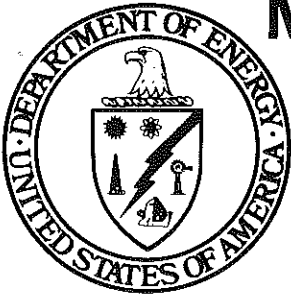


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**Final Environmental Impact Statement**

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**Memphis Light, Gas and Water Division  
Industrial Fuel Gas  
Demonstration Project**

**Memphis  
Shelby County  
Tennessee**

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**U.S. Department of Energy**

**May 1981**

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Cover Sheet  
Final Environmental Impact Statement  
Memphis Light, Gas and Water Division Industrial Fuel  
Gas Demonstration Plant Project  
Memphis, Tennessee  
DOE/EIS-0071

(a) Lead Agency: U.S. Department of Energy  
Cooperating Agencies: U.S. Environmental Protection Agency,  
U.S. Army Corps of Engineers

(b) Proposed Action:\* The cost sharing by the Department of Energy and the city of Memphis Division of Light, Gas and Water (MLGW) leading to the construction and operation of a 3155-ton/d industrial fuel gas demonstration project at Memphis, Shelby County, Tennessee.

(c) For Further Information Contact: (1) Richard Martello, U.S. Department of Energy, Chicago Operations and Regional Office, 9700 South Cass Avenue, Argonne, Illinois 60439, Ph: (312) 972-2306; (2) Dr. Robert J. Stern, Director, NEPA Affairs Division, Office of the Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness, Room 4G-064, Forrestal Building, Washington, D.C. 20585, Ph: (202) 252-4600; or (3) Stephen H. Greenleigh, Esq., Acting Deputy General Counsel for Programs, Room 6D-033, Forrestal Building, Washington, D.C. 20585, Ph: (202) 252-6947.

For Copies of the EIS Contact: Richard Martello at the address noted above.

(d) Designation: Final EIS (FEIS).

(e) Abstract: The statement assesses the potential environmental impacts associated with the construction and operation of a 3155-ton/d capacity facility, which will demonstrate the technical operability, economic viability, and environmental acceptability of the MLGW coal gasification plant at Memphis, Tennessee. Impacts addressed include potential impacts on terrestrial and aquatic ecology, including State and Federally declared threatened or endangered species; expected impacts on land use; projected alteration of flood elevation; potential changes to the quality of surface water and groundwater; compliance with State and Federal ambient air quality standards; and changes to existing economic and social characteristics of the site area. Additionally, the statement presents an identification of potential hazards associated with the operation of the proposed facility. MLGW's monitoring plan for the duration of the demonstration phase to assess the effectiveness of the planned mitigation measures is also presented.

(f) In assessing the potential environmental impacts of the proposed action, several programmatic and design alternatives are considered and evaluated. The range of alternatives assessed includes proceeding with the action as proposed, including continued operation at the demonstration plant capacity, delay of the action and subsequent continuation of the project, and no Federal action. In addition, alternative plant designs, alternative plant sites and alternative fates, including mothballing and decommissioning, are evaluated.

(g) A Record of Decision will be issued no earlier than 30 days after the FEIS Notice of Availability is published in the Federal Register. A Floodplain-Wetland Statement of Findings will also be issued.

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\* As part of the restructuring of the Federal Synthetic Fuels Program, the DOE Gasification Demonstration Program will be discontinued, and FY 1981 funding (\$45.4 million) has been proposed for rescission. Carry-over funds from past years will be used to continue final design work through FY 1981 for this joint project with the city of Memphis to design, build, and operate a medium-Btu fuel gas demonstration plant. At the end of this fiscal year, the administration proposes to conclude direct DOE support for the project. The project sponsor has proposed continuing the project under incentives provided by the Synthetic Fuels Corporation.





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**Final Environmental Impact Statement**

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**Memphis Light, Gas and Water Division  
Industrial Fuel Gas  
Demonstration Project**

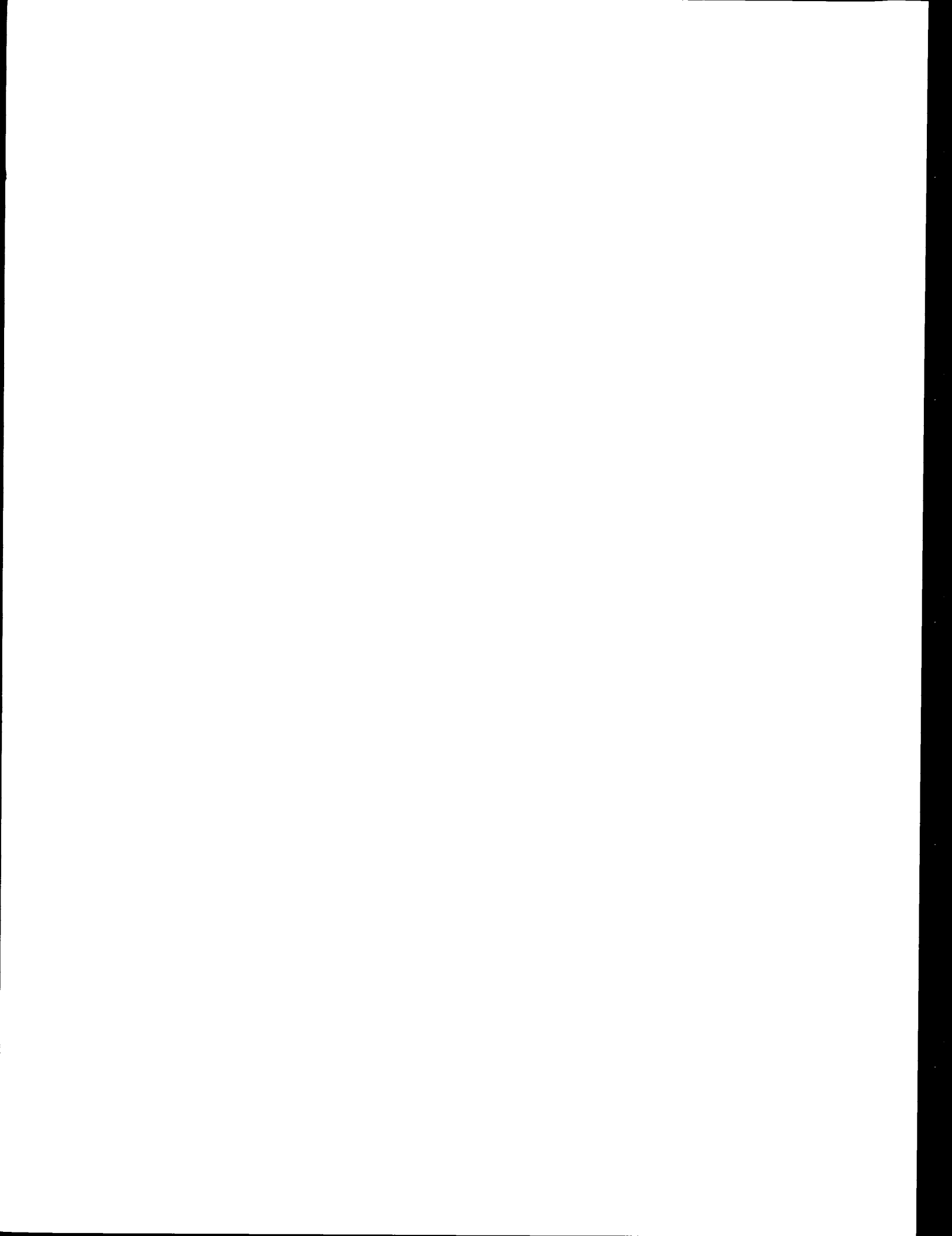
**Memphis  
Shelby County  
Tennessee**

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**U.S. Department of Energy**

**May 1981**

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## FOREWORD

This Final Environmental Impact Statement (FEIS) is issued by the U.S. Department of Energy (DOE) in accordance with DOE's guidelines published in the *Federal Register* on March 28, 1980 (45 FR 20694), for compliance with the National Environmental Policy Act (NEPA) as implemented by regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508, November 1978).

As part of the restructuring of the Federal Synthetic Fuels Program, the DOE Gasification Demonstration Program will be discontinued, and FY 1981 funding (\$45.4 million) will be proposed for rescission. Carry-over funds from past years will be used to continue final design work through FY 1981 for this joint project with the city of Memphis Light, Gas and Water Division (MLGW) to design, build, and operate a medium-BTU fuel gas demonstration plant. At the end of this fiscal year, the administration proposes to conclude direct DOE support for the project. The project sponsor has proposed continuing the project under incentives provided by the Synthetic Fuels Corporation (SFC). Whether or not DOE continues its involvement in the project, MLGW intends to carry out the monitoring and mitigation measures described in the EIS, except those specifically described as being a DOE responsibility. Additionally, while the SFC is not required by statute to consider environmental factors in its selection of projects, it has the authority to gather environmental data on proposed projects and the obligation to consider in its annual report to the Congress and the President environmental impacts of the Corporation's generic programs and decisions.

The proposed action will not require the opening of a dedicated coal mine or significant expansion of existing mines to supply the necessary feed coal. Therefore, impacts at specific mines are not addressed in this statement. However, because regional mining impacts will increase incrementally as a result of this project, these are discussed generically and on a regional basis in Sect. 1.4.6.2.

To comply with the requirements of NEPA, DOE is issuing this FEIS based on the best available information before any decision is made to proceed with major detailed design efforts and to commence construction of the MLGW facility. Utilizing a tiering approach, DOE will perform supplementary NEPA reviews as necessary to address significant environmental impacts not within the scope of this FEIS. For example, further NEPA review would be required if environmentally significant new information relevant to the selection of environmental control equipment arises as a result of further design efforts.

As an initial step in the NEPA process, MLGW at DOE's direction conducted a one-year baseline monitoring program at the proposed site and prepared and submitted an Environmental Report (ER). The ER provided DOE with detailed information on the proposed project and the environment in which it would be placed. The DOE has reviewed this ER and verified the data. Information from the ER was used in preliminarily identifying key issues for detailed analysis. Refinement of these issues resulted from the public scoping meeting held by DOE in Memphis on June 6, 1979.

The ER, together with the data elicited from the public scoping meeting and additional data collected and independently analyzed by DOE and its contractor, Oak Ridge National Laboratory, were utilized in the preparation of a Draft Environmental Impact Statement (DEIS). That document (DOE/EIS-0071D) was filed with the EPA on October 24, 1980, and a notice of availability was published in the *Federal Register* on October 31, 1980. Federal, state, and local agencies and groups and individuals with known interest in this proposed action were supplied copies of the draft statement and were requested to comment on its contents. Copies of the statement were also provided to other interested parties on request. Additionally, the opportunity to comment on the draft statement was provided at a public hearing conducted in Memphis, Tennessee, on December 3, 1980. The comment period ended December 15, 1980. The FEIS includes revisions where appropriate in response to the substantive comments received during the public comment period. The FEIS also includes revised information resulting from the availability of updated data received after issuance of the DEIS. However, this revised data does not significantly alter the projected impacts described in the DEIS.

The format of this Environmental Impact Statement follows the suggested format in the CEQ Regulations. Section 1 documents the purpose of the proposed demonstration plant, the need for it, and its current status. Also included in Sect. 1 is a discussion of the potential cumulative environmental impacts associated with a mature industry of industrial fuel gas plants. Section 2 describes the proposed action and alternatives to it, focusing on possible plant designs, fates, sites, and timing for the project. This section also summarizes the impacts of the project on the environment and compares these impacts at each of the alternative sites. Section 3 lays out in detail the critical features of the potentially affected environment at each of the alternative sites. Section 4 analyzes the environmental consequences of the proposed action at the proposed site and alternative sites during both the construction and operational phases of the project. Section 4 additionally discusses the alternative fates of the project. Section 5 presents the names and professional qualifications of the persons responsible for preparing the FEIS. Finally, Appendix A presents comments received on the Draft Environmental Impact Statement and DOE's responses, Appendix B provides important data used in the analysis, and Appendix C describes the assessment methodologies on which the conclusions of the report are based.

## SUMMARY

### 1. INTRODUCTION

This Final Environmental Impact Statement (FEIS) has been prepared by the U.S. Department of Energy (DOE) to assess the environmental impacts of a proposed DOE action\* leading to the construction and operation of a medium-Btu Industrial Fuel Gas Demonstration Project (IFGDP), the cost to be shared with the Memphis Light, Gas and Water (MLGW) Division of the city of Memphis. The proposed facility would utilize 3155 tons/d of high-sulfur coal and produce fuel gas for local pipeline distribution to industrial customers. This FEIS has been prepared in accordance with DOE's guidelines (45 FR 20694, March 28, 1980) for compliance with the National Environmental Policy Act (NEPA) as implemented by regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508, November 1978).

### 2. DESCRIPTION OF THE PROPOSED ACTION

On January 28, 1976, DOE published a request for proposal RFP-E(49-18)-2043 entitled "Fuel Gas Program." From the respondents to this request, two competing proposals were accepted, the MLGW proposed project and a proposed W. R. Grace and Company project to produce medium-Btu gas as a feedstock for an ammonia production facility. On February 22, 1980, DOE announced the selection of the MLGW project for continued DOE support in the industrial fuel gas area. DOE also announced that W. R. Grace and Company had withdrawn from the competition but would be awarded a contract to begin the evaluation of an indirect liquefaction facility capable of processing approximately 25,000 tons/d of coal into approximately 50,000 bbl/d of methanol/gasoline. If the MLGW demonstration phase is successful, in accordance with a 20-month operation program, there is a contractual provision whereby MLGW may purchase the U.S. government equity in the facility. Because of uncertainties in future funding as well as uncertainties in plant lifetime after completion of the demonstration phase, this FEIS considers the environmental consequences of alternative actions, including delayed action and no action, along with alternative fates, including continued operation, moth-balling, and decommissioning.

#### 2.1 Process description

The proposed MLGW fuel gas demonstration project will use the U-gas process developed by the Institute for Gas Technology (IGT) to produce approximately 620 MW ( $50 \times 10^9$  Btu/d) of gas. The plant will include three operating gasifiers and one spare. The major portion of this energy [570 MW ( $46.2 \times 10^9$  Btu/d)] will be in the form of fuel gas [nominal heating value of  $111.1 \pm 11.1$  kJ/m<sup>3</sup> ( $300 \pm 30$  Btu/scf)] delivered to industrial customers via a pipeline distribution system. The remainder will be delivered as pipeline quality gas into the Memphis natural gas distribution system to generate gas credits for the plant. These credits can be withdrawn as necessary.

In the U-gas process, crushed coal is dried and fed to the gasifier and fluidized with an oxygen-steam mixture at an operating temperature of 1025°C (1875°F). Fines elutriated from the fluidized bed with the raw fuel gas are returned to the gasifier through external cyclones. The ash agglomerates from the gasifier drop into a water-filled hopper in which they are quenched by a circulating stream and subsequently withdrawn from the hopper in the form of a water slurry. The hot, raw fuel gas is partially cooled in a waste heat boiler and fed to a venturi scrubber for removal of ammonia, hydrogen sulfide, and coal dust. The fuel gas is then compressed to 1.34 MPa (195 psig) and treated in a Selexol acid-gas absorption process to remove organic sulfur compounds.

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and the remaining hydrogen sulfide. The acid gas containing hydrogen sulfide is fed to a Claus unit. The tail-gas from the Claus unit is processed in a Beavon-Stretford tail-gas treating unit, and the vent gas goes to the atmosphere. The purified gas from the Selexol unit goes to distribution or conversion to pipeline quality gas.

## 2.2 Site description

The proposed site for the MLGW facility is located approximately 13 km (8 miles) west-southwest of downtown Memphis, Tennessee, on a floodplain peninsula adjacent to Lake McKellar and 1.2 km (4000 ft) east of the Mississippi River. The site's boundaries encompass 54 ka (134 acres) of land within Shelby County and the city of Memphis, Tennessee. The site is owned by MLGW and is zoned for heavy industry but is not currently in productive use. The area surrounding the site is rural in character with some heavy industry.

Winds are fairly brisk in the Memphis area, averaging 14.8 km/h (9.2 mph). Precipitation is abundant, averaging 124.7 cm (49.1 in.) annually, and is evenly distributed throughout the year. Air quality on the site itself has not been monitored. All of Shelby County has been classified by EPA as a nonattainment area for ozone, whereas metropolitan Memphis is classified as a nonattainment area for carbon monoxide. Presidents Island, located across Lake McKellar from the proposed site, is designated as nonattainment for total suspended particulates (TSP). Monitoring studies performed by MLGW at locations where the air quality impacts of the plant are likely to be greatest found better air quality than the EPA designations imply.

The proposed site (the Allen site) lies in the 100-year floodplain near the confluence of the Mississippi River and Lake McKellar. The site frequently is submerged when the Mississippi is at flood stage. During the 100-year and project-design floods, the existing site would be inundated by 7 and 10 m of water respectively. An alluvial aquifer underlies the site. The principal aquifer in the region is the 500-ft sand that supplies all of the water needs of the city of Memphis; it would be the source of water for the proposed plant.

Throughout the vast watershed of the Mississippi River, industrial, urban, and agricultural effluents cause localized water quality degradation. These problems are reduced in severity, however, by the Mississippi's enormous dilution capacity. The quality of the river's water in the vicinity of Memphis is inferior to the water quality upstream and downstream from the city. This degradation is the result of urban and industrial sources of pollution in the Memphis area. These sources include the Maxson Wastewater Treatment Facility near the Allen site, which consistently fails to meet Federal and State effluent standards. Lake McKellar water quality historically has been poor, although substantial gains have been made in the last ten years in controlling effluent discharges into the lake. Groundwater in the area fails to meet EPA standards for secondary drinking water because of excessive iron and manganese content.

A baseline monitoring program was initiated in 1978 to sample biota in the Mississippi River and Lake McKellar near the Allen site. Most of the fish species encountered were warm water, rough and forage species such as the gizzard shad. Only a small number of sport fish were found in the river, although sport species, such as largemouth bass, channel catfish, sunfish, and crappie, seemed somewhat more prevalent in the lake. These monitoring studies did not encounter any species included on the list of threatened and endangered species maintained by the U.S. Fish and Wildlife Service (USFWS) and the State of Tennessee.

The proposed site is located on the floodplain of the Mississippi River and is underlain by approximately 46 m (150 ft) of sand and gravel alluvium. Surface elevations over most of the area are about 61 m (200 ft), although a dike and a mounded dredge spoil on parts of the site are at an elevation of about 65 m (215 ft). The site is located in seismic risk zone 3, a zone in which major destructive earthquakes may occur. Soils on the Allen site are silty to sandy and are well to excessively drained.

The site is currently owned by MLGW and is zoned for heavy industrial use. It is covered by bottomland forest and meadow and, until recently, was used by the U.S. Army Corps of Engineers for the annual disposal of dredge spoil from the Lake McKellar barge channel. Near the site are the Allen Generating Plant, the T. E. Maxson Wastewater Treatment Facility, wooded bottomlands, and agricultural fields on which the principal crop is soybeans. The T. O. Fuller State Park and the adjoining Chucalissa Indian Village are recreational areas about 2 km east-southeast of the proposed site. Several existing and planned industrial parks are located near the proposed site, including the Presidents Island Complex, the Pidgeon Industrial Area, and the Rivergate Industrial Complex. In 1974, 47% of the land in Shelby County was in agricultural use.

The area to be affected on and near the proposed site consists of approximately 43 ha (108 acres) of medium-age floodplain forest, 16 ha (40 acres) of meadow, and 4 ha (10 acres) of nonvegetated land and water area. The floodplain forest is dominated by black willow. More mature bottom-land forest, which is dominated by box-elder and sugarberry, occurs in several areas within 3 km of the site.

About 28 ha (70 acres) of the floodplain forest on the site is considered by the USFWS to be low-to medium-quality wetland because of low food availability for wildlife. This low quality results, at least in part, from previous deposition of sediments from dredge spoils.

Important wildlife in the area of the site include bobcats, cottontail rabbits, white-tailed deer, racoons, swamp rabbits, wild turkeys, American kestrels, marsh hawks, Mississippi kites, six-lined racerunners, and others. No Federally listed threatened or endangered species are located in the impact area of the project. The Mississippi kite, a State-listed endangered species, uses the site area for foraging during the breeding season but does not nest at the site. Five other species of threatened or other special status on the Tennessee species list occur on the site.

The 1980 population of Shelby County, Tennessee, is estimated to be 772,523. The city of Memphis with an estimated 1980 population of 644,838 is one of the 20 largest cities in the United States. Shelby County and Memphis are located in the Memphis Standard Metropolitan Statistical Area (SMSA), which has a total estimated 1980 population of 927,772. The civilian labor force within the SMSA is 417,045 of which 351,908 are located in Shelby County. Unemployment is around 6%. Median income in Shelby County is estimated to be \$12,428.

The capacities of both public- and private-service sectors permit some expansion in demand without creating impacts such as the need for new revenues, the decline in the quality of service, or the need for new development. Residential choices are diverse and abundant. Rail transportation to the immediate vicinity of the site exists. Access roads directly to the site need some upgrading or traffic-control improvements to meet any projected increases in demand.

### 3. PURPOSE OF THE PROPOSED ACTION

The purpose of the proposed project is to demonstrate the proposed process as a viable and competitive solution for meeting the national demand for alternative energy sources to reduce oil imports. Operation of the demonstration plant should provide the information required to minimize technical and economic risk, confirm the effectiveness of environmental control systems, and encourage the transition to commercialization.

The technical feasibility of the process has been proven by the operation of the pilot-scale facility, the IGT U-Gas Pilot Plant at Chicago, Illinois. Although this facility has provided information necessary for the scale-up of the process equipment, a number of areas of technical uncertainty are still associated with the construction and operation of a commercial facility with sufficient capacity to be economically viable. These areas of uncertainty cannot be fully resolved by the operation of pilot-scale facilities. By providing for testing and production under commercial conditions, a demonstration plant can minimize the technical and economic risks associated with construction of the first commercial plant. Also, by providing an opportunity for design of the commercial-capacity facility based on monitoring and control equipment evaluation during its operation, the demonstration plant can significantly reduce the environmental risks associated with commercialization.

### 4. NEED FOR THE PROPOSED ACTION

The United States has large resources of coal, oil shale, and other materials that may be used through synthetic fuels production. Economically producible, high-grade oil shale resources alone have been estimated as adequate to provide more than  $67 \times 10^9 \text{ m}^3$  ( $418 \times 10^9 \text{ bbl}$ ) of synthetic oil — more than the reserves of the entire Middle East; the amount of coal available for conversion is sufficient to provide the nation's requirements for electricity, transportation, and industrial needs for a full century.

