gas (LNG) or natural gas, whichever is economically available at the time of generation. LNG would be supplied to the site from the Cove Point LNG terminal located in Maryland.

Atmospheric **fluidized bed coal combustion**, a combustion technology designed to reduce the formation of NO_x and SO_2, has been proposed by non-utility generators to produce electrical energy in Maryland; utilities have also considered the use of this technology. A fluidized bed consists of solid particles in contact with a gas flowing at high velocity. Fuel, ash, and chemical reagents are