Construction and operation of this demonstration project should allow resolution of a number of major uncertainties associated with the marketing, distribution, and the institutional arrangements required for the production and use of medium-Btu gas. Also, the project will demonstrate advanced gasification technology that should result in a significant improvement in the nation's posture to convert coal into industrial fuel gas or to produce synthesis gas required for indirect liquefaction and for the manufacture of chemicals.

The U-gas medium-Btu process should demonstrate satisfactory ash formation and removal from the bed with minimum carbon content. In addition, the cyclone system will recover fine particles elutriated from the bed and will recycle the particles back to the gasifier for conversion and thereby promote high process efficiency. The gas purification system will work at a high level of pollutant removal, producing acceptably low levels of contaminants in the waste streams. Process control systems and instruments will demonstrate the capability to maintain critical parameters such as the bed temperature at the level for agglomerating ash removal while components and materials function in corrosive and erosive high-temperature service.

## 5. COMMERCIALIZATION POTENTIAL

Further expansion of the U-gas program to a level of a mature commercial industry may likely result in regional impacts on air quality, water quality and availability, solid waste disposal, socioeconomics, and land use. These regional impacts were examined generically to provide programmatic estimates of the cumulative effect of national commercialization. To facilitate this examination a hypothetical scenario was developed, which postulates the number of plants and general candidate locations for the plants.

The commercialization of the medium-Btu gas (MBG) program will most likely occur in regions of the country in or near urban, industrialized areas that have reasonable access to coal fields and an adequate water supply. Once the hypothetical locations were selected, the aggregate regional environmental impacts were estimated, based on algorithms that provided a mechanism for translating the input/output characteristics of the Memphis plant into characteristics of the regionally located plants.

The analysis indicated that plants similar in design and size to the proposed Memphis facility could be located in regions throughout the United States, with little environmental degradation occurring if certain siting precepts were considered. With reasonable care in selecting sites for commercial MBG facilities and with proper engineering design, cumulative impacts from a mature industry should not represent significant changes in baseline environmental conditions such as air and water quality, solid waste disposal, land use, or community facilities and services. The exact magnitude of such impacts would depend on the eventual site selection process and on the specific location of individual gasification plants.

## 6. ENVIRONMENTAL IMPACTS RESULTING FROM THE PROPOSED ACTION

### 6.1 Air quality

Vehicle exhaust and fugitive dust emissions during construction should have a small short-term adverse effect on ambient air quality in the area of the site. Ground-level pollutant concentrations resulting from vehicle exhausts, however, are below ambient air quality standards. In addition, most of the fugitive dust emissions should be controllable since the fill material will be kept wet.

During the operational phase of the project, criteria pollutants emitted from the facility include TSP, sulfur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Coal dust emissions should not be significant beyond 100 m (330 ft) from the plant under typical meteorological conditions, although strong winds would carry these dust particles farther. Sulfur dioxide emissions during routine operation should not result in violations of air quality standards. Nonroutine emissions (such as during plant startup and emergency venting) should be higher but are not expected to violate air quality standards. Nitrogen dioxide emissions are likely to have negligible effects on air quality. Hydrocarbon emissions will be controlled by the controlled combustor and flare. In the unlikely event of flare failure during upset conditions, severe emissions of CO and H<sub>2</sub>S could occur.

### 6.2 Hydrology

Since the Allen site is located within the Mississippi River floodplain and subject to annual flooding, the site can be used for the project only if it is filled above flood level. Current plans include raising the site by as much as 9 m (30 ft) to protect the project from flood hazards. This action will reduce the floodplain's temporary water storage capacity. The result of the floodplain modification is a small but unavoidable increase in flood elevations in Lake McKellar along the Ensley Levee and the southern edge of Presidents Island. The added risk of flood damage caused by the project is quite small, however, since flood protection structures already in place should provide adequate protection against the increased flood elevations.



Groundwater is available in sufficient quantities to supply the construction and operation needs of the project without reducing water availability to other users. At the same time, the quality of the groundwater in the alluvial aquifer could be compromised by runoff from the plant's coal storage and solid waste disposal areas. These areas are being designed to minimize this risk — including installation of impermeable liners, thorough compaction of the ground beneath the liners, and use of monitoring systems to detect potentially harmful seepage.

### 6.3 Surface water quality

Construction impacts on the water quality of the Mississippi River consist primarily of localized, short-term perturbations (turbidity, increased levels of some chemicals, and increased oxygen demand of sediments) resulting from dredging. Lake McKellar may be adversely affected by site preparation operations (buildup and grading) and product gas pipeline construction because of inflowing sediment and perhaps ammonia in dredge fluids. The barge turning basin may suffer impacts from dredging, similar to those described above.

Wastewater discharge to the Mississippi River will be a potential impact occurring during demonstration plant operation. With dilution of the wastewater in a mixing zone, the impact to river water quality would be small incremental loadings of those constituents for which ambient concentrations exceed water quality criteria for water uses for which the affected reach of the river is classified. These uses do not include domestic use. Wastewater discharge will be permitted under the National Pollutant Discharge Elimination System (NPDES), administered jointly by the Tennessee Department of Public Health, Water Quality Division, and the U.S. Environmental Protection Agency. Outside of the mixing zone, operational impacts from wastewater discharge into the Mississippi River are anticipated to be minor. Coal spillages and increased turbidity may significantly reduce water quality in this small area due to barge traffic in Lake McKellar's turning basin. Periodic maintenance dredging may result in short-term perturbations in this same area.

### 6.4 Aquatic ecology

Aquatic habitat may be eliminated or modified by all construction activities (dredging, installation of wastewater discharge structures and product gas and water supply pipelines, site preparation, and barge dock construction). There will be loss and degradation of medium-quality aquatic habitat in the turning basin in Lake McKellar.

Outside of the mixing zone, operational impacts from wastewater discharge into the Mississippi River are anticipated to be minor. Increased barge traffic and periodic maintenance dredging may modify localized portions of aquatic habitat in the barge turning basin.

### 6.5 Geology and soils

Before construction activities begin, the site will receive approximately  $4.6 \times 10^6 \text{ m}^3$  ( $6.0 \times 10^6 \text{ yd}^3$ ) of hydraulically dredged fill material. Filling is necessary to raise the process areas from their current elevation of about 62 m (203 ft) to 71 m (233 ft), in order for the plant to lie above the project design flood level. This filling and grading is unavoidable if the site is to be used for industrial development. The impact on current topography, which consists of bottomland forest and meadow, cannot be avoided or mitigated.

Structure foundations are being designed in accordance with recommendations for seismic risk zone 3. The preliminary design includes a factor of safety of 3 for foundations bearing on soil. Final foundation design is included in phase II of the project. If a seismic event results in release of contaminants, potential sinks for these materials are Lake McKellar, the Mississippi River, and the alluvial aquifer. Resulting impacts cannot be quantified but could be significant.

All soils currently on the site would be covered by emplacement of the fill. Occurrence of a major flood prior to completion of the fill could result in erosion of the fill already in place. This erosion would require replacement of lost fill. Upon completion, soil losses can be minimized by using vegetative cover or riprap or by paving to protect the site.

## 6.6 Land use

Benefits provided by the floodplain forest (support of many wildlife species important for recreation, storage and slow release of floodwaters, water quality maintenance through sediment entrapment, and groundwater recharge) would be lost.

Use of the site for the proposed facility is consistent with the site's heavy industrial zoning classification and would preclude other potential uses of the site. Most of the offsite facilities (pipelines, utility lines, and access road) will be on existing rights-of-way, under water, under city streets, or in common rights-of-way and will have little effect on land use. Emission of air pollutants may have slight adverse effects on soybean yields in the vicinity of the facility, although these impacts are expected to be small and undetectable.

## 6.7 Terrestrial ecology

Onsite and offsite construction will disturb approximately 63 ha (156 acres), including 43 ha (108 acres) of medium-age floodplain forest of which 28 ha (70 acres) are wetlands, 16 ha (40 acres) of meadow, and 4 ha (10 acres) of nonvegetated land and water area. Mature bottomland forests in the area would not be affected. Operation of the facility would contribute slightly to any existing effects of air pollutants on vegetation.

Wildlife species would be virtually eliminated from the site but would continue to exist in areas surrounding the site. No endangered or threatened species listed by the Federal government would be affected. The Mississippi kite (listed by Tennessee as endangered) and the six-lined racerunner and swamp rabbit (listed by Tennessee as needing special management due to scarcity of their habitat) will experience loss of foraging and breeding habitat, although the kite does not appear to nest on the site.

## 6.8 Economic, social, and cultural impacts

The proposed facility should provide direct employment for 600 to 700 persons during the construction phase and for approximately 410 persons during operation. Secondary service jobs indirectly supported by the project may number about 570 during construction and 483 during operation. These secondary jobs to a large extent will not be new. Most service sectors in the Memphis area have enough surplus capacity to provide the infrastructure services that are required by the plant work force. Consequently, secondary benefits may be largely industrial output and income expansion rather than new secondary jobs. Because of the size and diversity of the Memphis economy, any added employment opportunities would be filled by local residents. The low level of in-migration caused by the project would be negligible compared with the population of the Memphis area. No significant strains on the housing stock and community infrastructure of the Memphis area are likely.

The proposed facility will provide industrial fuel to a number of its existing customers in the Memphis area. MLGW officials estimate that, within 5 years of facility construction, between 7 and 14 satellite industries that could utilize the MLGW product gas may move to the area. If such location of industries occurs, a long-run positive impact of economic growth for the area will result.

Construction activity at the Allen site should increase traffic on adjacent roads by 15 to 20%. The increased traffic load, especially from trucks and the construction activity on the new Mitchell Road, may cause minor traffic problems necessitating some traffic control measures.

The Allen site has been surveyed by a professional archaeologist; no prehistoric or historic relics were found. A copy of a letter from the State Historic Preservation Officer is included in Appendix B.8 as evidence of compliance with the National Historic Preservation Act. Selection of the proposed site should not significantly affect the visual amenities associated with nearby Fuller State Park and Chucalissa Indian Village.

## 6.9 Hazards identification

The proposed facility is largely composed of conventional subsystems that are to be operated safely within the bounds of current technology. Nevertheless, this facility will inherently contain many normal industrial hazards such as explosion, fire, and hazardous material release.

Because of their number, careful attention must be given during the final design phase to ensure that reasonable protection is afforded onsite and offsite personnel. Prior to plant operation, the probability and effects of these hazards will be quantified in a Safety Analysis Report.

#### 6.10 Health effects

A preliminary risk assessment has been performed based on data collected related to the composition of the raw gas from the U-gas pilot plant. Identified materials of concern include carbon monoxide (CO), ammonia (NH<sub>3</sub>), hydrogen sulfide (H<sub>2</sub>S), carbonyl sulfide (COS), hydrogen cyanide (HCN), carbon disulfide (CS<sub>2</sub>), polycyclic aromatic hydrocarbons (PAHs), tars and oils, phenols, mercaptans, thiophenes, amines, carbonyls, and trace elements. Based on the relative concentrations of the constituents in the raw gas stream and the relative Threshold Limit Values (TLVs) of these constituents, it is conservatively concluded that controlling emissions of CO and H<sub>2</sub>S below their respective TLVs will ensure that all other materials of concern will be well below appropriate TLVs. As a result of increased residence times in the demonstration plant gasifier compared with those in the pilot plant gasifier, relative concentrations of materials of concern are expected to be lower in the demonstration plant than those considered in this analysis. However, to ensure that the plant design, monitoring programs, and mitigation measures are adequate to safeguard occupational and public health, a detailed risk assessment, as described, will be performed prior to plant operation.

### 7. MONITORING PLAN

Monitoring programs will be carried out by MLGW during the construction and operational stages of this project. The purposes of monitoring programs include (1) documentation of baseline conditions prior to any construction or associated development of the project in order to predict and to describe the expected impacts and to propose appropriate mitigation measures; (2) determination of the extent of any unavoidable impacts as they occur, especially impacts that are associated with the greatest uncertainties; and (3) development of adequate data at all stages of the project in order to optimize modifications in the monitoring and mitigation programs and to detect unanticipated significant impacts.

The monitoring program presented in this statement is based on environmental issues identified on the basis of conceptual design. As a result of design completion and in light of the fact that the proposed plant involves development of a new gasifier technology for which some effluents are not fully characterized, DOE will undertake the following monitoring activities\* beyond those required by regulatory agencies:

- supplement the operational monitoring by supporting investigations on the release and effects of novel effluents; and
- quarterly reports will be prepared and made public, with program modifications where appropriate

### 8. PROJECT ALTERNATIVES

#### 8.1 Process

Differences in alternative plant designs are limited to pollution abatement equipment compatible with the U-gas process and the required specifications of the product gas. Based on the proposed integrated plant design, reasonable alternatives have been considered, which support the following aspects of plant design: (1) liquid waste treatment, (2) solid waste disposal, (3) sulfur emission control, (4) particulate emission control, (5) waste heat removal, (6) alternative plant fuels, (7) coal transportation alternatives, and alternative sources of plant make-up water.

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\* This monitoring plan is contingent upon continued DOE involvement with the project.

Based on the analysis of plant design alternatives, DOE believes that none of the alternatives considered offer a significant reduction in plant effluents or environmental impacts compared with the proposed plant design. A detailed discussion of these alternatives is found in Sect. 2.3.2.1.

## 8.2 Sites

DOE's Request for Proposal RFP-E(49-18)-2043 for a demonstration plant to produce industrial fuel gas from coal required that a site be specified as part of the proposal. MLGW selected the proposed Allen site for preliminary engineering and design. Subsequent site evaluation studies by MLGW considered in some detail a total of five sites for the MLGW facility, all within Shelby County, Tennessee (construction by MLGW is limited by State law to Shelby County only).

To evaluate the relative environmental impacts associated with construction and operation at alternative sites, an independent site evaluation was conducted. Engineering factors were used as a screening tool to eliminate sites on which construction was not considered to be feasible; evaluation of the remaining sites was conducted strictly on the basis of environmental factors.

Two of these five sites present significant land use problems. The Mud Island site was eliminated from consideration on the basis of land use, zoning, and public acceptance factors related to environmental and scheduling criteria. The North site was eliminated on the basis of environmental factors, including impacts on high quality wetlands; zoning problems; public acceptance problems; and scheduling criteria.

The remaining two alternative sites, Rivergate and Pidgeon, are zoned for heavy industry and could be developed so that they are technically suitable for the project. Both the Rivergate and Pidgeon sites, along with the proposed Allen site, are within the Memphis city limits.

The selection of the proposed site involved consideration for each alternative site of projected environmental impacts as well as costs of land acquisition, plant design modifications, and cost of delay. The DOE has prepared a report entitled "Identification and Evaluation of Alternatives to the Location of a Proposed Federal Action in the Floodplain." This report considers environmental, technical, economic, and scheduling factors. Based on this report, a Preliminary Statement of Findings concluding that no practicable alternative exists to siting the MLGW project in a floodplain or wetland has been published. The report and the Preliminary Statement of Findings are reproduced in Appendix C.8.

There are no overriding environmental concerns that preclude the construction and operation of the MLGW facility at the proposed site (Allen) or at either of the alternative sites (Rivergate and Pidgeon). For the most part, impacts of operation should be the same at each of the three sites, whereas differences in environmental impacts should occur as a result of facility construction. None of the alternative sites are obviously environmentally superior to the proposed site.

## 8.3 Alternative fates

The proposed action can be approved, rejected, or modified, or a decision may be delayed until some future date. If the project is approved, final design and construction will occur during a period of approximately four years (phase II). Following the phase III operating period, the MLGW facility could experience three potential alternative fates: continued operation at the demonstration plant capacity, mothballing, or total decommissioning.

During continued operation, the processing facilities will continue to operate as a commercial venture after the demonstration period, with minimal modification. The plant capacity will continue to process 3155 tons/d of coal, producing  $4.3 \times 10^6 \text{ m}^3$  (154 million scf) of medium-Btu gas (300 Btu/scf) and  $0.12 \times 10^6 \text{ m}^3$  (4.3 million scf) of high-Btu pipeline gas (950 Btu/scf), for an assumed operational period of 20 years.

### 8.3.1 Mothballing and decommissioning

Mothballing the demonstration plant implies that it would be shut down for an indefinite period of time. All production operations at the facility would cease, although there would be little or no disassembly of the equipment at the site.

There are several reasons why the plant might be mothballed. If, for example, the production process proves to be technically feasible and environmentally acceptable in most, but not all, respects, it may be necessary to shut down the plant until the technological problems are solved.

Should the proposed facility prove to be technically or economically unsuccessful, the plant would be decommissioned. Production operations would cease, and the site would either be restored to the extent feasible or converted to another industrial use.

Continued operation at the demonstration plant capacity has been summarized in Sect. 6; therefore, impacts associated with the mothballing and decommissioning fates are discussed below. Reference is made to impacts of continued operation where appropriate.

#### 8.3.1.1 Air quality

As a result of mothballing or decommissioning, both direct source and fugitive emissions associated with the operation of the demonstration plant would be eliminated. However, short-term fugitive dust emissions can be anticipated during decommissioning of the demonstration plant. The impact of these emissions will be similar to those experienced during the construction of the demonstration plant.

#### 8.3.1.2 Water quality

During normal plant operations, runoff and leachate from potentially contaminated areas (coal storage, main process areas, ash disposal, and product loading areas) will be collected and pumped to wastewater reclamation facilities for treatment prior to discharge or reuse within the plant. During the mothballing period, the site wastewater treatment system may be shut down. If necessary during the mothballing period or during decommissioning activities, runoff will be collected and pumped to the T. E. Maxson Wastewater Treatment Facility for treatment prior to discharge.

The Resource Conservation and Recovery Act (RCRA) of 1976 requires the continued groundwater monitoring of hazardous waste disposal sites during and after disposal operations. Although studies of the pilot plant ash indicate that it is nonhazardous, suitable treatment and monitoring programs will be adopted if further research conducted during the demonstration period concludes otherwise. If it is determined that the RCRA applies, then continuous monitoring will be conducted if the plant is mothballed or decommissioned. If the groundwater monitoring program detects that leachate has penetrated the protective liners provided at the disposal site, the leak will be located and the liner will be repaired. Leachate will be sent to the Maxson Wastewater Treatment Facility.

#### 8.3.1.3 Ecology

The termination of facility emissions to the environment as a result of mothballing or decommissioning would have a general beneficial impact on local ecological systems. However, if uncontrolled, the water quality impacts to Lake McKellar resulting from site runoff could have adverse effects on aquatic biota. During the mothballing period or after decommissioning, herbaceous meadow vegetation similar to that originally found on the site could likely be established.

#### 8.3.1.4 Socioeconomics

Most of the permanent operational labor force of 270 and the service staff of 140 (totalling 410) employed during the demonstration period will be terminated if the facility is mothballed or decommissioned. However, to decommission the facility, a work force somewhat smaller than the number of persons employed during construction of the demonstration plant will be required for a short time.

If the demonstration plant is mothballed or decommissioned, the industries developed to support the facility would suffer economic loss. Because only minor expansion of community services is required to support the demonstration plant, only minor impacts on community services would be anticipated as a result of mothballing or decommissioning.

#### 8.4 Delay of action

A delay in the construction of the demonstration plant will result in a delay in the construction of the full-scale commercial medium-Btu gasification facilities. This delay will, in turn, have an impact on meeting the overall energy goals. On a local and regional level, a delay in the construction of this medium-Btu gasification demonstration plant will result in a delay of the economic advantages associated with this project.

#### 8.5 No action

Failure to act on the proposed project will not provide the intended information on operation of the U-gas process at commercial scale. Although another project could be initiated to demonstrate this technology, a significant delay of this portion of the coal conversion demonstration program will result.

The physical and biological environment of Memphis and Shelby County could remain unaffected by this project if the no-action alternative is chosen. However, plans exist for portions of the Allen site, in the absence of the proposed project, to become a future ash disposal area for the TVA Allen Generating Plant. If the no-action option is selected, the region will not receive the economic benefits of increased employment associated with the construction and potential continued operation of the demonstration plant.

#### 9. SUPPLEMENTAL DOCUMENTATION

In addition to the DEIS and this FEIS, supporting documents are available for public inspection at

U.S. Department of Energy  
Chicago Operations Office  
Projects Management Division  
9800 South Cass Avenue  
Argonne, Illinois 60439

Government Document Room  
Memphis-Shelby County Public Library and Information Center  
1850 Peabody Avenue  
Memphis, Tennessee 38101

Public Reading Room  
FOI-Rm 1E-090  
1000 Independence Avenue, S.W.  
Washington, D.C. 20585

These documents include

*Industrial Fuel Gas Demonstration Plant Program, Phase I, Mechanical Design, Vol. 1, Overall Plant Description*, prepared for the Department of Energy under Contract ET-77-C-01-2582.

*Industrial Fuel Gas Demonstration Plant Program, Phase I, Mechanical Design, Vol. 2, Air Separation*, prepared for the Department of Energy under Contract ET-77-C-01-2582.

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*Industrial Fuel Gas Demonstration Plant Program, Phase I, Mechanical Design, Vol. 6, Sour Water Stripping*, prepared for the Department of Energy under Contract ET-77-C-01-2582.

*Industrial Fuel Gas Demonstration Plant Program, Phase I, Mechanical Design, Vol. 9, Utility Area*, prepared for the Department of Energy under Contract ET-77-C-01-2582.

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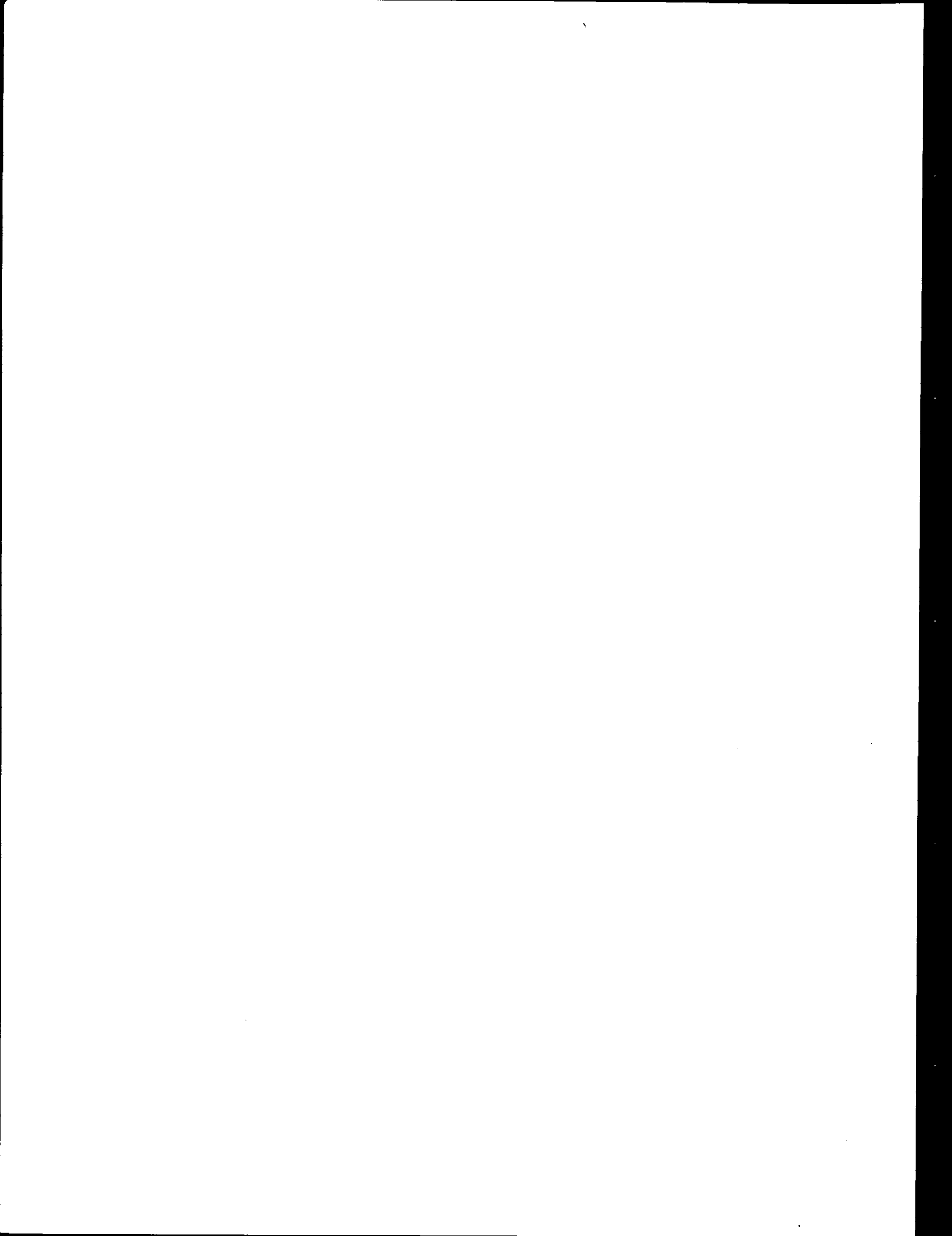


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## 1. STATUS, PURPOSE, AND NEED

### 1.1 DESCRIPTION OF THE PROPOSED ACTION

This statement evaluates the environmental impacts associated with construction and operation in Memphis, Tennessee, of a medium-Btu synthetic industrial fuel gas demonstration facility designed to process 3155 tons of coal per day. This facility is proposed to demonstrate the technical operability, economic feasibility and environmental acceptability of converting high-sulfur coal on a commercial scale into fuel gas for local pipeline distribution.

The proposed Memphis Light, Gas and Water (MLGW) fuel gas demonstration project will use the U-gas process to convert high sulfur coal into industrial fuel gas having a nominal gross heating value of 270 to 330 Btu/scf, and deliver it to industrial consumers via a pipeline distribution system.

The proposed site is situated on 134 acres approximately 8 miles west-southwest of downtown Memphis, Tennessee, on a peninsula within a floodplain adjacent to Lake McKellar and 4,000 feet east of the Mississippi River. The demonstration facility will process washed Kentucky No. 9 coal into fuel gas; the coal will be transported to the site by barge. The revenues generated from the fuel gas during the plant operational period will be used to offset the project costs.

In the process, crushed coal is fed to the gasifier with an oxygen-steam mixture in a fluidized bed at high temperature. Fines elutriated from the fluidized bed with the raw fuel gas are returned to the gasifier through external cyclones. The ash agglomerates from the gasifier drop into a water-filled hopper in which they are quenched by a circulating water stream and subsequently withdrawn from the hopper in the form of a water slurry. The hot, raw fuel gas is partially cooled in a waste heat boiler and fed to a venturi scrubber for removal of ammonia, hydrogen sulfide, and coal dust. The fuel gas is then compressed to 195 psig and treated in a Selsol acid-gas absorption process to remove organic sulfur compounds and the remaining hydrogen sulfide. The purified gas is sent to distribution. A Claus unit, coupled with a Beavon-Stretford unit, converts sulfur compounds removed from the gas to elemental sulfur.

Upon completion of the operational phase of the demonstration plant, MLGW has the option of purchasing the facility and the plant would continue to produce medium-Btu fuel gas at the demonstration capacity. This document is prepared in conformance with recent regulations and guidelines for the implementation of the National Environmental Policy Act published by the Council of Environmental Quality.<sup>1</sup>

#### 1.1.1 History and development of the proposed action

On 28 January 1976, the Energy Research and Development Administration (ERDA) published a request for proposal RFP-E(49-18)-2043 entitled "Fuel Gas Program." The objective was to: (1) demonstrate the technical, environmental, and economic feasibility of medium-Btu gasification; (2) secure a demonstration plant to advance the current state of the art in medium-Btu coal gasification technology; and (3) encourage commercialization of this technology. Two proposals were accepted: the MLGW proposed project, and a proposed W.R. Grace and Company project to produce medium-Btu gas as a feedstock for an ammonia production facility. Contracts were signed with both companies to carry these proposals through the conceptual design phase. This phase has been completed for both projects, and a comparative evaluation of these competing proposals has been conducted. On February 22, 1980, it was announced that the MLGW project would receive continued DOE support in the industrial fuel gas area. W.R. Grace and Company withdrew its competitive proposal, but DOE awarded a contract to evaluate an indirect liquefaction facility capable of processing approximately 25,000 tons/d of coal into approximately 50,000 bbl/d of methanol/gasoline. With this redirection, the W.R. Grace project has been removed from the industrial

gasification program and as an alternative to the MLGW Industrial Fuel Gas Project. If the MLGW demonstration phase is successful, in accordance with a 20-month operation program, there is a contractual provision whereby MLGW has the right to purchase the U.S. Government equity in the facility. This Final Environmental Impact Statement considers the environmental consequences of alternative actions, including delayed action and no action, along with alternative fates, including continued operation, mothballing, or decommissioning.

On May 21, 1980, the cost-shared contract between DOE and MLGW was signed. The provisions of the contract include limitations on activities prior to issuing a Final Environmental Impact Statement. Both parties recognize that full authorization of the project is contingent on completing the National Environmental Policy Act (NEPA) process. Accordingly, no orders shall be placed for long-lead materials or equipment nor any commitment made to construction activities without the written authorization by DOE. DOE will provide such authorization only after the issuance of the Record of Decision.\*

#### 1.1.2 Technical and environmental status of the proposed project

The proposed MLGW project is divided into three phases. Activities during Phase I involved conceptual plant design, baseline environmental field studies, and the preparation of an Environmental Report. Phase II will involve detailed engineering design and construction, and Phase III is the plant operational demonstration period.

Phase I was completed in December 1979. Phase II is estimated to require four years, with site preparation expected to begin in the summer of 1981. The plant is expected to begin operating in 1984, with the Phase III demonstration period lasting 20 months.

Environmental requirements associated with the proposed project include the preparation of Draft and Final Environmental Impact Statements; a Floodplain/Wetlands Determination as required by EO 11988 and EO 11990; permits pertaining to air quality, water quality, and solid waste disposal, and possible Toxic Substance Control Act registration, as required by local, state, and Federal agencies. A summary of the permit requirements, responsible agencies, and current schedule is given in Appendix C.7.

#### 1.1.3 Project review procedures

DOE has incorporated check points into the contract that allow Government control of various decision making processes. These check points include design and operation review, operational and monitoring plans, and project termination decisions.\*

Three major design reviews have or will be conducted during Phases I and II. The first, a Preliminary Design Review for Phase I, was conducted in December 1979, and was approved by DOE. Two formal Final Design Reviews will take place: (1) when all major equipment locations are selected, and (2) when plans are approximately ninety percent complete. All associated drawings and information will be used and reviewed at these two review points. The purpose of these reviews is to verify that the project conforms to technical specifications as well as environmentally related specifications which are governed by Federal, state, and local regulations. These reviews also develop the corrective actions required to allow continuation of project activities. In addition, DOE must review and approve the various operations plans (Plan for Plant Start-up and Shakedown, Investigation of Plant Variables Plan, Long Term Run Plan) as well as Environmental Plans (Environmental Monitoring, Safety, Industrial Hygiene, and Major Disaster Plans).

An Operational Review will be held twelve months after the effective date of Phase III. If the proposed plant does not perform to specifications, provision is made in the contract that Phase III can be discontinued and the plant disposed of. These parameters include those used during the Preliminary and Final Design Review, as well as any additional parameters imposed by Federal, state, or local regulations since the second Final Design Review. The Operational Review serves as a check point in Phase III in case defined parameters, including demonstrating environmental feasibility and acceptability, are found to be unattainable.

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\* As part of the restructuring of the Federal Synthetic Fuels Program, the DOE Gasification Demonstration Program will be discontinued, and FY 1981 funding (\$45.4 million) has been proposed for rescission. Carry-over funds from past years will be used to continue final design work through FY 1981 for this joint project with the city of Memphis to design, build, and operate a medium-Btu fuel gas demonstration plant. At the end of this fiscal year, the administration proposes to conclude direct DOE support for the project. The project sponsor has proposed continuing the project under incentives provided by the Synthetic Fuels Corporation.

Finally, it is provided in the contract that the contract may be terminated by the Government in whole, or from time to time, in part: (1) "Whenever for any reason the Contracting Officer shall determine that such termination is in the best interest of the Government," (2) "Whenever the contractor shall default in performance of this contract in accordance with its terms and shall fail to cure such default within a period of ten days (or such longer period as the Contracting Officer may allow) after receipt from the Contracting Officer of a notice specifying the default." Any such termination shall be effected by delivery to the contractor of a Notice of Termination specifying whether termination is for default of the contractor or for the convenience of the Government, the extent to which performance of work under the contract is terminated, and the date upon which such termination becomes effective.

## 1.2 PURPOSE AND NEED FOR COAL GASIFICATION

### 1.2.1 National policy

The United States is at a pivotal point in its energy and economic history. In the past, economic growth was influenced by abundant supplies of inexpensive, readily available domestic fossil energy; currently, the United States competes in an international market place to purchase the supplies of oil and gas on which the domestic economy has become dependent. In the past, economic planners could assume an uninterrupted supply of energy from a variety of sources. Currently, the United States must search for new supplies of energy needed for economic expansion. The high cost and uncertain availability of once inexpensive and plentiful energy have become major obstacles to the orderly growth of the U.S. economy, and the potential for disruption of the vital energy supplies deteriorates the national security posture of the United States.

In 1979, the United States consumed approximately 79 quads (1 quad =  $10^{15}$  Btu) (including coal exports) of energy. Almost 48 percent (37.9 quads) of the 1979 energy demand was supplied by petroleum, whereas natural gas supplied about 25 percent (19.5 quads), coal supplied 20 percent (15.4 quads), and nuclear and hydroelectric power supplied about 6% (5.2 quads).

Domestic oil and natural gas resources are not capable of supplying the U.S. demand for oil, gas and their products. In 1970 imported oil supplied 12% of the U.S. oil demand, and imported gas supplied 4% of the U.S. gas demand. By 1979, these percentages had increased to 42% and 6%, respectively, generating the urgent requirement for the rapid implementation of measures to reduce foreign oil dependence.

Among the estimated recoverable domestic fossil fuel resources, coal, unconventional gas, oil shale, and petroleum from enhanced recovery methods account for 90-95% of the recoverable resource base, of which 65-85% of the recoverable base is coal. The annual rate and total amount of recovery for each of these resources is determined by economics, the successful implementation of new technologies, and the solution of environmental and socioeconomic problems. However, this resource base, with successful research, development, and demonstration (RD&D) of relevant technologies, does provide the potential to reduce reliance on foreign oil.

The April 1977 submission to Congress of the National Energy Plan (NEP) and accompanying legislative proposals was designed to produce a coherent energy policy for the United States. The legislative proposals of the National Energy Plan led to five acts, passed by Congress in 1978, and known collectively as the National Energy Act. The five acts were the National Energy Conservation Policy Act, the Powerplant and Industrial Fuel Use Act, the Public Utilities Regulatory Policies Act, the Natural Gas Policy Act, and the Energy Tax Act.

The National Energy Conservation Policy Act provides for several conservation and solar energy programs that offer a variety of loans and grants designed to make buildings more energy efficient. The Powerplant and Industrial Fuel Use Act prohibits the use of oil and natural gas in new electric utility generation facilities and new industrial boilers. This act requires existing facilities to use coal and coal-oil mixtures, it limits the use by these facilities of natural gas to 1974-1976 proportions, it prohibits these facilities from switching from oil to gas, and it requires that these facilities cease using natural gas by 1990.

The Public Utility Regulatory Policies Act of 1978 provides for eleven voluntary standards for rate design, as well as other utility practices, that are to be considered by State regulatory authorities and non-regulated utilities. The Natural Gas Policy Act of 1978 sets maximum prices for various categories of natural gas. The act provides for the deregulation of certain

gas, although price controls on deregulated gas may be reimposed by Congress, or by the President, for one 18-month period. The Energy Tax Act of 1978 provides for tax credits for insulation and conservation measures, and for residential installation of wind or solar equipment.

The NEP-II was submitted to Congress in May 1979, and further defined energy policy by emphasizing the development of oil substitutes. On July 18, 1979, the Import Reduction Program was announced, containing additional legislative proposals. Based upon these initiatives, Congress passed the Energy Security Act on June 30, 1980. The Energy Security Act created a Synthetic Fuels Corporation (SFC) and a Solar Energy and Energy Conservation Bank. The SFC, with the potential for \$88 billion in resources was established to stimulate the production of 2 million barrels per day of synthetic fuels by 1992. The Bank was authorized \$3 billion in order to provide Federal subsidies for residential and commercial investments in energy conservation and renewable energy resources. The Energy Security Act also provided for a biomass financial assistance program, authorized at \$1.45 billion over two years, designed to encourage the development of biomass energy, including alcohol fuel from crops, wood, and agricultural and municipal wastes. The act required the President to immediately begin taking action to have the Strategic Petroleum Reserve filled at an average fill rate of 100,000 barrels per day for the fiscal year 1981, and for every fiscal year thereafter. Furthermore, beginning October 1, 1980, with some exceptions, oil from the Naval Petroleum Reserve may not be used for any purpose other than filling the Strategic Petroleum Reserve. Finally, the act provided statutory support for gas and electric utility investments in conservation.

The Synthetic Fuels Corporation and the Department of Energy's Alternative Fuels Production Program are two of the major elements of the National Synfuels Production Program. Under the Alternative Fuels Production Program, DOE is empowered to share the risks of synthetic fuel project development with the private sector through cost sharing agreements, loan guarantees, price guarantees, purchase agreements to produce synfuels and other mechanisms. These are the same powers that are extended to the Synthetic Fuels Corporation. Since neither the Alternative Fuels Production Program nor the Synthetic Fuels Corporation existed before last year, all Federal support for the Memphis project has been provided by the DOE (and previously, ERDA) Fossil Energy Program.

In the United States, government involvement in research and development has generally been justified when one of the following criteria applies:

1. The costs and benefits to individual elements of the private sector are not commensurate with the costs and benefits of the Nation as a whole.
2. The funds required to bring research and development to a successful conclusion are too great or the risks too high for the private sector.
3. Information is required for such government functions as planning, formulating policy, and establishing regulations and incentives.

Following these criteria, a Federal role in synthetic fuels research has been developed. The uncertain nature of future energy prices, high development costs, and technical risks associated with the development of new synthetic fuel technologies have made Federal involvement necessary.

#### 1.2.2 The Department of Energy's program for technology development

To meet the national goal of reducing oil imports, a combination of conservation, increased utilization of domestic resources and early implementation of alternative energy technologies is essential. In formulating its programs for meeting the nation's broad-based energy goals, DOE must consider a wide range of program options. Although it is desirable to develop the broadest possible range of technologies, the available economic and personnel resources are



limited, and each technology must be evaluated on the basis of its potential for energy production or reduction in consumption, the resources required for further development, and the technical economic and environmental risks associated with the technology. The program options available to DOE are discussed briefly in the following sections.

In the following sections, a brief description of each of the technology or program options is provided along with an estimate of near term (1985, 1990) or mid-term (2000) contributions to meeting our nation's energy needs. These estimates have been taken from the second National Energy Plan<sup>2</sup> except where noted otherwise. Primary environmental effects of each of the options are noted where data is available. However, no attempt has been made to compare one option with another by quantifying resource consumption, emissions or wastes. To do so would be misleading because data reported for a particular technology can show considerable variation depending upon such variables as fuel type, plant size or configuration, degree of pollution control, and end-user requirements for level of fuel purity.

#### 1.2.2.1 Contribution of nonfossil energy sources

##### Conservation

Energy conservation is best viewed as a series of actions to cut waste and get more from each unit of energy used. This is done in three ways: by improving the energy efficiency of buildings, vehicles, and industrial equipment, by substituting energy-efficient goods and services for energy-intensive ones, and by curbing the need for energy services.

Conservation is an immediate and cost-effective means to deal with the energy problem. There have been many recent studies on the long-term energy demand in the United States, both inside the government and elsewhere. Using these studies, projections of consumption by end use in 1990 were made to assess the possible results of a Federal conservation program. For a real gross national product (GNP) growth rate of 3.1%, Table 1.1 shows the possible energy savings in 1990 compared to a projection of "business as usual" practice.<sup>3</sup>

Table 1.1. U.S. energy consumption (quads)

|                      | Residential/commercial | Industrial | Transportation | Total |
|----------------------|------------------------|------------|----------------|-------|
| No-change path, 1990 | 43                     | 47         | 24             | 114   |
| Possible, 1990       | 30                     | 38         | 18             | 86    |
| Savings, %           | 30                     | 20         | 25             | 25    |

Source: U.S. Department of Energy, Policy Programming and Fiscal Guidance, FY 1982-1986, draft, January 30, 1980.

The industrial sector of our economy uses more energy than any other sector, and is therefore critically important to the nation's overall energy conservation efforts. Primary environmental concerns of projects listed in the Environmental Development Plan for Industrial Energy Conservation involve issues of air emissions and solid waste generation. While a number of technologies under development would result in reduced air emissions, several could increase emissions or change the composition of emissions. In either case, continued development would require measurement of emissions and assessment of the need for additional emission controls. Solid waste concerns center on determination of safe disposal techniques.

The savings noted in Table 1.1 look attainable, especially since they do not entail major technological breakthroughs. Although conservation offers great potential for near-term reduction in energy consumption and associated dependence on foreign resources, it alone cannot provide a long-term solution.

##### Solar

These technologies are already playing a small but significant role. As oil prices continue to rise and conventional energy resources face constraints, solar energy use can be expected to

continue to rise--to 9 to 12 quads in the year 2000, based on projections of current trends. Approximately six quads of this total would be from decentralized solar energy systems--including direct use of biomass products, passive solar uses, active space heating and cooling, and industrial and agricultural process heat.

Based on the findings of the Domestic Policy Review of Solar Energy, the national solar goal could be most likely achieved by the following technology mix (shown in descending order of anticipated importance).

1. Biomass
2. Hydroelectric
3. Agricultural and Industrial Process Heat
4. Active Heating, Cooling and Hot Water
5. Wind
6. Photovoltaics
7. Passive Design
8. Solar Thermal Power
9. Ocean Systems

Biomass and hydroelectric together are expected to constitute about one-half of the total renewable energy necessary to meet this goal. Industrial and agricultural heat, plus residential/commercial space and water heat are expected to constitute another third. A variety of electricity generating technologies (primarily wind) constitute the remaining portion.<sup>3</sup>

Solar energy is already economically competitive with electricity for providing hot water, and with other fuels for a few specific process and space heat applications (passive solar and wood combustion, for example). The time when competitiveness with oil may be achieved is highly uncertain; but if current oil price trends continue, solar energy could possibly provide an economic alternative to oil for space conditioning and process heat in another 10 years. Solar thermal electric applications will likely require a longer time, perhaps into the next century. However, it is possible that wind will be competitive much earlier.<sup>3</sup>

Direct solar energy systems are relatively benign in terms of environmental effects, producing few pollutants under normal operations. Environmental concerns center on leakage, improper handling or disposal of toxic additives in solar system heat transfer fluids. Possible consequences of fluid discharges are contamination of potable water supplies, decreased efficiency of sewage treatment plants and ecosystem damage. Net heat residuals from solar electrical power generation are a potential source of thermal pollution. Land use impacts and micro-climatic modification due to solar central power system operations are also concerns.

#### Biomass

The concept of a cultivated forest, or silviculture, has received increasing attention and may be a major source of biomass in the future. Experimentation on three varieties and techniques for producing optimal yields is taking place. Also yields on existing commercial forestlands can be improved. Either of these approaches could increase yields to two to three times current levels. Additional sources of biomass energy include agricultural residues such as straw, cornstalks and cane stalks; marine plant matter such as ocean kelp and water hyacinths; animal manure from feedlots; and municipal solid waste and sewage.

A wide range of assessments of the total quantity of biomass available for energy use might be expected, because of the variety of sources and uses. Nevertheless, the estimate of total long-term U.S. resources reported in three studies were surprisingly close, at 8, 10.5, and 12.8 quadrillion Btu. Woody crops and residues comprise the major portion of the resource. Other crops grown specifically for energy use are expected to play a minor role because of competing demands for food and fiber crops. The Domestic Policy Review of Solar Energy estimated that biomass could contribute 5.4 quads of energy by the year 2000.<sup>3</sup>

Environmental issues concerning terrestrial biomass production are presented in Section 1.4.7, Alternatives.

### Hydroelectric

Development of hydroelectric generating capacity is limited to specific geographic areas, and, to a large extent, most of the favorable sites have already been developed. In view of the growing public opposition to the commitment of additional land resources for hydroelectric development, the potential for significant increases is not certain. Hydropower is already the most fully developed renewable energy resource. Approximately 3 quads per year are now produced at primarily large-scale, high-head facilities. The Domestic Policy Review projected that an increase of 0.5 to 1 quad of high-head (mostly large-scale) production is possible. While small hydro projects produce a negligible amount of power at the present time, the DPR set a target of 0.8 quads by the year 2000 from predominantly low-head facilities. Studies underway since the DPR suggest that these estimates could be low.<sup>3</sup>

Environmental issues associated with hydroelectric power generation include the loss of habitats upstream and downstream; the prevention of upstream spawning by several main species, such as salmon; and, when spillways are used the addition of nitrogen to the water. Land drowned as a result of dam construction can result in severe socio-economic impacts such as loss of prime agricultural lands, forests and mineral resources, and the displacement of resident populations.

### Geothermal

Geothermal resources in the form of geopressed aquifers in the Gulf States of Texas and Louisiana contain recoverable methane, thermal and hydraulic energy. Domestic Policy Review estimates place possible capacities for direct thermal applications at 0.1 quad per year by 1985 and 1.0 quad per year by 2000. However, development of the available resources is limited in some cases by environmental considerations associated with control of hydrogen sulfide and disposal of brines. Environmental problems associated with resource development are presented in Section 1.4.7, Alternatives.

### Nuclear

Development of nuclear power represents a significant potential for additional energy. The future growth of nuclear power is dependent upon overcoming financial, environmental, and social issues which it now faces.

The salient feature of nuclear energy forecasts has been their systematic decline. Although the excesses of the past (forecasts of up to 1000 GWe of installed nuclear capacity by the year 2000) are now widely recognized, there has been a continued erosion of even recent forecasts that had been considered conservative. For example, the 1977 EIA Annual Report predicted that from 200 to 275 GWe of nuclear capacity would be on line in the United States by 1995. By contrast, the 1979 EIA Annual Report placed the estimate at 148 GWe. Since 1975, the number of new plants ordered has been exceeded by cancellations.<sup>4</sup>

Each of the various stage of nuclear energy production is a source of potential environmental concern. These stages include: mining, milling, uranium hexafluoride production, enrichment, fuel fabrication, power generation, reprocessing and waste disposal. Mining operation, both open pit and underground, produce impacts similar to those associated with coal production, and include land disturbance, water consumption, and effluent discharges. In addition, miners are exposed to low levels of radiation from radon gas, a decay product of uranium. Milling operations to produce yellow cake generate large volumes of solid and liquid tailings, which must be disposed of as low level radiation wastes. Uranium hexafluoride production, enrichment and fuel fabrication are also sources of low-level liquid and gaseous radiation wastes. Power generation creates problems of thermal pollution and radioactive emissions. More significant, however, are the problems associated with fuel reprocessing and waste disposal. Fuel reprocessing results in the highest levels of radioactive emissions of any of the previously noted operations and disposal of high level radiation wastes have not been commercially demonstrated.

#### 1.2.2.2 Contribution of non-gaseous fossil energy sources

The DOE Fossil Energy Program is structured to develop appropriate technologies to help meet future U.S. energy needs. The technology base effort develops basic information and advanced concepts with potential application for providing energy from coal, oil, gas, and other fossil resources. The technology base elements are basic research, applied research, and exploratory development of the extraction, conversion, and utilization of fossil energy resources. The

technology base focuses on better scientific and engineering data for research and development programs and on basic improvements to process efficiencies and/or use of lower cost technology that can operate in an environmentally acceptable manner.

To meet the national goal for reducing oil imports, early implementation of a number of energy technologies is essential. In addition to the non-fossil energy sources mentioned above, energy sources of coal liquefaction, shale oil extraction, improved direct combustion of coal, coal-oil mixtures, and others will be needed to meet national policy objectives. Implementation of improved environmental controls will also be needed to ensure acceptability of the new technologies for use of fossil fuels.

#### Increased production of domestic oil

The decontrol of domestic crude oil prices is expected to reduce petroleum imports by increasing the incentive for domestic production of oil and reducing consumer demand for petroleum products. By 1990, the increase in domestic production is expected to be 0.4 to 0.7 million barrels/day. The reduction in domestic consumption attributable to decontrol will also be substantial. By 1985 decontrol is expected to reduce domestic petroleum consumption by 0.3 to 0.5 million barrels/day. By 1990, the reduction is estimated at 0.4 to 0.7 million barrels/day.

The environmental concerns associated with domestic oil production are presented in Section 1.4.7, Alternatives.

#### Outer continental shelf (OCS) leasing

The offshore zone of the continental shelf contains sizeable reserves of oil. Estimates of undiscovered recoverable oil from the offshore zone, out to depths of 650 feet, range from 12.5 to 38 billion barrels.<sup>5</sup> In recent years, the estimates have been consistently revised downward. Oil companies ranked 17 major offshore areas based on their view of resource potential and their order of development preference. The top five areas were the Central Gulf of Mexico, the Gulf of Alaska, the West Gulf of Mexico, Southern California, and the Mid-Atlantic.<sup>6</sup>

Domestic production of oil may be increased through additional exploration and development of new fields and by enhanced recovery of existing resources.

The environmental effects of offshore oil exploration and production are largely the same as those for onshore production. However, the effects of a blowout or a major oil spill upon marine and coastal ecosystems are potentially severe and long lasting.

#### Direct coal utilization

Coal constitutes about 77% of the U.S. conventional energy reserves but currently supplies less than 20% of energy consumption. The increased utilization of domestic coal reserves appears to offer the greatest near-term potential for increased domestic energy production. Available technology for utilization of coal is currently limited primarily to direct combustion in conventional boilers. Intensive efforts are underway to develop improved combustion techniques, to expand utilization of commercially available technology for conversion of coal into gaseous and liquid synthetic fuel products, and to develop more efficient conversion technologies.

Two advanced techniques for direct utilization of coal currently under development are fluidized-bed combustion and magnetohydrodynamics. Fluidized-bed combustion systems offer the potential for efficiency utilizing the large U.S. reserves of high-sulfur coal in a manner that controls the emissions of gaseous pollutants, including sulfur dioxide and, to some extent, nitrogen oxides. In a fluidized-bed boiler, the combustion air passes upward through a grid which supports a thick bed of granular, noncombustible material, such as coal ash and lime. The air fluidizes the material (expands the volume and turbulently mixes the material) and with the relatively small amount of air used to inject the pulverized coal, supports the desired combustion. The heat transfer surfaces or boiler tubes can be embedded in the fluidized bed directly because combustion occurs at temperatures that will not damage the tubes. The heat release and heat transfer coefficients of a fluidized-bed boiler are high, greatly reducing the required boiler size, weight and cost.<sup>7</sup> Atmospheric fluidized-bed units for powerplants are expected to be commercially available by 1990. The Energy Information Administration 1979 Annual Report predicts electricity generation using atmospheric fluidized-bed boilers to be 1.2 quads by the year 2000.<sup>4</sup>

The second technology that has been under development for direct coal utilization is magnetohydrodynamic (MHD) power generation. Combustion of coal results in the production of hot gases (plasma) which are passed transversely through a magnetic field. If a pair of electrodes are placed at right angles to the direction of the magnetic field, in the moving plasma, an electric current is induced between the two electrodes. It is believed that use of MHD technology in conjunction with conventional coal-fired power stations could improve overall plant efficiency by as much as 20 percent. Principle problems requiring solution are recovery of the seeding material used to enhance the reaction and corrosion of the electrodes caused by prolonged exposure to hot corrosive gases.<sup>8</sup> This technology is not expected to be commercially available until after the year 2000.<sup>4</sup>

Although direct combustion of coal with required controls on particulate and sulfur dioxide emissions currently appears to be the most cost-effective method for the large-scale utilization of coal (particularly for electric power generation), the cost of required pollution control equipment limits the utilization of coal in small- and moderate-size plants. The disposal of large quantities of ash and flue gas desulfurization residues also limits the applicability of direct combustion. In addition, many applications require either gaseous or liquid fuels and are unsuited for direct coal utilization. For these reasons, conversion of coal into low-sulfur, low-ash, gaseous or liquid fuel products is highly desirable.

#### Enhanced oil recovery\*

Enhanced oil recovery (EOR) involves in-situ modification of the reservoir conditions or oil resource characteristics to improve the recovery of oil. Techniques currently in use or under development include: improved waterflooding, micellar-polymer flooding, carbon dioxide flooding, steam flooding and in-situ combustion. Improved waterflooding entails injection of a mixture of caustic soda or a thickening agent with water into a reservoir for the purpose of increasing flood displacement efficiency. Micellar-polymer and carbon dioxide flooding entail alternate injections of these surfactants as displacing fluids followed by injections of water as a driving fluid. Steam injection in place of the aforementioned techniques results in reducing the viscosity and specific gravity of heavy oils and thus decreases their resistance to flow. The same effect is possible through in-situ combustion where air is injected and a portion of the oil is burned in place generating sufficient heat within the bank to decrease resistance to flow. Gases resulting from combustion also increase reservoir pressures, thus enhancing the movement of the less viscous oil toward a production well.

Primary recovery (from reservoir pressure) and secondary recovery (from water or gas injection) can capture about one-third of the oil in place, enhanced oil recovery has the potential to recover 10 to 15 percent more, or approximately 40 to 60 billion barrels. Currently only steam injection techniques are near commercialization; however, enhanced oil recovery could contribute as much as 0.5 to 1 million barrels per day by 1985 and between 2 to 3 million barrels a day by 2000.<sup>3</sup>

Enhanced oil recovery is a viable, near-term option to increase recovery and domestic production of petroleum products. The decontrol of domestic crude oil prices will offer greater incentives for enhanced oil recovery.

The objective of the DOE enhanced oil recovery program is to reduce the uncertainty in the selection and operation of the appropriate technology/site combinations, to expand the application of the methods, and to improve the productivity of the technology in an environmentally acceptable manner.

The environmental concerns associated with enhanced oil recovery are presented in Section 1.4.7, Alternatives.

#### Oil shale

Oil shale is fine-grained marlstone sediment rich in hydrocarbon derivatives. This hydrocarbon material, kerogen, produces a synthetic oil or gas upon pyrolysis.

Oil shale is a major resource and the technology for developing it is considered to be commercially available. Shale oil industries have existed in 14 countries but are currently operating only in Estonia and Manchuria.

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\*Material in this section taken from Reference 7.

Both surface and underground mining techniques can be used to extract oil shale. Once mined, the shale can be subject to surface retorting during which oil and gas are produced from the kerogen. Alternately, the shale can be left in the ground and in-situ retorting can be applied. During this process, a heat carrier (air or combustion gases) is introduced into the shale bed through an injection well to pyrolyze the kerogen in the shale. The oil and gas from in-situ retorting are extracted through production wells with the spent shale remaining in place. Fracturing or leaching the shale bed is frequently necessary to facilitate production.

The technology for surface retorting is more advanced than it is for in-situ retorting. The current DOE program includes shale oil production research on true in-situ methods, modified in-situ methods, above ground methods, and supporting research for oil shale processing and control technology.

The largest and richest oil shale reserves in the United States are located in the Green River formation in the tri-state region of Colorado, Utah, and Wyoming. The U.S. Geological Survey (USGS) has identified shale oil resources at over  $2 \times 10^{12}$  bbl, of which 90% is in the shales of the Green River formation. Development of the resource is currently limited by economic and environmental consideration;<sup>9, 10, 11</sup> however, up to one million barrels of shale oil could be produced in 2000.<sup>2</sup>

The environmental concerns associated with developing the oil shale resource are considered in Section 1.4.7, Alternatives.

#### Coal Liquefaction

Coal liquefaction is the production of liquid hydrocarbons from coal by changing the hydrogen-to-carbon ratio of the coal being processed. This can be accomplished through direct liquefaction involving direct hydrogenation, solvent extraction or pyrolysis or through indirect liquefaction where coal gasification precedes liquefaction.

The development of commercial coal liquefaction processes will provide a route, within environmental guidelines, to increased domestic production of coal fossil fuels and feedstocks. Synthetic fuels derived from coal liquefaction processes can replace refined petroleum products most effectively in two distinct markets. One market uses low-ash, low-sulfur boiler fuels suitable for clean generation of electric power and industrial steam. The other market uses high-grade fuels such as jet and diesel fuel, gasoline, heating oil, and chemical feedstocks. The contribution of coal liquefaction to meeting national energy needs is estimated at between 0.3 and 1.0 million barrels per day in 2000.<sup>2</sup>

The goal of the Federal government liquefaction program is to facilitate the establishment of a synthetic liquid fuels industry. Specifically, the objectives have been:

- o Demonstrate the technical capability to produce clean liquid and solid fuels from coal by direct liquefaction.
- o Develop improved indirect liquefaction processes to produce liquid fuels from synthesis gas made from coal.
- o Provide technical and financial incentives for commercialization of those technologies that are currently ready for development such as indirect liquefaction.
- o Promote the development of more advanced third-generation coal liquefaction processes which can be commercially viable in the 1990-2000 time frame.

The general strategy of the liquefaction activity is to promote coal liquefaction through R&D. Four direct liquefaction processes are in advanced development stages.

- o Solvent Refined Coal (SRC) processes I and II are being tested in 6 ton/day and 50 ton/day (coal) pilot plants, respectively, that are currently in operation. Technical demonstration plants of 6000 tons/day size (one for each process) are in design stages.
- o H-Coal is undergoing continued development in a 600 ton/day pilot plant which began operation in FY 1980. Continued support work involves a 3 ton/day PDU.

- o Exxon Donor Solvent (EUS) is undergoing development in a 250 ton/day pilot plant which began operation during FY 1980. Continued laboratory and engineering research support backs up the pilot plant operation.

Third-generation (direct liquefaction) processes include disposal catalyst processes, a two-stage liquefaction process (TSL), and flash hydrolysis. Bench-scale and PDU studies continue in order to define the potential of these and newer processes for scaled up engineering studies.

Indirect liquefaction processes (liquid fuels via synthesis gas from coal) include the SASOL process, now commercial in South Africa. An accelerated effort is underway in the United States to develop new and improved indirect processes tailored to U.S. coals and markets. Design and construction of a small (100 barrels/day) methanol-to-gasoline pilot plant based on a Mobil process is underway and a 36 barrels/day liquid phase/slurry phase syngas to methanol plant is being prepared for operation.

The environmental concerns associated with coal liquefaction are considered in Section 1.4.7, Alternatives.

#### 1.2.2.3 Contribution of gaseous fossil energy sources

##### Increased production of conventional gas resources

Natural gas currently plays an important role in domestic energy markets for two reasons: (1) natural gas currently provides a quarter of total U.S. energy supply and (2) natural gas can, as a technical matter, easily displace oil in large portions of the industrial and electric utility sectors. Uncertainties exist about the size of the future contribution of domestic, imported, synthetic, and natural gas to total U.S. energy needs. Estimates range from 22 to 24% in 1985 and from 15 to 20% in 2000.

There are two main categories of conventional natural gas. The first is made up of gas associated with oil production, shallow gas and other easily obtainable gas, and constitutes the majority of present gas production. Production from these sources is projected to decline from 16.2 trillion cubic feet in 1980 to 8 trillion cubic feet in 1990 and 4.3 trillion cubic feet in the year 2000. The other category of conventional gas includes those resources that can be recovered using conventional technology but that have been too technically difficult or expensive to discover, verify, extract. This category includes outer continental shelf gas, deep gas basins, the western overthrust belt, and Alaskan gas.

Proven gas reserves off of the Gulf of Mexico and southern California are estimated at 35.7 trillion cubic feet. Atlantic and Alaskan off-shore areas are thought to contain large quantities of potential, but as yet, unproven reserves. Estimates of gas production during the next 20 years from the outer continental shelf vary greatly.

Natural gas produced at depths of 15,000 feet or more below the surface is known as deep gas. Deep gas basins with potentially large deposits include the Appalachian Basin, Anadarko Basin, Gulf Coast, the Delaware Basin (Texas), the Mississippi Embayment and basins in the Rocky Mountains. Of the above, the Anadarko Basin, covering 11,080 square miles in the Oklahoma and Texas panhandle, has the greatest prospect for the production of deep gas with proven reserves of 3 trillion cubic feet and potential reserves of 88 trillion cubic feet. Previous to deregulation of deep gas, high production costs were a serious constraint to development.

The Western Overthrust Belt is a strip of folded and faulted sedimentary strata running from northern Alaska, southwest through Canada and the western United States into Mexico. The Overthrust Belt is considered one of the most promising oil and gas producing provinces in North America. Proven reserves of natural gas are over 2.25 trillion cubic feet. The extremely complex geological structures and the complicated land and mineral ownership patterns have contributed to the expensive drilling costs which were considered deterrents to resource development.

Alaskan gas from the North Slope is estimated at 26 trillion cubic feet of proven reserves, or more than ten percent of total U.S. reserves. Plans are currently underway for construction of

a 4800 mile pipeline which would bring this gas to California and the Midwest. Completion of this pipeline is scheduled for 1984.

Production from all of these sources is projected to increase from 1.4 trillion cubic feet in 1980 to 6.6 trillion cubic feet in 1990 and to 6.9 trillion cubic feet by 2000. Overall production from conventional gas resources is expected to decrease from 17.6 trillion cubic feet in 1980 to 14.6 trillion cubic feet in 1990 and 11.2 trillion cubic feet in 2000. Increases in production potential of the conventional gas resources would result from increased exploration and development of the harder to find resources, or from unexpected, but possible, new discoveries of easily recovered gas. Further discussion concerning these resources may be found in Section 1.4.7, Alternatives.

The environmental impacts from the conventional sources would occur primarily during the site preparation, road construction and pipeline construction activities. These impacts include temporary air quality degradation, land disturbance, soil and productivity losses, increased noise levels and increased sedimentation of streams. The extent of these impacts will depend largely on the location of the resource and the quality of the gas being extracted. Natural gas may be produced in association with oil (associated and dissolved gas) or from predominantly gas (nonassociated gas) wells,<sup>8</sup> affecting the number and size of the facilities required for processing. Facilities that may be required include those separating sand and water from the gas, separating liquid hydrocarbons from the gas, compression of the gas and sulfur removal. If the amount of liquid hydrocarbons is high, additional facilities may be required to process these liquids into usable fractions.

Impacts similar to those for site preparation would occur during construction of gas pipelines. Air quality would be affected by emissions from heavy equipment and by burning of refuse. Topsoil and nearby streams could be affected by grading activities and erosion. Because, for the most part, pipelines are constructed underground, surface impacts would be mainly temporary, though pipeline rights-of-way would be permanently unavailable for some types of development. Impacts would also occur at construction sites for compressor stations at locations along the pipelines but these would be mostly temporary and localized.

After construction, the only significant impacts would be to air quality at compressor stations as part of the natural gas is burned to maintain compression.

#### Enhanced gas recovery\*

Natural gas, despite a 15 percent decline in production in the past 5 years, remains the largest contributor to domestic energy supply. Continued decline in gas production will increase reliance on imported oil and gas. If more of this fuel becomes available, the decline could be offset and gas could be diverted to industrial users of oil, thus reducing oil imports. Production from unconventional gas sources could play an important role in achieving this goal.

Domestic production and reserves, dominated by conventional gas resources, have generally declined. Annual production (dry) in 1979 was 19.5 trillion cubic feet (Tcf), slightly higher than 1978 production 19.1 Tcf but down from the 1973 peak of 21.7 Tcf. Estimated production for the first eleven months of 1980 was 17.6 Tcf compared to 17.8 Tcf for the same period of 1979. Proven reserves have dropped below 200 Tcf from their 1967 peak of 293 Tcf. In only one year since 1967 have additions to reserves kept pace with depletion of reserves through production. (That year was 1970, when the associated gas reserves of Prudhoe Bay were "booked.") The ratio of reserves to production for the lower 48 states at the end of 1978 was an all-time low of 8.8 to 1, compared to almost 15 to 1 only a decade earlier. Reserve additions (excepting Prudhoe Bay) have replaced only 46 percent of the withdrawals during the 1970's.

This serious decline in production, reserves, and reserve-production ratios has continued despite a near tripling of average natural gas price (in real terms) since 1973, the emergence of still higher price intrastate markets, and a corresponding doubling of exploratory effort. Additions to reserves per successful exploratory well drilled since 1970 have decreased from 10.7 to 2.3 billion cubic feet (Bcf) per well. Estimates of conventional gas resources in two areas for which a re-evaluation is complete resulted in a 60 percent decrease in the estimated recoverable resource. The prior estimate was in 1974. Similar downward revisions have been made in estimates of inferred reserves for these areas.

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\*Material in this section taken from Reference 12.



These data point to sharply declining availability and rapidly increasing costs of conventional gas production from the contiguous United States. The phased decontrol and special provisions of the Natural Gas Policy Act (NGPA) of 1978 provide incentives for accelerated exploration, but the apparent decline in the number and quality of conventional gas prospects suggests that numerous supplementary gas sources will be required to meet the demand of gas.

National energy policy identifies unconventional gas resources as a potential supply target. As a result, the DOE Unconventional Gas Recovery Research, Development and Demonstration Program was established. Four large, unconventional gas resources have been identified as having significant potential for development and positive impact of future supplies. These are:

- o Low-permeability (tight) lenticular and blanket-type gas sandstones of the western United States,
- o Gas-bearing Devonian and Mississippian shales of the eastern United States in Appalachia and the Midwest,
- o Natural gas present within coal seams and associated strata, and
- o High-temperature, high-pressure (geopressed) aquifers of the Gulf Coast.

It is estimated that these resources could produce four to five Tcf per year by 2000.<sup>2</sup> A description of these resources and a discussion of the environmental consequences of their development is provided in Section 1.4.7, Alternatives.

#### Coal gasification

Coal gasification comprises the chemical reaction of coal with oxygen to produce carbon monoxide and in other instances, in the presence of steam, hydrogen. Other gases produced include carbon dioxide, methane, and sulfur compounds such as hydrogen sulfide and carbonyl sulfide. If air is used directly in the reaction as the source of oxygen, nitrogen will also be present in the gas. The gases produced in these reactions are generally characterized by their heat of combustion, as follows:

- o Low-Btu: 100 to 175 Btu/scf,
- o Medium-Btu: 250 to 650 Btu/scf, and
- o High-Btu: 900 to 1000 Btu/scf.

Low-Btu gas would most likely reflect use of air as the oxygen source directly in the reaction to such an extent that the gas contains nitrogen.

Medium-Btu gas would contain hydrogen, carbon monoxide, and methane but essentially no nitrogen. The normal heating value for medium-Btu gas is in the range of 300 to 325 Btu/scf, which corresponds to the heating values of the components hydrogen and carbon monoxide. If significant amounts of methane are present, the heating value could reach higher limits.

High-Btu gas, nearly pure methane, is formed from medium-Btu gas or synthesis gas by hydrogen shift and methanation reactions and the subsequent removal of the carbon dioxide.

It is uneconomical to transport the low-Btu gas off-site. The economic transportation limits for medium-Btu gas depend upon a variety of site and technology specific factors, but is unlikely to be in excess of 50 to 75 miles. These gases are used for industrial operations such as metal finishing, cement, lime, brick, glass, and food processing.

The high-Btu gas, which may be used industrially or domestically, is transported in a nationwide pipeline grid.

The primary coal gasification reaction may be conducted either underground (in-situ) or in surface facilities.

Gas is a competitive and very convenient energy form because it is sulfur-free, provides high-Btu gas distribution in an efficient pipeline system, and burns with no ash and little tendency to carbon formation. However, it cannot displace transportation fuels.

It is anticipated that the U.S. energy demand in the year 2000 will require about 3 trillion scf per year of synthetic gas, and even higher contributions will be required in the subsequent

two decades. Because gas readily displaces liquid fuels in stationary systems, the demand exists under current market conditions.

#### Underground coal gasification

Underground coal gasification (UCG) is the technology now under development to convert coal to a combustible gas while still in place underground. The gas product is conveyed to the surface and, after cleanup, can be utilized as a low- or medium-Btu gas, upgraded to pipeline quality gas, or utilized to produce liquid fuels through indirect liquefaction. The development of UCG could greatly expand the usable reserves of the United States by utilizing coal currently considered unmineable by conventional means because it is uneconomical. Underground coal gasification processes will, therefore, complement surface-based processes that require mined coal.

Current estimates of the most suitable UCG resources include low-volatile bituminous and lower rank coal seams at least 5 feet thick that lie between depths of 200 and 3000 feet.

The four major program elements of DOE's UCG technology development program are:

- o Western low-Btu gas,
- o Western medium-Btu gas,
- o Eastern coal technology, and
- o Steeply dipping beds.

The overall program goal of UCG is to demonstrate in-situ gasification schemes to produce low- and medium-Btu gas from coals of different ranks and from different geographical areas in an environmentally safe manner.

At the present time, a multimodule western low-Btu test is planned for 1984 to 1985. The successful completion of this test (Hanna 5) could make low-Btu gas produced from UCG a commercial reality by 1987 or 1988. A planned pilot test will include the production of electricity from a 60 MW electric generating facility. Because of the modular nature of UCG (i.e., commercial configuration would comprise a multiple array of systems of a type similar to those in pilot tests), demonstration before commercialization does not appear to be warranted at this time.

The western medium-Btu gas project is expected to provide a medium-Btu gas for chemical feedstocks or, as an upgraded gas, a source of synthetic pipeline gas (SPG) for use in the national pipeline network. The encouraging test results from this past year and the increasing demand for SPG that is projected over the next few years could lead to the commercialization of this technology in the late 1980s.

The commercial application of eastern coal technology and steeply dipping beds is not expected until the late 1980s or early 1990s, assuming that the technological uncertainties and environmental concerns associated with these options are adequately resolved.

The environmental concerns associated with underground coal gasification are presented in Section 1.4.7, Alternatives.

#### Surface gasification

There are several approaches for the government to take regarding synthetic gas development. First, there are existing synthetic gas coal technologies that are used commercially outside of the United States. However, uncertainties involving cost and environmental performance must be resolved for these technologies to operate in the United States. In order to obtain a near-term contribution to the energy supply from synthetic fuels, the government can provide incentives (e.g., tax credits, price supports, exemptions from excise taxes, etc.) that will encourage the construction and operation of these first-generation synthetic fuel technologies in the United States.

Another approach the government may take is to conduct long-range planning activities to remove uncertainties and to reduce lead time for the development of second-generation synthetic fuels technologies. The second-generation gasification technologies could use a wide range of U.S. coals, particularly caking coals, which would have higher environmental performance and efficiency and an increase in reliability.

Surface coal gasification (SCG) is, in one sense, a mature technology. Before the abundance of natural gas in the 1930s, domestic gas was produced primarily from coal by using the water gas reaction. Industrial gas, or producer gas, was produced by partial oxidation of coal to form carbon monoxide. This technology was less efficient for energy conversion and would fall short of current environmental requirements. More mature technology has since been applied in Europe and South Africa, where natural gas has not been readily available. Hence, there are available first-generation gasifiers (Lurgi, Koppers-Totzek, etc.); however, certain improvements are promised by units now being developed (British (slagging) Lurgi, COGAS, BI-GAS, HYGAS, etc.). Third-generation technology includes flash hydrogenation of coal particles. The extent of thermal efficiency improvement achieved by third-generation processes over the efficient second-generation processes has yet to be firmly determined.

In summary, SCG technology is well understood and has demonstrated good overall thermal efficiencies in converting various types of coal to clean-burning gas products, and commercial facilities based on the first-generation technology have been constructed and operated. In comparison, commercialization of underground coal gasification technologies does not appear to be probable before the late 1980s.

### 1.2.3 DOE surface coal gasification program

In response to the July 15, 1979 announcement of the Import Reduction Program, the Office of Fossil Energy within the Department of Energy conducted a comprehensive reexamination of the entire Fossil Energy Program. The existing strategy for coal gasification was modified as part of the reexamination. Instead of continuing to address a broad range of technologies which appear promising and would eventually reach maturity, the strategy for coal gasification was modified to focus upon those technologies which had the potential to make an earlier contribution to these Oil Import Reduction Policies.

Successful development of the technology needed for surface gasification of coal will enable the United States to use its large deposits of coal to produce a wide variety of energy products and chemical feedstocks. A major focus of the development program is to provide the ability to gasify caking eastern coals at pressures greater than atmospheric. The successful completion of the projects in this activity will provide the means to convert coal into a number of clean synthetic gaseous and liquid fuels as well as a synthesis gas suitable for continued conversion into other fuels and chemicals. The synthetic gaseous fuels include high-Btu gas having a heating value of approximately 950 Btu-scf and low- and medium-Btu gases having heating values which range from approximately 100 to 500 Btu/scf.

The high-Btu gas is intended for use principally as a fuel for residential and commercial heating as well as for industrial applications which require clean high-energy fuel. The low- and medium-Btu gases are used for industrial process heat and electric power generation. The same technology can be used as the first step in producing synthesis gas which can be subsequently processed into chemical feedstocks and liquid fuels.

The intended end uses of high-Btu gas differ from those of medium- and low-Btu gases; thus, the program objectives are different. The objectives of the High-Btu Gasification program are to:

- o Evaluate the technological and economic status of existing first-generation processes and assess their suitability for meeting the U.S. market needs.
- o Promote the development of new and improved second-generation technology to convert domestic coals (caking as well as noncaking) to synthetic natural gas of pipeline quality.
- o Continue the development of third-generation gasification processes.

The objectives of the Low-/Medium-Btu Coal Gasification program are to:

- o Promote the development of improved gasification technologies to convert coal in an environmentally acceptable manner to gaseous fuels for use in electricity generation, as an industrial fuel, and as a chemical feedstock.

- o Ensure that technological advances in low-/medium-Btu gasification are made available to users of existing commercial gasification systems and provide operating data sufficient to establish the confidence level necessary for other potential industries and utilities to use this technology.
- o Promote the development of cleanup equipment and systems suitable for use with low-/medium-Btu gasifiers in satisfying current as well as projected environmental requirements.

DOE supported low-/medium-Btu coal gasification projects include development of fixed-bed, entrained-bed, fluidized-bed, and molten salt systems. These projects are being carried out at the process demonstration unit, pilot plant, and demonstration plant levels. One such proposed project is the Memphis Industrial Fuel Gas Demonstration Project employing the U-gas process. This demonstration plant would process 3155 tons of coal into 171 million standard cubic feet of industrial fuel gas per day.

Although many gasification processes under development have the same objectives, each is characterized by important differences. These differences include reaction conditions, coal pre-treatment, method of feed, reactor configuration, heat supply, gas purification, methanation process, and product slate. The Lurgi gasification process has been utilized as a benchmark for measuring process economics of those processes currently under development.

Improvements to present technology will be measured primarily in terms of comparative capital and operating costs, as well as ability to operate successfully with U.S. caking-type coals.

Early identification and characterization of potential environmental contaminants is necessary to minimize ultimate impacts. Standard of environmental performance serve as goals for developmental efforts to reduce environmental impacts, to minimize the severity of any impact should it occur, and to minimize the costs of technology and equipment required to accomplish these goals.

### 1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

#### 1.3.1 Need for medium-Btu industrial fuel gas

Medium-Btu gas can serve as a substitute for oil or natural gas in two broad market applications. As a fuel gas, it can be used to satisfy industrial fuel requirements for process heat and steam-raising applications where the direct use of coal is either impossible or economically or environmentally undesirable. The second application is the use of a synthesis gas as an intermediate in the production of hydrogen, ammonia, and organic chemicals such as methanol, ethanol, acetic acid, acetic anhydride, ethylene, and methyl-butyl ether (MTBE). Coal-derived synthesis gas is required for indirect coal liquefaction and for the production of the hydrogen needed for direct coal liquefaction.

A third market area, that could have significant effects on energy supplies in the mid- to long-term, is as a fuel in combined cycle generation. The near-term importance of this application is that it offers utilities a means of electricity production in environmentally sensitive areas where extremely low emissions are required. Over the longer term, this technology could become the system of choice for utilities because of its potential economic and environmental advantages. This utilization of medium-Btu gas is not considered in the market projections shown below because, although early demonstrations are planned by EPRI and Southern California Edison, it is not expected to have broad market application until after 1990.

Table 1.2 shows, by sector, the total potential market for medium- and high-Btu gas from coal. This market is made up of those end-uses that could reasonably be served by gas after subtracting from potential demand the supply from estimated domestic natural gas production and uses that can be served by direct combustion of coal. The remaining applications can be served by medium- and high-Btu gas from coal, imported gas and in some cases imported oil. The sectoral demand is based mainly on the 1979 Annual Report to Congress published by DOE's Energy Information Administration. Additional analysis has been done for the industrial sector to illustrate the potential range for this demand for both a low and high growth scenario.

Projections of future domestic natural gas supply vary considerably due to significant uncertainties associated mainly with future discoveries and production of enhanced gas. The high estimate shown below is from the 1979 Annual Report to Congress. The lower estimate is consistent with several recent estimates, including ones made by Exxon, Shell, and Lewin & Associates (under contract to DOE).

The conclusion that can be drawn from the data in this table is that even given low industrial growth and high domestic natural gas supply, medium- and high-Btu gas from coal provides an alternative for displacing imported oil or gas in the 1990 time period. Alternative assumptions about industrial growth and domestic natural gas supply could make the potential coal gas market significantly larger. It should be noted that although most projections show electric utility demand for gas declining throughout the 1990's, it is likely that natural gas supply will decline at an even faster rate, thus increasing the desirability of additional domestic sources of gas supply.<sup>13</sup>

**Table 1.2. Potential annual gas demand (quads)**

| Sector                      | 1979 | 1990      |
|-----------------------------|------|-----------|
| Residential                 | 5.3  | 5.1       |
| Commercial                  | 2.5  | 2.4       |
| Electric utility            | 3.3  | 0.9       |
| Transportation              | 0.5  | 0.6       |
| Industrial                  | 8.4  | 9.3-10.9  |
| Total potential gas demand  | 20.0 | 20.3-21.9 |
| Domestic natural gas supply |      | 15.3-18.7 |
| Potential coal gas market   |      | 1.6-6.6   |

Source: "Analysis of the Market and Product Costs for Coal Derived High-Btu Gas," DOE/Fossil Energy, Office of Plans and Technology Assessment, DOE/FE-0011, December 1980.

In spite of technical, economic and environmental uncertainties and the lack of recent operating experience with the use of medium-Btu gas, a number of recent studies have indicated significant market acceptance subject to competitive product cost. These studies<sup>14</sup> suggest market penetration ranging from 0.6 to 2.0 quads in the 1990 to 2000 time frame.

The programmatic information presented in this chapter is based on 0.6 quads by 1992. This figure is consistent with the 1.6 to 6.6 quad potential market shown above for high and medium-Btu gas from coal.

### 1.3.2 The role of the Memphis U-Gas demonstration project

The Memphis U-Gas Demonstration Project is proposed in order to (1) demonstrate the technical, environmental, and economic feasibility of industrial fuel gas production from high-sulfur coal by the U-gas process; (2) advance the current state of the art in coal gasification for industrial fuel gas with the construction and operation of a demonstration plant; and (3) encourage commercialization of industrial fuel gas production from coal.

The MLGW demonstration and commercial plant designs were chosen to be the same size because (1) the industrial fuel gas is intended for multiple users, (2) of the economics for operation and payback, (3) of operational maintenance factors, and (4) of the number of customers that could be conveniently served by the plant due to the limitations of the distribution system.

If successful, the MLGW plant would be able to provide synthetic gas to many existing nearby customers currently using natural gas and oil. Included among these existing customers are chemical plants, food processing plants, hospitals, a metal processing plant, and an oil refinery.

Construction and operation of this demonstration project would therefore allow resolution of a number of major uncertainties associated with the marketing, distribution, and the institutional arrangements required for the production and use of medium-Btu gas. Also, the project would demonstrate advanced gasification technology that could result in a significant improvement in the Nation's posture to convert coal into industrial fuel gas or produce synthesis gas required for indirect liquefaction and the manufacture of chemicals.

#### 1.3.2.1 Technical advancement

##### Demonstrate process reliability

The U-Gas process would demonstrate satisfactory ash formation and removal from the bed with minimum carbon content. In addition, the cyclone system would recover fine particles elutriated from the bed and recycle the particles back to the gasifier for conversion and thereby promote high process efficiency. The gas purification system would work at a high level of pollutant removal, producing acceptably low levels of contaminants in the waste streams. Process control systems and instruments would demonstrate the capability to maintain critical parameters such as the bed temperature at the level for agglomerating ash removal while components and materials functioned in corrosive and erosive high temperature service.

##### Desirable gasifier operating characteristics

The U-Gas process would operate at a 1800-1900°F range that would be high enough to avoid most tar and oil production and would be at the boundary of the slag producing region. Additional benefits of increasing the temperature and pressure of the gasifier would be a higher throughput and less costly gasifier construction cost to produce a given quantity of gas. Operation at a high enough temperature would produce incipient fusion on the surface of the ash particles, thus, promoting agglomeration of the ash to such a size to permit discharge from the gasifier. These agglomerated ash particles are less likely to leach toxic material after disposal than would the finely divided unagglomerated material.

Successful injection of coal would demonstrate reliable operation of the U-Gas agglomerating ash system and would promote the commercial acceptability of the technology.

##### Improve technical operability/expand thermodynamic data base

Potential users of the U-Gas process would be more likely to consider the technology as commercially ready when a large amount of successful operating time on a commercial sized unit is shown. By operating a large unit, the thermodynamics of the agglomerating ash process would be better established and the numerous chemical engineering processes in gasification, raw gas cleanup and waste treatment better understood. Process efficiency would be improved as operating experience is gained and the technical feasibility and adequate environmental control of all aspects of the process could be demonstrated and improved.

##### Environmental data base

Because of the lack of complete environmental characterization of most existing gasifier installations, it is important to demonstrate adequate control of air, water, and solid waste emissions in a commercial sized facility.

The Selexol system used for sulfur removal would demonstrate reliable operation and the cleanup of other pollutants would be simplified because the U-Gas process operates at a high enough temperature so that no substantial tars or oil appears in the raw product gas. Ash disposal problems will be simplified if the U-Gas process demonstrates a low cyclic carbon concentration in the agglomerated ash.

Information would be gained regarding waste stream characterization and the behavior and efficiency of the installed pollution control equipment. The monitoring systems employed to collect this information are summarized briefly in section 1.4.8.2, Monitoring and Review; more

specific and detailed discussions are provided in appropriate sections throughout the main body of the Final Environmental Impact Statement.

Information gained during the operation of the MLGW plant should also suggest a broader range of areas that require examination prior to full commercialization of the U-Gas process. As noted in section 2.2.1.8, for example, initial test results from the U-Gas pilot plant indicate that leaching from the ash agglomerates should not be a problem using the design coal, with respect to the application of the Resource Conservation and Recovery Act. Further monitoring of the leachates would be conducted at the demonstration facility to validate these results, given the larger loadings released by the larger facility. Additional leachate testing should be conducted on coals from other regions where U-Gas commercialization may occur to substantiate the safety of ash leachate.

As the data base is expanded, the relationship between the size of the facility and the size and quality of the waste streams would be better understood, allowing more efficient system design for future facilities.

#### Ability to accept a wide variety of U.S. coals

Most existing commercial gasification processes utilize noncaking lignite or subbituminous coals. Fixed-bed gasifiers must use screened coals to avoid the fines fraction being removed with the product gas. The U-Gas process would accept the size range of coal from a modern mechanized mine which produces a large fraction of coal fines.

#### Usage of end gas

If coal gasification is to be widely used to displace existing petroleum and natural gas consumption, successful examples of utilization must be provided. Several existing DOE programs utilize gasifiers for single purpose application but the Memphis U-Gas facility would be the first modern installation in which the gasifier would have to satisfy the requirements of multiple customers. The output of the MLGW plant would be utilized as an industrial fuel gas. Other gasification projects in the U.S. are directed toward a product for chemical synthesis or large utility boiler usage and produce a gas with different specifications.

A unique feature of the MLGW plant would be the inclusion of a small methanation facility that would be used to produce SNG. Inasmuch as the demand for industrial fuel gas (IFG) is cyclical, either the plant would have to operate at varying production rates, which is inherently inefficient, or the excess gas would have to be stored for use when the demand is high. An economic study indicated that it would be less costly to produce methane from the IFG than to provide the required tank storage. The methane, so produced, is essentially equivalent to natural gas, and can be injected into the existing natural gas pipeline. When the IFG demand is greater than the capacity of the plant, natural gas would be extracted from the pipeline, diluted with nitrogen to the heating value of IFG, and supplied to the consumers, thereby guaranteeing that the IFG consumers would have a continual source of fuel.

#### 1.3.2.2 Relationship to other gasification technologies

There are thirteen coal gasifiers currently in operation in the United States for industrial applications. Of these thirteen, all but one (the Holston Defense Corporation, funded by the Department of Defense) have been at least partially funded by private industry. Nine were funded completely by industry. All of these gasifiers produce low-Btu gas. Four additional facilities are under construction, two of which would produce medium-Btu gas. Of these four, one is being funded by the Tennessee Valley Authority, two are partially funded by industry and one (the Southern California Edison facility) is totally industry supported. The TVA and Southern California Edison projects would produce medium-Btu and both would utilize a gasification unit developed by Texaco.

There are at present more than one hundred low/medium-Btu coal gasification technologies in some stage of development. In spite of this abundant activity, there has been only limited advanced development and technology transfer to date. For example, of the seventeen gasification units in operation or planned for operation in the 1980s, nine utilize the Wellman-Galusha gasifier developed in the 1920s and 1930s. Some of the more advanced technologies and their sponsors are listed below.

| <u>Type</u>    | <u>Process</u>           | <u>Sponsor</u>                   |
|----------------|--------------------------|----------------------------------|
| Entrained Flow | Babcock & Wilcox         | The Babcock & Wilcox Company     |
|                | Bi-Gas                   | Bituminous Coal Research, Inc.   |
|                | Foster Wheeler           | Foster Wheeler Energy Corp.      |
|                | Kopper-Totzek            | Koppers Company, Inc.            |
|                | Texaco                   | Texaco Development Corp.         |
| Fluidized Bed  | BCR Low-Btu              | Bituminous Coal Research, Inc.   |
|                | CO <sub>2</sub> Acceptor | Conoco Coal Development Company  |
|                | COGAS                    | COGAS Development Company        |
|                | HYGAS                    | Institute of Gas Technology      |
|                | Winkler                  | Davy Powergas, Inc.              |
|                | U-Gas                    | Memphis Light, Gas and Water     |
| Fixed Bed      | Lurgi                    | American Lurgi Corporation       |
|                | Wellman-Galusha          | McDowell-Wellman Engineering Co. |
|                | Woodall Duckham          | Woodall-Duckham (USA) Limited    |
|                | STOIC                    | Foster Wheeler                   |
| Molten Media   | Aluminum Molten Salt     | Rockwell International Corp.     |
|                | Otto-Rummel              | Dr. C. Otto and Comp. G.m.b.H.   |

In addition to major projects sponsored by industry or the Federal Government, a number of small gasifiers have been made commercially available through combined industry/Department of Energy funding. The Federal program is of short duration, focusing on use of caking coals, development of two-stage gasifiers, improvement of single-stage gasifiers and evaluation of environmental acceptability. Government participation in these projects was approximately 50 percent funding.

Of the seven projects originally under this program, one was terminated by the Department of Energy after project evaluation, and two others were terminated by the industry partner for economic reasons. Of the remaining four projects, three have involved the instrumentation of single-stage Wellman-Galusha gasifiers with equipment for particulate removal, and one utilized a two-stage STOIC gasifier. Valuable information has been obtained on material and energy balances and gasifier performance from the one operational facility, and all plants will be equipped with environmental monitoring equipment.

Pressurized, high temperature entrained bed gasifiers, when developed, will meet these Fossil Energy objectives. However, despite a long history of development, high temperature entrained bed gasifiers, both atmospheric and pressurized, have some important residual problems:

- o Because of the high temperature slagging conditions, refractory life tends to be too short, especially when coals with high ash fusion temperatures are used for gasification.
- o Thermally efficient operation requires improvement in the design of associated waste heat boilers downstream of the gasifier. The raw gas, whose exit temperature is about 2400°F, contains erosive and corrosive components, requiring waste heat boilers to operate under extreme conditions.
- o High temperature gasification of coal ensures that all by-product hydrocarbons including undesirable tars and oils are gasified to extinction. However, these high operating temperatures require more oxygen and consume more coal.



Accordingly, an alternate approach to a flexible pressurized gasifier is one operating at a lower, non-slagging, but relatively high temperature to produce a raw gas of relatively low methane content. Such a gasifier would be more suitable for production of SNG, have fewer inherent unresolved technological problems, and could still be an economic choice for production of synthesis gas and/or hydrogen.

Table 1.3 summarizes the salient characteristics of selected medium-Btu gasification processes, including U-Gas. The two other technologies with no heavy hydrocarbons are the Winkler and Texaco processes. The Winkler gasifier operates at atmospheric pressure, however, and is limited to reactive, non-caking coals. While Texaco can accept caking coals, it presents the various problems associated with high operating temperatures. Texaco does operate at pressure, however, as does the Lurgi gasifier, but the Lurgi process is limited to non-caking, sized, relatively reactive coals.

A major advantage of U-Gas over other technologies is that the process was designed to gasify coal at the highest possible temperature short of fusing or slagging the ash. This corresponds to an operating temperature range of about 1550-1900°F, almost 800°F lower than an entrained-bed gasifier.

This lower operating temperature results in a number of benefits:

- o Effective long-lived refractories are readily available.
- o Waste heat boiler design problems are significantly reduced or eliminated.
- o The coal gasification temperature is sufficiently high to convert most hydrocarbons, with the exception of methane, to synthesis gas.
- o The operating temperature is high enough to result in almost complete carbon burn out, ash is discharged essentially carbon free.
- o Relative to entrained bed gasification, the 800°F lower operating temperature results in lower operating cost and increased thermal efficiency.

For synthesis gas applications, including indirect liquefaction, the fluidized-bed U-Gas gasifier presents major advantages over current technology. It is pressurized, can accept a broad spectrum of U.S. coals, including coal fines, produces no tars or toxic by-products, and has relatively low methane yields. Although entrained-flow gasification is generally considered the system of choice of synthesis gas applications, it is not apparent at this stage of development of both entrained-flow and fluidized-bed gasifiers that operational considerations may not favor the U-Gas system. More importantly, the U-Gas system is based upon low temperature technology and offers an important fallback position to developmental problems that have persisted in the evolution of entrained-flow gasification technology.

For fuel gas application, the U-Gas gasifier approaches closely the technically ideal system. It accepts a broad range of U.S. coals, operates at low temperatures and, hence, provides improved efficiency and produces no tar or difficult to handle by-products. The clean product gas, after acid gas scrubbing, contains about 5 percent methane. The presence of methane in medium-Btu gas is advantageous for industrial or utility fuel application and for conversion to pipeline quality high Btu gas. At these modest levels, the methane content is sufficiently low to permit its economic separation for those applications that require pure synthesis gas.

These technical factors can be translated into improved economics. Projections of the economic benefits associated with advanced as opposed to currently commercial gasifiers indicate cost savings ranging from 20 to 30 percent. In addition, the availability of this technology will allow the gasification of eastern caking coals and, hence, further extend the application of import reduction measures to the eastern portion of the Nation.

#### 1.4 PROGRAMMATIC ENVIRONMENTAL IMPACTS

##### 1.4.1 Introduction

###### 1.4.1.1 Purpose

This section contains an analysis of the potential environmental impacts associated with the cumulative effect of the medium-Btu gasification program including commercialization

Table 1.3. Technical objectives of gasifier program

| Gasification technology<br>Process example                                      | Fixed bed                                                                                 |                                                                                            | Fluidized bed                                                                    |                                                                                                    | Entrained bed                                                              |                                                                                             |
|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
|                                                                                 | Dry ash<br>Wellman-Galusha                                                                | Slagging ash<br>Slagging Lurgi                                                             | Dry ash<br>Winkler                                                               | Agglomerating ash<br>U-gas                                                                         | Dry ash<br>Garrett flash pyrolysis                                         | Slagging ash<br>Texaco                                                                      |
| Ability to accept a wide variety of U.S. coals                                  | Lignite to anthracite; screened to remove fines; weakly caking coal                       | Subbituminous and bituminous; screened to remove fines; caking coal                        | Lignite and subbituminous; no caking coals                                       | Can handle all coals; caking coals                                                                 | High volatile bituminous                                                   | Subbituminous and bituminous; all sizes; all caking coals                                   |
| Develop desirable operating characteristics in gasifier                         | Low throughput; lock hopper coal feed; 590 to 650°C (1100 to 1200°F) product gas; dry ash | Oxygen — medium-Btu; lock hopper coal feed; 370 to 540°C (700 to 1000°F) product gas; slag | Air or oxygen; 620 to 790°C (1150-1450°F) product gas; dry ash                   | Oxygen — medium Btu; 980 to 1040°C (1800-1900°F) product gas; agglomerating ash                    | Air; 810 to 930°C (1500-1700°F) product gas; pipeline gas equivalent       | Oxygen — medium Btu; water-slurry feed; 1200 to 1430°C (2200-2600°F) product gas; slag      |
| Expand environmental data base                                                  | Tar and oil; leaching from dry ash; water treatment; tar and oil, ammonia, phenolics      | Tar and oil; no leaching from quenched slag                                                | No heavy hydrocarbons; high carbon content ash                                   | No heavy hydrocarbons; little or no leaching problems; Selexol system S removal                    | Tar and oil                                                                | No heavy hydrocarbons; high sulfur removal; Rectisol system; no leaching from quenched slag |
| Improve technical operability/improve thermodynamics data base                  | Commercially proven operability; atmospheric pressure only                                | Over 2000 h operating time on pilot plant; 600 psi pressure                                | Commercial operability proven on lignite and subbituminous; atmospheric pressure | Expand data base on thermochemical reactions; 6000 h operating time; 50 to 350 psi pressure        | Results on 3.6 tons/d liquefaction plant use as base; atmospheric pressure | Proven on all ranks of coal; 10,000 h of operating time; 350 psi pressure                   |
| Demonstrate process reliability<br>— Existing unit size<br>— Proposed unit size | Commercial operation<br>100 tons/d                                                        | One pilot plant<br>800 tons/d<br>3000 tons/d<br>Refractory and hearth materials            | Commercial operation<br>600 tons/d<br>Fines carryover                            | One process development unit<br>20 tons/d<br>3155 tons/d<br>Fines carryover; carbon content in ash | One pilot plant<br>3.6 tons/d<br>250 tons/d demonstration unit             | Several demonstration units<br>180 tons/d<br>1000 tons/d<br>Refractory lifetime             |
| Increase diversity of use of end gas                                            | Fuel gas; single user                                                                     | SNG* production; multiple user                                                             | Chemical synthesis gas; single user                                              | Industrial fuel gas; multiple users; upgrade a portion to SNG as a pilot for large SNG production  | Fuel gas and 700 Btu/scf gas upgraded to pipeline equivalent               | Chemical synthesis gas; hydrogen and methanol                                               |
| Comments                                                                        | Low throughput fixed-bed design                                                           | Pressurized operation and slagging design increase throughput                              | Limited to atmospheric pressure and low rank coals                               | Promising second generation technology                                                             | In early development stage                                                 | Most promising second generation technology                                                 |

\*SNG, Synthetic natural gas.

The cumulative effects of commercialization of the U-Gas process are discussed in the same general context as those effects of an individual, site-specific analysis. That is, the impacts are discussed on the basis of a multi-media analysis including air, water, solid waste, socio-economics and land disturbed. The analysis differs from a single plant concept in that specific environmental consequences can only be identified on a generic basis.

#### 1.4.1.2 Approach

The approach to determining the environmental impacts associated with the commercialization phase of the program follows the same general methodology that was used in both the Alternative Fuels Programmatic EIS<sup>15</sup> and the Draft Coal RD&D Programmatic EIS.<sup>16</sup> The analysis begins with a definition of the input/output characteristics of a Baseline Unit Plant. The Baseline Unit Plant was defined to have the characteristics of the Memphis Plant. The input requirements (coal, water, etc.) and output environmental parameters (air emissions, solid waste, etc.) of the Baseline Unit Plant are summarized in Section 1.4.2.

The input/output characteristics of unit plants located in other parts of the country were derived from the estimates for the Baseline Unit Plant. The algorithms used in this derivation are given in Appendix B.5. In deriving the algorithms, it was assumed that all the Unit Plants located in other parts of the country had the same product output in Btu's as the Memphis plant. Other outputs and inputs would depend upon the region of the country in which the plant was located and would vary according to such parameters as coal and coal mining characteristics. Any problems with the use of other types of coals would be overcome by redesigning appropriate modules or siting near acceptable coal fields.

The algorithms are used to extrapolate estimates of the environmental parameters of the Memphis plant (the Baseline Unit Plant) to estimates of the environmental parameters of the Unit Plants located in other parts of the country. The next element in the analysis is to estimate how many of these Unit Plants there are likely to be and where they could be located. Having this and the regional environmental parameters, it is possible to aggregate the effects and perform an analysis of the cumulative effects of the commercialization of the U-gas process.

In order to estimate the number and location of the Unit Plants, it is necessary to predict the total production level at some time in the future when commercialization is considered mature, although not necessarily at its peak. These estimates are developed in Section 1.4.3 and are taken to be an annual production of 0.6 quads of medium-Btu fuel gas by 1992.

The general approach throughout the analysis was to take the best estimate available of parameters and, where there was some uncertainty as to what the best estimate was, to take an estimate that, if anything, overstated the environmental effect of U-gas commercialization. Consistent with this approach, it was assumed that the entire 0.6 quads per year of medium-Btu fuel gas produced by 1992 would be produced by the U-gas process. This assumption is further supported by the fact that U-gas is the medium-Btu gasification process closest to domestic commercialization. This analysis to estimate the number and location of the Unit Plants is also provided in Section 1.4.3.

#### 1.4.2 Baseline unit plant definitions

The unit plant constitutes a base module for industrial fuel gas production. It is capable of providing sufficient output (51.3 billion Btu/day) to feed a large steel mill or refinery, or to be used in conjunction with other plants to form a gas distribution network.

As conceived, the unit plant is equipped with four U-Gas process gasifiers, three of which will be in production and one in reserve. Auxiliary equipment to supply steam, oxygen and nitrogen requirements of coal gasification and gas treatment is provided in the design as well as equipment for waste treatment and disposal, feedwater treatment, and waste heat removal. "Best Available Control Technology," where applicable, would be applied under criteria existing at the future 1992 date. Electrical power and makeup water are assumed to be provided by local utilities. Plant design parameters which affect the commercialization scenario (Section 1.4.3) and which are addressed in the programmatic environmental analysis (Section 1.4.6) are identified as follows.

#### 1.4.2.1 Baseline unit plant output

The unit plant is designed to produce 171 million standard cubic feet per day (scfd) of industrial fuel gas with a heating value of  $300 \pm 30$  Btu/scf. One hundred tons per day of liquid sulfur are produced as a result of acid gas removal and sulfur recovery.

#### 1.4.2.2 Process inputs

Principal material inputs for the gasification process are coal, water, oxygen and nitrogen. Coal input for gasification and steam generation would be 3155 tons per day based upon use of Western Kentucky #9 coal. The proximate and ultimate analysis of this coal type are provided in Table 1.4. Makeup water is supplied at the rate of 2.7 million gallons per day. Recirculated water is used for steam generation, process cooling and gas treatment. Oxygen and nitrogen needs are provided by a cryogenic air separation unit. Process oxygen is produced at a rate of 147,390 pounds per hour and is used for coal gasification and wastewater treatment. Nitrogen is produced at a rate of 11,240 pounds per hour for use in coal preparation and fueling and gas treatment. Other inputs, primarily used for gas treatment and pollution control, are listed in Appendix B.0.3.

During operation, the unit plant will employ 410 persons. The land use requirement for this facility is approximately 134 acres.

**Table 1.4. Proximate and ultimate analysis of Kentucky No. 9 coal**

|                                      | Weight %     |
|--------------------------------------|--------------|
| <b>Proximate analysis</b>            |              |
| Moisture                             | 7.00         |
| Volatile matter                      | 35.40        |
| Ash                                  | 16.46        |
| Fixed carbon                         | 41.14        |
|                                      | <hr/> 100.00 |
| <b>Ultimate analysis (dry basis)</b> |              |
| Carbon                               | 66.83        |
| Hydrogen                             | 4.52         |
| Oxygen                               | 5.45         |
| Nitrogen                             | 1.26         |
| Sulfur                               | 4.24         |
| Ash                                  | 17.70        |
|                                      | <hr/> 100.00 |

#### 1.4.2.3 Effluents

##### Air Pollutants

During the normal operation of the unit plant, atmospheric emissions will occur from the following sources:

- o Direct losses from coal supply and preparation,
- o Treated sulfur-recovery tail-gas,
- o Plant flare pilot combustion gas,
- o Boiler flue gas, including incinerator off-gas, and
- o Cooling tower evaporation and drift.

Total emissions from the above sources are estimated in Table 1.5 based upon combustion of high sulfur Western Kentucky #9 coal and application of best available control technology.

**Table 1.5. Air emissions from the  
baseline unit plant**

| Pollutant        | Emissions (lb/h) |
|------------------|------------------|
| Sulfur dioxide   | 296              |
| Nitrogen dioxide | 473              |
| Carbon monoxide  | 47               |
| Particulates     | 35               |
| Methane          | 6                |
| Ammonia          | 1                |
| Carbon dioxide   | 2                |

#### Wastewater

The wastewater stream is made up of:

- o Process wastewater (gas-scrubbing blowdown, sour water stripping condensate, and methanator condensates)
- o Cooling tower blowdown,
- o Coal pile runoff,
- o Ash pile runoff,
- o Process area storm drainage,
- o Boiler-feedwater preparation wastes.

After treatment, wastewater from these sources collects in a holding basin prior to discharge or recirculation as boiler feedwater, ash quench makeup or cooling tower makeup. Excess treated wastewater is sent to an outfall at the rate of 681 gallons per minute. The composition of the discharged effluent is noted in Section 2.2.1.4, "Analysis of final liquid discharge."

#### Solid Waste

Solid wastes produced during plant operation include:

- o Agglomerated ash from coal gasification
- o Fly ash and bottom ash from steam generation
- o Sludge from flue gas desulfurization
- o Sludge from wastewater treatment
- o Spent catalysts from various process modules.

Gasifier agglomerated ash is generated at the rate of 49,583 pounds per hour during combustion of Western Kentucky #9 coal while boiler ash and bottom ash are produced at 8000 pounds per hour. Sludge from flue gas desulfurization amounts to 7670 pounds per hour, while sludges from wastewater treatment and from spent catalysts amount to 1000 pounds per hour and 326 pounds per hour, respectively. The composition of these wastes are noted in Section 2.2.1.8 "Solid waste storage system."

#### 1.4.3 Scenario development

This section presents the results of an analysis to estimate the number and general location of the plants that constitute the extent of commercialization by the year 1992. The results of this analysis will provide the basis for the assessment of the cumulative environmental impacts associated with a mature industry. The cumulative impacts are presented by state, based upon regionalized loadings using the algorithms derived in Appendix B.5. It should be emphasized that the number of general location of the plants are used here only to facilitate an environmental analysis and should be considered hypothetical.

The year 1992 was chosen because it is the target year identified in the Energy Security Act (P.L. 96-294) signed into law June 30, 1980 establishing "... a national goal of achieving a synthetic fuel production capability equivalent to at least 600,000 barrels per day of crude oil by 1987 and of at least 2,000,000 barrels per day of crude oil by 1992, from domestic sources." Two million barrels of oil per day is equivalent to about 4.2 quads per year.

The analysis was composed of three steps that are listed below and discussed later.

1. Estimate the total national market penetration of medium-Btu gas (MBG) by 1992.
2. Determine the most likely areas of the country where MBG commercialization will occur.
3. Assign plants to these areas so that the aggregated output will yield the total estimated in step one.

A number of recent market studies plus information from the Office of Assistant Secretary for Fossil Energy, Division of Policy and Strategic Planning,<sup>12</sup> indicate market penetrations ranging from 0.6 to 2.0 quads in the 1990 to 2000 time frame. The estimate needed in Step 1 is taken to be 0.6 quads of medium-Btu gas by 1992. The Memphis U-Gas plant will produce about 50 billion Btu's per day so that about 36 plants will be needed to provide 0.6 quads per year:

$$\frac{0.6 \times 10^{15} \text{ Btu per year}}{50 \times 10^9 \text{ Btu per plant per day} \times 330 \text{ stream days per year}} = 36 \text{ plants}$$

The areas likely for MBG commercialization were taken from a recent report<sup>13</sup> and were based upon an analysis of projected oil to coal price ratios across the U.S. and an accounting of those states that experienced industrial fuel gas shortages in the 1975-1978 time period. The report identified 14 primary states as key targets for initial commercialization efforts. These 14 states are shown in Figure 1.1.

The number of plants in each state was estimated by using the projected total and relative growth in all manufacturing and in the chemical and metals industries in the candidate states and surrounding states. The chemical and metals industries were used because these have been identified<sup>13</sup> as likely early targets for commercialization of medium-Btu gasification plants. The projections to 1990 were taken from preliminary Office of Business and Economic Research Service (OBERS) projections published by the Bureau of Economic Analysis of the Department of Commerce.

Table 1.6 shows the results of the projections by economic region. Using the data in the table the number of plants was assigned to each state. The methodology for assigning plants to states was not a rigorous application of a set of well developed and quantified measures, but rather a general consideration of all factors including the information in Table 1.6, coal and water resources, natural gas resources and the additional constraint of locating at least one plant in each candidate state.

The general location within each state need not be identified per se. However, a geographical analysis was conducted to determine if there were general areas within each state that, in addition to the criteria that led to the selection of the state, also met the criteria of water availability, proximity to coal supplies and near an urban industrialized area. With this in mind, the following areas within each state are representative of those in which commercialization of the MBG process could occur.

- o The Los Angeles to San Diego corridor utilizing the availability of sea water for cooling. The Sacramento to San Francisco area using water from the Sacramento River, Suisun Bay or any of several reservoirs in the area. Coal would be transported by existing rail from the Uinta (Eastern Utah) coal fields. On the basis of analysis discussed above, it was estimated that 3 plants would be located in California.
- o The area in south-east Wyoming within the Casper-Laramie-Cheyenne triangle using water from the North Platte River or existing reservoirs. Coal would be transported from the Green River or Powder River coal fields. On the basis of analysis discussed above, it was estimated that 1 plant would be located in Wyoming.
- o The Fort Collins-Denver-Colorado Springs-Pueblo corridor east of the Rocky Mountain foothills using water from existing reservoirs and the South Platte River. Coal would be from the Denver coal fields. On the basis of analysis discussed above, it was estimated that 1 plant would be located in Colorado.
- o The Dallas-Austin-Houston triangle using water supplied by the Neches, Trinity, Brazos and Colorado rivers and coal from the lignite fields of Texas. On the basis of analysis discussed above, it was estimated that 2 plants would be located in Texas.

**Table 1.6. Projected increase in earnings 1980-1990**

Millions of 1967 dollars

| Region                           | Far West   | Rocky Mountain       | Plains          | Southwest | Great Lakes                   | Southeast              | Middle East                                          |
|----------------------------------|------------|----------------------|-----------------|-----------|-------------------------------|------------------------|------------------------------------------------------|
| Selected states                  | California | Wyoming,<br>Colorado | North<br>Dakota | Texas     | Illinois,<br>Indiana,<br>Ohio | Kentucky,<br>Tennessee | Pennsylvania<br>New Jersey,<br>Delaware,<br>Maryland |
| All manufacturing                |            |                      |                 |           |                               |                        |                                                      |
| Total increase                   | 7,010      | 1,708                | 4,536           | 6,903     | 14,678                        | 21,214                 | 5,235                                                |
| Percent increase                 | 28         | 51                   | 32              | 54        | 23                            | 51                     | 12                                                   |
| Chemical and metal<br>industries |            |                      |                 |           |                               |                        |                                                      |
| Total increase                   | 873        | 167                  | 359             | 824       | 3,037                         | 2,984                  | 1,597                                                |
| Percent increase                 | 44         | 39                   | 34              | 47        | 30                            | 50                     | 21                                                   |

- o The area in North Dakota accessible to the large man-made lakes of the upper Missouri River. Coal would be from lignite fields of the Fort Union coal region. On the basis of analysis discussed above, it was estimated that 1 plant would be located in North Dakota.
- o The areas in Illinois accessible to the Mississippi or Illinois rivers in the Chicago-Peoria-Springfield corridor using coal from the Eastern Interior coal fields. On the basis of analysis discussed above, it was estimated that 3 plants would be located in Illinois.
- o The eastern Indiana (Terre Haute-Indianapolis-Evansville triangle) using water from the Wabash and White rivers and coal from the Eastern Interior coal fields. On the basis of analysis discussed above, it was estimated that 3 plants would be located in Indiana.
- o Areas in northern Kentucky in the Louisville-Frankfort-Lexington corridor accessible to water from the Ohio and Kentucky rivers. Coal would be transported by rail from either the Eastern or Western Kentucky coal fields. On the basis of analysis discussed above, it was estimated that 5 plants would be located in Kentucky.
- o Areas in Tennessee near the industrialized cities of Memphis, Nashville, Chattanooga and Knoxville using either ground water or water from the Mississippi, Cumberland, and Tennessee rivers. Coal would be barged to Memphis from the Eastern Kentucky coal fields and would be rail transported or barged from Tennessee coal fields for the Central and Eastern Tennessee development. On the basis of analysis discussed above, it was estimated that 5 plants would be located in Tennessee.
- o Areas in Northern Ohio in the Toledo-Cleveland-Akron-Youngstown corridor accessible to water from Lake Erie or several reservoirs. Areas in Central and Southern Ohio in the Columbus-Dayton-Cincinnati triangle using water from the Scioto, Miami, and Ohio rivers, respectively. Coal would be transported by rail from the Northern Appalachian coal fields. On the basis of analysis discussed above, it was estimated that 4 plants would be located in Ohio.
- o Areas in Pennsylvania around the industrial centers of Pittsburgh on the Ohio River, Harrisburg on the Susquehanna, Allentown near the Delaware River and Philadelphia on the Delaware River. Coal would be from the Northern Appalachian coal fields and would be rail transported to the Eastern Pennsylvania centers. On the basis of analysis discussed above, it was estimated that 3 plants would be located in Pennsylvania.
- o Large areas in Maryland including the Eastern Shore accessible to water from the North Branch of the Potomac, the Potomac, upper Chesapeake Bay, and any of the several rivers on the Eastern Shore. Coal would be rail transported and barged from the Northern Appalachian coal fields. On the basis of analysis discussed above, it was estimated that 1 plant would be located in Maryland.
- o Areas in Delaware around the cities of Wilmington and Dover using either ground water or water from the Delaware Bay. Coal would be rail transported from the Northern Appalachian coal fields. On the basis of analysis discussed above, it was estimated that 2 plants would be located in Delaware.

The entire northern half of the heavily industrialized state of New Jersey using water from the Atlantic Ocean, and the Hudson and Delaware rivers. Coal would be rail transported from the Northern Appalachian coal fields. On the basis of analysis discussed above, it was estimated that 2 plants would be located in New Jersey.

#### 1.4.4 Description of existing environment

The characteristics of the existing environment for the medium Btu plants will be determined to some extent by the siting requirements of synthetic fuel processing. Key parameters include the location of coal supplies, water availability, and the industrial markets generally associated with large urban areas. Since details of the environment will depend upon the specific sites selected, the following description of water availability, socioeconomics, air quality, coal supplies and transportation systems is very general in nature.



#### 1.4.4.1 Water availability

There are significant regional implications associated with water availability in addition to those related to specific siting requirements. In the East, for example, an extensive network of waterways exist that provides a substantial source of water. This network includes the Mississippi and Ohio Rivers and their several large tributaries. The Susquehanna and Delaware systems farther to the East also serve as a major source. Many synthetic fuel plants will probably locate in close proximity to industrial markets that have developed along these waterways. Industrial activities along the southern shores of the Great Lakes will also draw synthetic fuel production to an area with the advantage of that source of water. In addition, the relatively abundant rainfall in the East generally assures an adequate supply of ground water in areas where surface water is not available.

In the West, however, water availability is a critical issue that may ultimately determine the extent of synthetic fuel development. Ground water and surface water are both often in short supply, particularly in times of low rainfall. In addition to the availability of water in absolute terms, water rights will play a significant role in the siting of synthetic fuel processing facilities. In many cases, existing supplies have been completely allocated leading to controversy over future rights and privileges of water use. This controversy involves state and local authorities as well as the rights of Indians to water on and around their reservations. It is clear that water is a very critical issue in the West both in terms of availability and allocation for synthetic fuel process development.

#### 1.4.4.2 Socioeconomics

Product markets is another key issue in the siting of medium Btu synthetic fuel plants. Since they will require multiple users or very large industrial customers, it is likely that plants will be located in close proximity to Standard Metropolitan Statistical Areas (SMSA). In addition to assuring an adequate market, these large urban areas provide a source of labor to construct and operate the facilities. This local source of labor reduces the need to import workers and thereby reduces the socioeconomic impact on community facilities and services. At the same time, large urban areas generally have a relatively abundant supply of housing, schools and medical facilities. Other services such as fire and police protection and water and sewer distribution systems are usually adequate to accommodate the small incremental population increase anticipated.

Socioeconomic impact is more critical in sparsely populated areas of the West than in large metropolitan areas of the East. While the potential exists for some isolated cases of socioeconomic impact in the West, this is again reduced to a large extent by the multiple user siting requirement. Plants will have to be restricted to the few existing urban concentrations of the West. These urban centers may not, however, be large enough in all cases to reduce socioeconomic impact to the low levels anticipated in the East. The exact magnitude of impact will depend upon the site selection process and the specific location of individual synthetic fuel plants.

#### 1.4.4.3 Coal supplies

A major advantage of the U-gas process is the ability to accept the wide range of coal types found throughout the United States. Plants locating in the northeastern states will be able to use bituminous coals supplied by the Northern Appalachian coal fields. Lignite will be used from the Texas and Fort Union coal regions to supply plants in Texas and North Dakota, respectively. Facilities located in Wyoming and Colorado will be supplied by subbituminous deposits of the Powder River and Denver coal Regions. West coast plants will depend upon bituminous coal transported from coal fields in the Uinta region of Utah. This ability to accept a variety of coal types provides the flexibility to locate medium Btu gas plants throughout the United States.

#### 1.4.4.4 Air quality

Air pollution law is based on the premise of protecting and enhancing public health and welfare regardless of location. Accordingly, the Clean Air Act (CAA) authorizes two procedural programs. First, in highly polluted areas, protecting public health and welfare is to be assured through the attainment of National Ambient Air Quality Standards (NAAQS). This is of particular significance in the East where many of the plants will be located in large urban areas.

The second procedural program of the CAA mandates the prevention of significant air quality deterioration (PSD) in relatively clean air areas. This program is aimed at preserving clean air resources and preventing the development of new air quality problem areas. It also serves to preserve, protect, and enhance the air quality in areas of special natural recreational, scenic, or historic value, such as national parks and wilderness areas. These standards have played a significant role in western coal development in the past and must be considered in any future sitings of synthetic fuel processing plants in the West. This is particularly true for Class I PSD areas.

#### 1.4.4.5 Transportation systems

Location near large urban areas generally assures the advantage of adequate transportation systems. In the East, in particular, the well developed network of highways provides access to plant sites both for construction materials and personnel. Transportation of coal can usually be achieved easily and at lower costs by barge on the waterway system or, in some cases, by a combination of rail-barge transportation. Plants located in the far eastern states can depend on coal transported from the Northern Appalachian region by railroads entirely.

Both the rail and barge systems are well developed in the eastern United States. Coal requirements for all 36 U-Gas facilities would amount to only about five percent of the coal produced in the United States in 1979. It is unlikely that any new track or equipment would be required to transport this additional coal. The exception to this may be the need for short rail spurs to connect existing lines with specific U-Gas facilities. The need for such construction would depend on actual site selection.

Transportation of coal in the West must depend entirely on rail transportation. There have been questions raised concerning the ability of those railroad systems to accommodate future coal transportation requirements for synthetic fuel production. The potential for such problems will be reduced to some extent, however, by the location of U-Gas plants in urban areas where rail networks are more extensive. In addition, the majority of the western facilities would be constructed near coal supplies, also helping to minimize transportation difficulties. The only U-Gas facilities not located close to coal supplies would be those in California. Though historically, only small amounts of coal have been shipped to California, rail lines do exist between both the northern and southern consuming areas and the coal producing regions in Utah.

The discussion is not intended to understate the problem. It could be noted that the amount of coal required by the U-Gas facilities postulated in this report represents only a small part of the coal that would be required to meet Federal energy production goals from synthetic fuels.

It will be necessary to construct pipeline delivery systems to move the product gas from the conversion facilities to the points of end use. In some cases, this may entail constructing a pipeline from the U-Gas facility to connect with an already existing fuel gas distribution system. In other cases, the distribution system itself may have to be constructed. All U-Gas facilities in this scenario would be constructed within a short distance of the consuming markets, thus minimizing the amount of pipeline construction required.

#### 1.4.5 Principal issues

There are significant environmental risks associated with the construction and operation of commercial coal gasification plants, particularly when considering the cumulative effects of a mature industry. As commercialization evolves, these risks will have to be faced and environmental protection built into the process. Various sources have attempted to compile and rank order these problems and risks; however, the major uncertainty occurs because empirical information from the operation of a commercial scale plant is not available for a U.S. based process. Even with such data from a limited number of individual plants, the cumulative effects can only be estimated based upon theory and models. The major issues associated with cumulative impacts as opposed to individual, site-specific, concerns are as follows:

- o Uncertainties regarding air quality considerations, emission control, siting in attainment or non-attainment areas.
- o Water availability, particularly in the West where competition is already severe among community development, agriculture and industry.

- o Socioeconomic issues related to rapid increases in population in sparsely populated areas. Provisions must be made for adequate time and resources to plan for the required housing and public facilities.
- o Disposal of large volumes of solid waste that may contain hazardous compounds. Much additional research and development is necessary to determine optimal siting strategies.
- o Experience is limited in land reclamation in the dry regions where the western coal is located. Research and compliance with existing surface mine regulations could reduce these impacts.
- o The role of state and local governments. These entities must become involved early in the planning process to ensure adequate communications and to avoid unnecessary legal and institutional constraints on development.
- o Long-term risks posed by the buildup of carbon dioxide in the atmosphere. Worldwide use of all fossil fuels, including coal-based synthetic fuels, may have to be curbed if some theories are confirmed.

Government regulations applicable to medium Btu gasification and expanded coal use are listed in Section 1.4.8. Detailed discussion of air, water, land use, and occupational health and safety issues relative to expanded coal use and Federal legislation applicable to these issues may be found in Reference 17. Discussions of issues related to intergovernmental relations, Indian concerns, community development, transportation and other issues are provided in Reference 16.

#### 1.4.6 Environmental analysis

##### 1.4.6.1 Approach

In Section 1.4.3, gasification plants were hypothetically sited in various states based upon market penetration assumptions concerning favorable economic conditions, previous curtailment of gas supplies and growth in potential user industries. While it can generally be assumed that user industries would be located in major metropolitan areas and that gasification plants would be located with respect to end users rather than at mine mouth locations, it is not practical at this time to select specific gasification plant sites for analyses. Consequently, a regionalized or state-level environmental assessment has been developed in the following section based upon the number of unit (gasification) plants located within each state and the coal mining requirements necessary to supply these plants when intrastate coal is available for use.

State-level environmental loadings associated with coal mining requirements, and the construction and operation of plants located within a state are estimated on the basis of algorithms presented in Appendix B.5. The relative importance of these loadings is established by comparison with projected (1990) state-level loadings (i.e., net residuals) for energy production, processing and end use as reported in runs of the Strategic Environmental Assessment System (SEAS). The SEAS is a macroeconomic simulation model which calculates pollutant loads based on economic growth and energy supply patterns. The national energy production and consumption levels used as inputs to the SEAS model were projected by the FOSSIL 2 model and reflect the energy initiatives incorporated in the Second National Energy Plan. The estimates of the aggregated regional loadings from the commercial U-Gas plants and those state-level loadings projected by the SEAS model are not precise enough to represent anything more than a framework for a general comparison and to put the comparison in the proper context. The cumulative loadings from the U-Gas plants should not be considered as increases over those estimated by the SEAS model. Since the energy being produced by the U-Gas plants is already being produced in some form and way in the SEAS model, the net increase or decrease cannot be estimated.

1.4.6.2 Cumulative environmental impactsAir quality

The U.S. Environmental Protection Agency (EPA) has promulgated Primary NAAQS (health-based) and Secondary NAAQS (welfare-based) for seven criteria air pollutants. Table 1.7 displays the present standards. Areas having air quality exceeding these levels are termed Nonattainment Areas (NA).

**Table 1.7. The National Ambient Air Quality Standards**

| Criteria air pollutants                | Time period       | Units             | Primary | Secondary |
|----------------------------------------|-------------------|-------------------|---------|-----------|
| Sulfur dioxide                         | 3 h <sup>a</sup>  | μg/m <sup>3</sup> |         | 1300      |
|                                        | 24 h <sup>a</sup> | μg/m <sup>3</sup> | 365     |           |
|                                        | Annual            | μg/m <sup>3</sup> | 80      |           |
| Nitrogen dioxide                       | Annual            | μg/m <sup>3</sup> | 100     | 100       |
| Total suspended particulates           | 24 h <sup>a</sup> | μg/m <sup>3</sup> | 260     | 150       |
|                                        | Annual            | μg/m <sup>3</sup> | 75      | 60        |
| Carbon monoxide <sup>b</sup>           | 1 h <sup>a</sup>  | mg/m <sup>3</sup> | 40      | 40        |
|                                        | 8 h <sup>a</sup>  | mg/m <sup>3</sup> | 10      | 10        |
| Lead                                   | 3-month average   | μg/m <sup>3</sup> | 1.5     | 1.5       |
| Hydrocarbons (nonmethane) <sup>c</sup> | 3 h <sup>a</sup>  | μg/m <sup>3</sup> | 160     | 160       |
| Ozone                                  | 1 h <sup>a</sup>  | ppm               | 0.12    | 0.12      |

<sup>a</sup>Levels not to be exceeded more than once per year; annual standards not to be exceeded.

<sup>b</sup>Change proposed for 1-h primary and secondary standards to 29 mg/m<sup>3</sup>.

<sup>c</sup>For use as a guide in devising plans to achieve the ozone standard.

Source: U.S. Environmental Protection Agency, *National Primary and Secondary Ambient Air Quality Standards*, 40 CFR 50.4 et seq., 1980.

A PSD area is one whose air quality is purer than that required by NAAQS or is unclassified. Significant deterioration is said to occur when the amount of new air pollution exceeds a fixed maximum allowable increase. The reference point for determining air quality deterioration is the baseline concentration, which is the ambient concentration existing at the time of the first PSD permit application submittal in the area. To date, only PSD increments for sulfur dioxide (SO<sub>2</sub>) and total suspended particulates (TSP) have been established. Increments are currently under investigation for the other five criteria air pollutants. Table 1.8 provides the current increments for SO<sub>2</sub> and TSP.

**Table 1.8. Prevention of significant air quality deterioration increments ( $\mu\text{g}/\text{m}^3$ )<sup>a</sup>**

|                                     | Class I | Class II | Class III |
|-------------------------------------|---------|----------|-----------|
| <b>Total suspended particulates</b> |         |          |           |
| Annual geometric means              | 5       | 19       | 37        |
| 24-h maximum                        | 10      | 37       | 75        |
| <b>Sulfur dioxide</b>               |         |          |           |
| Annual arithmetic mean              | 2       | 20       | 40        |
| 24-h maximum                        | 5       | 19       | 182       |
| 3-h maximum                         | 25      | 512      | 700       |

<sup>a</sup>The U.S. Environmental Protection Agency established an area classification scheme to be applied in all prevention of significant air quality deterioration (PSD) areas. The basic idea was to allow a moderate amount of industrial development but not enough to degrade air quality to the point that it barely complied with standards. In addition, states were allowed to designate certain areas where pristine air quality was especially desirable. All PSD areas were categorized as class I, class II, or class III. Class I areas are pristine areas subject to tightest control, class II are areas of moderate industrial growth, and class III are areas of major industrialization. Under EPA regulations, all areas were initially categorized as class II. States were authorized to reclassify specified areas as class I or III. There are 58 mandatory Federal class I areas that include major national preserves.

Source: U.S. Environmental Protection Agency, *Requirements for Preparation, Adoption, and Submittal of Implementation Plans*, 40 CFR 51.24, 1980.

States are required to develop State Implementation Plans (SIPs) to properly develop or implement air pollution control plans. One principal regulatory mechanism of a SIP is the New Source Review (NSR) process. NSR requires, among other things, that major emitting sources be examined by a reviewing authority to assure that they incorporate prescribed emission limitations (i.e., New Source Performance Standards (NSPS)). A major emitting source is one that has the potential to emit, after control, 100 tons per year for non-attainment areas or 100 or 250 tons per year (the amount depending on the source category) for PSD areas of any criteria air pollutant. There are 28 source categories (including steam generators) currently having a NSPS and affected by the 100 ton per year rule. All MBG plants considered here have two auxiliary steam generators which will be subject to NSPS review. The 1977 Amendments to the CAA directed EPA to accelerate the NSPS program, so that standards will be periodically issued for most major source categories (possibly synthetic fuel production plants). Since the majority of MBG plants will be located in urban areas, the NSR rules for NA areas will probably be invoked most often.

The emissions of the major criteria air pollutants from plant operation and coal mining have been estimated for the MBG scenario. It is not possible, however, to estimate the impacts that these emission levels may have on air quality for every plant and mine since predicting air quality requires knowledge of local meteorological conditions. In section 4.1.1, the air quality impacts of the proposed MLGW facility have been assessed for both construction and operation phases. The following provides the state level emission inventory and regulatory considerations for coal mining and plant operation. The emissions from plant construction activities are considered temporary by the U.S. Environmental Protection Agency and, therefore, not rigorously evaluated under PSD and NA preconstruction permit rules.

Table 1.9 provides, by state, the level of emissions expected from the steam boilers of one plant. As can be seen, the potential for the emissions from the steam boilers to exceed 100 tons per year exists for at least one criteria air pollutant in all states. This would require all states to invoke new source review of the steam boilers at all sites.

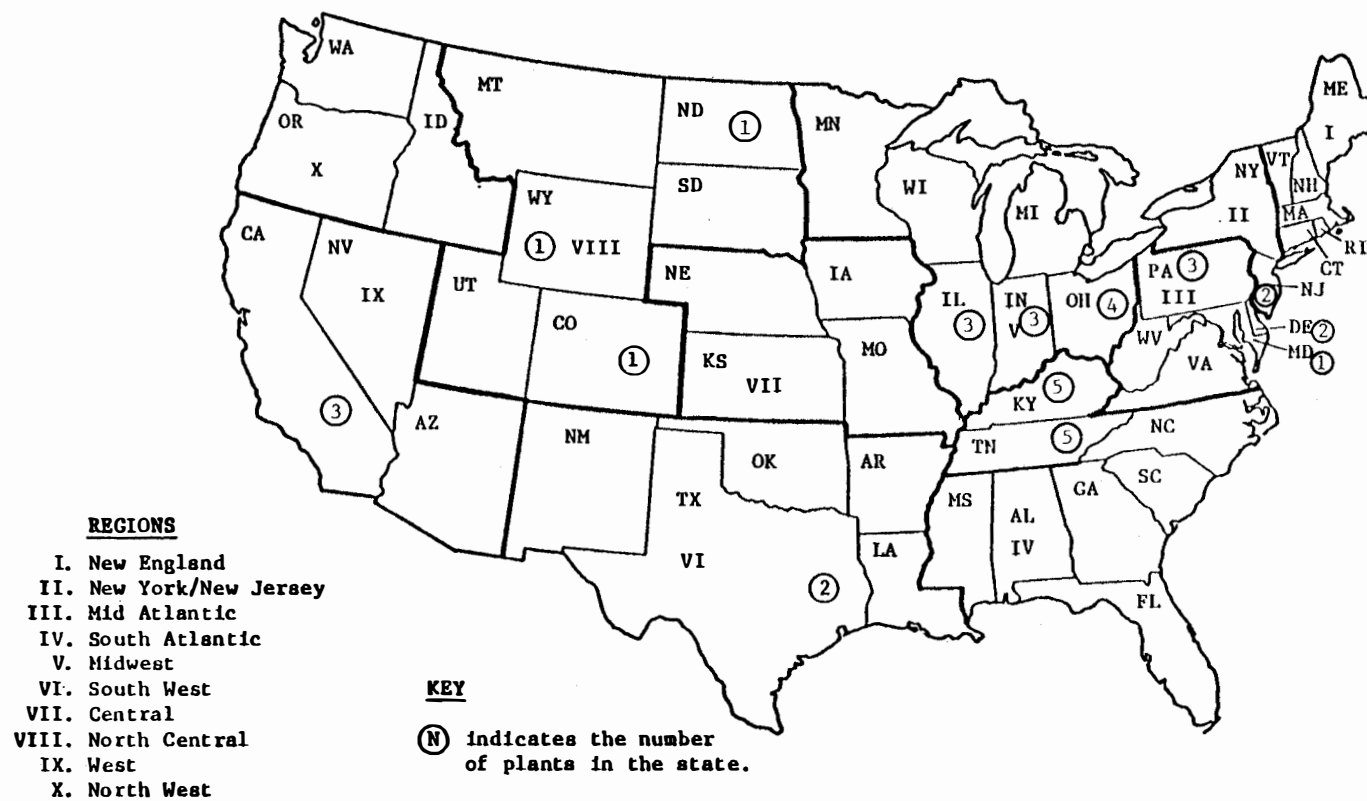


Fig. 1.1. Potential States for MBG Commercialization

Table 1.10 provides the projected emission inventory for plant operation and mining in 1992. Table 1.11 compares these emissions with those from the energy production, processing, and end use sectors in each state, and the total emissions in each state. In all states, the emissions from the MBG plants and the associated mining will be a minor component of the total emissions from industrial combustion. Nevertheless, plants sited in all states will be required to undergo NSR for NA and PSD permit rules because their air emissions for sulfur oxides and nitrogen oxides would exceed 250 tons per year.

**Table 1.9. Inventory of air pollutant emission from steam boilers, one plant**

| State        | (tons/year)        |              |                 |              |                 |
|--------------|--------------------|--------------|-----------------|--------------|-----------------|
|              | Particulate matter | Sulfuroxides | Nitrogen oxides | Hydrocarbons | Carbon monoxide |
| Pennsylvania | 52.2               | 245.9        | 1494.5          | 15.0         | 49.9            |
| Delaware     | 52.3               | 245.9        | 1494.5          | 15.0         | 49.9            |
| New Jersey   | 52.3               | 245.9        | 1494.5          | 15.0         | 49.9            |
| Maryland     | 47.5               | 242.4        | 1469.6          | 15.0         | 49.1            |
| Ohio         | 52.7               | 773.0        | 1564.6          | 15.8         | 52.3            |
| Indiana      | 48.7               | 630.8        | 1607.8          | 16.2         | 53.5            |
| Illinois     | 30.1               | 611.4        | 1508.4          | 15.0         | 50.3            |
| Kentucky     | 105.3              | 999.5        | 1856.8          | 18.6         | 61.8            |
| Tennessee    | 60.6               | 792.0        | 1563.4          | 15.8         | 52.3            |
| Texas        | 88.3               | 324.7        | 2845.3          | 28.5         | 95.0            |
| North Dakota | 62.6               | 333.0        | 1877.8          | 18.6         | 62.6            |
| Wyoming      | 53.9               | 179.8        | 1775.7          | 17.8         | 59.4            |
| Colorado     | 74.1               | 127.5        | 1675.5          | 16.6         | 55.8            |
| California   | 51.5               | 84.7         | 1675.1          | 16.6         | 55.8            |

#### Water availability

As presented in Chapter 2 of this environmental impact statement, the Memphis gasification facility will require 1,882 gallons per minute of make-up water. This is equivalent to about 860 gallons of water per ton of coal processed. Water requirements for other facilities will be dependent on the type and quantity of coal used. Part of the water content of the coal, for example, can be used to satisfy overall plant water requirements. For the purposes of this programmatic effort, however, all facilities are assumed to have the same overall water needs. Based on the anticipated coal requirements of the plants in this commercialization scenario, the Memphis facility falls at about the middle of the water requirements range. That is, the coal to be used in the Memphis plant is about in the middle of the range of water content of the regional coals.

In addition to the water needs of the gasification plants, substantial amounts of water are needed for coal mining. The principal categories that consume water in coal mining are dust control for roads, mines and embankments and revegetation of reclaimed areas. However, the mine location and the type of mine, surface or underground, would strongly influence the quantity of water consumed.

Water sprayed for dust control in the mine and on the road are based on rainfall and evaporation rates and are calculated based on area disturbed, evaporation rate, rainfall rate, and wetted area rate.

The derivation of water use requirements for U-gas facilities and associated coal mining are presented in Appendix B.5.

In order to provide some perspective on the impact of the water requirement values, Table 1.12 shows the combined water requirements of U-gas facilities postulated in this scenario and the

Table 1.10. Air pollutant emission inventory for 1992 from MBG commercialization

|              | Particulate matter |        |       | Sulfuroxides    |        |       | Nitrogen oxides |        |       | Carbon monoxide |        |       | Hydrocarbons    |        |       |
|--------------|--------------------|--------|-------|-----------------|--------|-------|-----------------|--------|-------|-----------------|--------|-------|-----------------|--------|-------|
|              | Plant operation    | Mining | Total | Plant operation | Mining | Total | Plant operation | Mining | Total | Plant operation | Mining | Total | Plant operation | Mining | Total |
| Pennsylvania | 314                | 3      | 317   | 1012            | 7      | 1019  | 5981            | 84     | 6065  | 60              | 51     | 111   | 60              | 9      | 69    |
| Delaware     | 78                 | 0      | 78    | 253             | 0      | 253   | 1495            | 0      | 1495  | 15              | 0      | 15    | 15              | 0      | 15    |
| New Jersey   | 78                 | 0      | 78    | 253             | 0      | 253   | 1495            | 0      | 1495  | 15              | 0      | 15    | 15              | 0      | 15    |
| Maryland     | 147                | 1      | 148   | 499             | 3      | 502   | 2941            | 28     | 2969  | 30              | 17     | 47    | 30              | 3      | 33    |
| Ohio         | 322                | 2      | 324   | 3120            | 5      | 3125  | 6262            | 59     | 6321  | 63              | 36     | 99    | 63              | 6      | 69    |
| Indiana      | 232                | 10     | 242   | 1918            | 9      | 1925  | 4926            | 127    | 4953  | 49              | 77     | 126   | 49              | 14     | 63    |
| Illinois     | 171                | 10     | 181   | 1856            | 9      | 1865  | 4528            | 119    | 4647  | 45              | 72     | 117   | 45              | 13     | 58    |
| Kentucky     | 689                | 10     | 699   | 6041            | 9      | 6050  | 9288            | 130    | 9418  | 93              | 79     | 172   | 93              | 15     | 108   |
| Tennessee    | 442                | 2      | 444   | 3996            | 5      | 4001  | 7821            | 74     | 7895  | 79              | 5      | 84    | 79              | 7      | 86    |
| Texas        | 278                | 19     | 295   | 878             | 5      | 881   | 5693            | 89     | 5782  | 57              | 46     | 103   | 57              | 8      | 63    |
| North Dakota | 95                 | 4      | 99    | 342             | 3      | 345   | 1679            | 40     | 1919  | 19              | 25     | 44    | 19              | 5      | 24    |
| Wyoming      | 88                 | 4      | 90    | 188             | 3      | 191   | 1777            | 39     | 1818  | 18              | 24     | 42    | 18              | 5      | 23    |
| Colorado     | 103                | 4      | 107   | 135             | 3      | 138   | 1676            | 38     | 1712  | 17              | 22     | 39    | 17              | 4      | 21    |
| California   | 242                | 0      | 242   | 278             | 0      | 278   | 5026            | 0      | 5026  | 50              | 0      | 50    | 50              | 0      | 50    |
| Utah         | 0                  | Minor  | Minor | 0               | Minor  | Minor | 0               | Minor  | Minor | 0               | Minor  | Minor | 0               | Minor  | Minor |



Table 1.11. Air emissions from MBG commercialization compared with energy sector and state total

|              | Particulate matter |                         |                 | Sulfur oxides |                         |                 | Nitrogen oxides |                         |                 | Carbon monoxide |                         |                 | Hydrocarbons |                         |                 |
|--------------|--------------------|-------------------------|-----------------|---------------|-------------------------|-----------------|-----------------|-------------------------|-----------------|-----------------|-------------------------|-----------------|--------------|-------------------------|-----------------|
|              | Emission           | State energy sector (%) | Total state (%) | Emissions     | State energy sector (%) | Total state (%) | Emissions       | State energy sector (%) | Total state (%) | Emissions       | State energy sector (%) | Total state (%) | Emissions    | State energy sector (%) | Total state (%) |
| Pennsylvania | 317                | 0.2                     | 0.1             | 1019          | 0.1                     | 0.1             | 8065            | 0.6                     | 0.6             | 111             | a                       | a               | 89           | a                       | a               |
| Delaware     | 76                 | 0.8                     | 0.5             | 253           | 0.5                     | 0.5             | 1495            | 2.6                     | 2.6             | 15              | a                       | a               | 15           | a                       | a               |
| New Jersey   | 76                 | 0.1                     | 0.1             | 253           | 0.1                     | 0.1             | 1495            | 0.4                     | 0.4             | 15              | a                       | a               | 15           | a                       | a               |
| Maryland     | 146                | 0.3                     | 0.2             | 502           | 0.2                     | 0.2             | 2969            | 1.2                     | 1.2             | 47              | a                       | a               | 33           | a                       | a               |
| Ohio         | 324                | 0.2                     | 0.1             | 3125          | 0.2                     | 0.2             | 6321            | 0.6                     | 0.6             | 99              | a                       | a               | 69           | a                       | a               |
| Indiana      | 242                | 0.2                     | 0.1             | 1925          | 0.2                     | 0.2             | 4953            | 0.6                     | 0.6             | 126             | a                       | a               | 63           | a                       | a               |
| Illinois     | 161                | 0.1                     | 0.1             | 1865          | 0.1                     | 0.1             | 4647            | 0.5                     | 0.5             | 117             | a                       | a               | 68           | a                       | a               |
| Kentucky     | 699                | 0.6                     | 0.2             | 5050          | 0.4                     | 0.4             | 9418            | 1.5                     | 1.5             | 172             | a                       | a               | 108          | a                       | a               |
| Tennessee    | 444                | 0.7                     | 0.2             | 4001          | 0.4                     | 0.4             | 7895            | 1.8                     | 1.8             | 84              | a                       | a               | 86           | a                       | a               |
| Texas        | 295                | 0.1                     | 0.1             | 681           | 0.1                     | 0.1             | 5782            | 0.3                     | 0.3             | 103             | a                       | a               | 63           | a                       | a               |
| North Dakota | 99                 | 0.2                     | 0.2             | 345           | 0.2                     | 0.2             | 1919            | 1.6                     | 1.6             | 44              | a                       | a               | 24           | a                       | a               |
| Wyoming      | 90                 | 0.2                     | 0.1             | 191           | 0.2                     | 0.2             | 1616            | 1.0                     | 1.0             | 42              | a                       | a               | 23           | a                       | a               |
| Colorado     | 107                | 0.2                     | 0.1             | 138           | 0.1                     | 0.1             | 1712            | 0.5                     | 0.5             | 39              | a                       | a               | 21           | a                       | a               |
| California   | 242                | 0.1                     | 0.1             | 276           | 0.1                     | 0.1             | 5206            | 0.4                     | 0.4             | 60              | a                       | a               | 50           | a                       | a               |
| Utah         | Minor              | a                       | a               | Minor         | a                       | a               | Minor           | a                       | a               | Minor           | a                       | a               | Minor        | a                       | a               |

\*No data available.

Table 1.12. Aggregate water requirements (acre-ft/year)

| State        | Water use    |             |        | 1990 State water use (%) |             |
|--------------|--------------|-------------|--------|--------------------------|-------------|
|              | U-gas plants | Coal mining | Total  | Energy sector            | Total state |
| California   | 8,233        | 0           | 8,233  | 2.6                      | 1.1         |
| Colorado     | 2,744        | 47          | 2,791  | 2.0                      | 1.3         |
| Wyoming      | 2,744        | 50          | 2,794  | 2.4                      | 2.2         |
| North Dakota | 2,744        | 66          | 2,810  | 7.2                      | 6.3         |
| Illinois     | 8,233        | 122         | 8,355  | 2.6                      | 0.1         |
| Indiana      | 8,233        | 130         | 8,363  | 3.6                      | 1.3         |
| Ohio         | 10,978       | 185         | 11,163 | 2.6                      | 0.1         |
| Kentucky     | 13,723       | 277         | 14,000 | 6.3                      | 4.0         |
| Tennessee    | 13,723       | 235         | 13,958 | 4.9                      | 2.5         |
| Texas        | 5,489        | 142         | 5,631  | 0.8                      | 0.5         |
| Pennsylvania | 8,233        | 265         | 8,498  | 2.6                      | 0.8         |
| New Jersey   | 5,489        | 0           | 5,489  | 5.5                      | 1.1         |
| Delaware     | 2,744        | 0           | 2,744  | 53.2                     | 5.0         |
| Maryland     | 5,489        | 87          | 5,576  | 13.3                     | 3.0         |
| Utah         | 0            | 100         | 100    | 0.14                     | 0.09        |

associated coal mining as a percentage of water use by the energy sector in 1990 for the affected states and as a percentage of total projected water use in these states. The energy sector is defined here to include all activities associated with the production, processing, and end use of energy.

With few exceptions, the percentage projections do not appear inordinately high. The obvious exceptions are Delaware and Maryland in the East and North Dakota in the West. The most notable factor for the eastern states is the broad discrepancy between the values given for energy sector water requirements and total state water requirements. Both Delaware and Maryland are small states with relatively stable patterns of growth and energy use. This stability and the limited availability of resources dictate limited growth in the energy sector over the forecast period. Note, for example, that there is no coal mining in Delaware. Thus, the facilities projected in this scenario represent a large share of the energy sector water requirements but show considerably less impact on the total state water use.

In the case of North Dakota, the percentage values shown are relatively high for both energy sector and total state water use. This is because North Dakota, though a large state in area, is sparsely populated with minimal industrial development. Therefore, any new major water requirement, such as that for a U-gas facility, will represent a relatively large percentage increase in both water use categories.

Relatively large increases in water use by the energy sector in other states, such as Kentucky and Tennessee, are due primarily to the large number of facilities, five in each state, postulated in the scenario. The percentage increase in total state water use in these states, however, would not appear to be sufficiently high to restrict projected growth.

Most water resources regions now have, or are projected to have, problems supplying surface water for all desired uses.<sup>20</sup> In general, instream flows are considered inadequate in the southwest, the lower Colorado, and much of the High Plains Region extending from Texas to Nebraska. Competing offstream uses and increased recognition of the importance of instream values will result in water shortages in many portions of the nation.

Ground water overdraft is a severe problem in central California, south central Arizona, the Texas Gulf Coast, the lower Mississippi, the eastern portions of Wisconsin and Illinois, the east coast of North Carolina, and the High Plains Region. Among the problems associated with ground water overdraft is that continuation of current trends will result in a sharp decline in the availability of groundwater for use in agricultural irrigation. This decline is directly related to the increased energy costs associated with pumping.

At the same time, however, a study team of the Los Alamos Scientific Laboratory reported that "...computer energy/environment model analyses suggest that possible problems of water availability in the West should not impede the energy industry..."<sup>21</sup> They claim that by using water-conserving technology and buying agricultural water rights, water shortages could be avoided.

It is not possible, at the programmatic level of analysis, to predict the ability of specific water systems to satisfy the requirements of synthetic fuels development. Such determinations must be made on the basis of site-specific considerations. It is safe to say, however, that neither the gasification facilities postulated nor any other synthetic fuel facilities will be constructed if sufficient water supplies are not available.

Two final considerations are worthy of note regarding water availability. It is possible that design changes could be made as appropriate for specific regional siting, to allow more water recirculation. This would reduce both the overall facility water requirement and the ultimate amount of plant effluents.

Secondly, it must be kept in mind that the 36 medium-Btu gasification facilities postulated in this report represent only a small part of the anticipated synthetic fuels industry in 1992 and beyond. Careful planning and consideration of water availability issues are required to establish long-term goals and priorities that are both reasonable and attainable in terms of energy production and competition with other water users.

#### Water quality

The components of the liquid effluents from the Memphis gasification facility are presented in Chapter 2 of this report and the anticipated impacts from both construction and operation of the plant are discussed in Chapter 4. As noted in the Impacts section, several of the effluent components are of particular concern because their levels exceed current water quality criteria. This problem could worsen should water quality standards become more stringent in the future.

In the case of the Memphis plant, some of the components are of concern because the ambient levels of these components in the receiving waters of the Mississippi River also exceed current criteria. This will result in an increase in both the area and time required for dispersion and dilution of component concentrations to acceptable levels.

This condition should not exist in receiving waters for most of the plants postulated in this chapter. The Mississippi and Ohio River basins are affected by an uncharacteristically high level of industrial development, and their waters are not representative of national water quality.

As is the case with most pollutant streams, the environmental impacts of the liquid effluents from medium-Btu gasification facilities will be highly site-specific. A major factor is the size and flow rate of the receiving waters which affects the capacity of the waters to disperse or dilute the pollutant streams. As noted above, ambient water quality is also an important factor.

Acid mine drainage from the mining activity to support medium-Btu gasification facilities should not degrade water quality since effective control measures are now almost universally employed by the coal industry. The most severe problems associated with acid drainage are the result of past mining practices in Northern Appalachia.

Over the past decade, primarily in response to Federal and state legislation, the quality of surface water in the United States has shown signs of improvement. However, river basins in almost the entire eastern half of the country, and in much of the sparsely populated western area, are still affected by industrial waste discharges. If the surface water quality is to continue to improve, discharges from synthetic fuels and other industrial developments must be kept to an absolute minimum.

One impact of improving surface water quality has been the gradual deterioration of groundwater supplies. This has resulted from greatly increased disposal of solid and liquid wastes in surface containments which allow waste constituents to leach into groundwater supplies. Because the exact nature of gasification wastes from the various medium-Btu processes are not yet known, particular care must be taken in their disposal.

All facilities that discharge into surface water will require National Pollutant Discharge Elimination System (NPDES) permits prior to operation. It can be assumed, then, that facilities granted these permits will be able to demonstrate compliance with applicable Federal standards. Depending on the specific site, similar or more stringent permit requirements may be necessary for certification by states. In addition to being required to meet current Federal and state

standards in order to operate, it should also be noted that during the timeframe under consideration in this statement, that is from 1980 to 1992, control equipment development should continue so that plants could be altered to achieve lower or zero discharge levels.

One of the primary problems in predicting water quality impacts is that the impacts of individual effluent components are not yet fully understood. This problem is greatly aggravated at the programmatic level of consideration because of the chemical variation in the effluent receiving media and differences in coal feed characteristics.

Continuing research and development efforts are being conducted by both the Department of Energy and the Environmental Protection Agency to: (1) improve waste stream characterization from synthetic fuels facilities; (2) increase understanding of the potential environmental effects of individual waste stream components; (3) increase understanding of the synergistic relationships between these components; and (4) develop improved methods of controlling the amounts of liquid effluents and specific components of liquid effluents.

One significant outgrowth of these efforts is the increasing interest in designing conversion facilities with essentially zero liquid discharge. This can be achieved theoretically by improving the recycle capabilities of plant water systems. By conducting a periodic purge of the water system to prevent contaminant buildup, potentially harmful wastes can be removed in a more easily managed solid form. Such systems could also prove extremely valuable in areas with poor or questionable water availability.

In the commercialization scenario developed in this report, the gasification facilities in five states (Tennessee, Kentucky, Illinois, Indiana, and Ohio) would release effluents into receiving waters that ultimately join the Mississippi River. Though each of the eighteen plants in these states may meet applicable standards at the time of construction, their combined effluents could well produce effects downstream that have not yet been foreseen.

The potential for bioaccumulation in aquatic organisms and the effects of this accumulation on reproductive and migration behavior, for example, can not be predicted at the present time, particularly taking into account the expected twenty to thirty year life of the facilities.

#### Land disturbed

Land will be disturbed as a result of three major activities associated with the medium-Btu coal gasification commercial projects. These include the preparation of plant sites, the surface mining of coal, and, in some cases, the construction of transportation corridors. The greatest disturbance will be created by surface mining shown in Table 1.13. Over 1,500 acres per year will be disturbed resulting in a 20 year plant life disturbance of approximately 31,000 total acres. There will be considerable variation between states, however, depending on the number of plants sited, the amount of coal required, and the seam thickness of coal beds. These estimates were derived using the algorithms developed in Appendix B.5.

**Table 1.13. Land disturbed**

| State        | State surface mining<br>total (1976) [ha (acres)] | Mining for U-gas plants |                         |
|--------------|---------------------------------------------------|-------------------------|-------------------------|
|              |                                                   | [ha (acres)/year]       | Statesurface mining (%) |
| California   |                                                   |                         |                         |
| Colorado     | 177 (437)                                         | 27 (67)                 | 15.3                    |
| Delaware     |                                                   |                         |                         |
| Illinois     | 1142 (2821)                                       | 80 (198)                | 7.0                     |
| Indiana      | 1050 (2593)                                       | 86 (212)                | 8.2                     |
| Kentucky     | 1610 (3977)                                       | 80 (198)                | 5.0                     |
| Maryland     | 95 (234)                                          | 28 (68)                 | 29.1                    |
| New Jersey   |                                                   |                         |                         |
| North Dakota | 256 (633)                                         | 24 (60)                 | 9.5                     |
| Ohio         | 931 (2300)                                        | 58 (144)                | 6.3                     |
| Pennsylvania | 1547 (3822)                                       | 83 (206)                | 5.4                     |
| Tennessee    | 173 (428)                                         | 63 (155)                | 36.2                    |
| Texas        | 404 (998)                                         | 92 (228)                | 22.8                    |
| Wyoming      | 270 (667)                                         | 9 (22)                  | 3.3                     |
| Total        |                                                   | 630 (1558)              |                         |

One way to provide an indication of the relative impact of land disturbed is to relate the acres disturbed by the project to a common base. In this case, the project related acres disturbed per year have been compared to the total acres disturbed by all surface mining in each state. This base has been calculated from 1976 surface mine productivity data<sup>22</sup> using average seam thicknesses for each state. This provides an index for comparing project related land disturbed to existing mining activity as shown in Table 1.13. The higher the index, the more land disturbed by the project compared to existing land disturbed. For example, Maryland reflects a relatively high index of 29.1 even though land disturbed from mining is expected to remain relatively low at 68 acres per year. Tennessee is the only state with a higher index (36.2) than Maryland. Texas ranks third in terms of the relative index, but ranks first in terms of the number of acres (228) disturbed per year by U-Gas related surface mining. This relationship is more pronounced in Pennsylvania and Kentucky where relative indexes are low while project related acres disturbed per year exceed 200 in each state.

Although surface mining creates the greatest land disturbance, the acreage shown in Table 1.13 will not all be disturbed at the same time. Typical surface mining operations involve simultaneous activities of surface clearing, top soil removal, coal removal, backfilling and revegetation. As a result, the amount of land being disturbed at any one time will be considerably less than the total acres indicated.

The amount of time it will take to restore disturbed land to a usable state will vary from region to region. In the Northern Appalachian Region, for example, natural succession and recovery of hardwood vegetation could take 100 years.<sup>16</sup> Natural hardwood disturbed in the Eastern Interior Region would require 150 to 200 years to reestablish.

Vegetation recovery of mined lands in the Western Interior is hampered by drought and toxicity.<sup>16</sup> After 22 years, a regrowth forest of sycamore, red cedar and pines would reach a height of 50 feet. Soil not affected by acidity could be expected to produce a harvestable pine forest in 100 years and a natural oak-hickory forest in 200 years.

Recovery of strip-mined lands in Texas would take less than 15 years for natural grasses and agricultural land, but about 100 years for natural forest.<sup>16</sup> Land in western areas such as Powder River and Fort Union would be more difficult to recover. However, planting, fertilizing and supplementary water could result in the reestablishment of some grasses in a few years with constant care.<sup>16</sup> Vegetation and restoration in the Green River Region would be hampered by low rainfall, harsh topography, and short growing season. The range would have to be planted and mulched in order to return the range to useful grazing in a few years.

#### Solid waste

The principal sources of solid waste associated with coal gasification are mining wastes, gasifiers and auxiliary boiler ash, and secondary wastes (i.e., sludges) from pollution control equipment. Solid waste from underground coal mining is estimated at approximately three percent of the coal extracted.<sup>23</sup> Solid wastes which are generated from surface mining are returned to the mining site and, thus, do not constitute a disposal problem.<sup>24</sup> Gasifier and boiler ash loadings and estimates of sludge generation are based upon the loading factors (algorithms) presented in Appendix B.5. Loadings for mining and plant wastes by state are presented in Table 1.14. For purposes of comparison, projected state solid waste loadings are also presented in this table. State-level loadings are derived from SEAS data discussed in Section 1.4.6.1.

Inspection of Table 1.14 shows that total solid waste from medium-Btu coal gasification would result in a 0.2 to 15.2 percent increase in estimated solid waste generation on a state basis. This increase could be problematic in areas or states where disposal capacity is limited. Coal gasification wastes are under review, but are not currently classified as hazardous under the Resource Conservation and Recovery Act (RCRA) regulations and, thus, are not subject to stringently regulated disposal practices. However, these wastes can contain trace elements and potentially toxic metals which pose a water quality hazard if improper disposal occurs.<sup>24</sup>

Disposal of these wastes in sanitary landfills would cost \$12 per ton, based upon estimates for new utilities,<sup>24</sup> and this cost would be a factor in determining whether coal gasification is economically viable.

Table 1.14. Solid waste generation by state (10<sup>6</sup> tons/year)

| State        | Coal mining waste <sup>a</sup> | Gasifier and boiler ash <sup>a</sup><br>(dry weight) | Sludges <sup>a</sup><br>(dry weight) | Total gasification wastes | Total solid wastes (1990) <sup>b</sup><br>(dry weight) | State solid waste due to gasification (%) |
|--------------|--------------------------------|------------------------------------------------------|--------------------------------------|---------------------------|--------------------------------------------------------|-------------------------------------------|
| California   |                                | 0.20                                                 | 0.07                                 | 0.27                      | 6.14                                                   | 4.4                                       |
| Colorado     |                                | 0.15                                                 | 0.02                                 | 0.17                      | 86.3                                                   | 0.2                                       |
| Delaware     |                                | 0.09                                                 | 0.02                                 | 0.11                      | 0.86                                                   | 12.8                                      |
| Illinois     | 0.02                           | 0.17                                                 | 0.07                                 | 0.26                      | 11.36                                                  | 2.3                                       |
| Indiana      | 0.02                           | 0.28                                                 | 0.07                                 | 0.37                      | 13.84                                                  | 2.7                                       |
| Kentucky     | 0.09                           | 1.01                                                 | 0.11                                 | 1.21                      | 11.62                                                  | 10.4                                      |
| Maryland     | 0.03                           | 0.18                                                 | 0.04                                 | 0.25                      | 3.02                                                   | 8.3                                       |
| New Jersey   |                                | 0.20                                                 | 0.04                                 | 0.24                      | 2.03                                                   | 11.8                                      |
| North Dakota |                                | 0.13                                                 | 0.02                                 | 0.15                      | 1.37                                                   | 10.9                                      |
| Ohio         | 0.06                           | 0.42                                                 | 0.09                                 | 0.57                      | 14.35                                                  | 10.2                                      |
| Pennsylvania | 0.09                           | 0.32                                                 | 0.07                                 | 0.48                      | 13.45                                                  | 3.6                                       |
| Tennessee    | 0.08                           | 0.62                                                 | 0.11                                 | 0.81                      | 5.31                                                   | 15.2                                      |
| Texas        |                                | 0.35                                                 | 0.04                                 | 0.39                      | 21.64                                                  | 1.8                                       |
| Utah         | 0.08                           |                                                      |                                      | 0.08                      | 2.18                                                   | 3.7                                       |
| Wyoming      |                                | 0.10                                                 | 0.02                                 | 0.12                      | 2.04                                                   | 5.9                                       |

<sup>a</sup>Wastes associated with medium-Btu coal gasification.<sup>b</sup>State total for all solid wastes as projected by Strategic Environmental Assessment System model.

### Socioeconomic

Socioeconomic impact is determined to a large extent by the size of the project population and its relationship to existing community facilities and services. In general, metropolitan areas can accommodate larger population increases than rural areas and still experience less impact. While the exact size of communities near U-Gas facilities will depend upon the siting of individual plants, the need for multiple users requires that they be located in close proximity to relatively large urban areas. It is assumed, therefore, that community characteristics for all U-Gas projects will be similar to those described for the Memphis site. Based on that assumption, values for such parameters as migration rates, family size, and employment multipliers were also assumed to be the same in calculating employment and population data in this section. The potential for variation from these basic assumptions is discussed for western areas, however.

### Employment

Direct and indirect employment for construction, operation, and mining are presented in Table 1.15. These data have been derived using the following assumptions:

- o Each plant will require a peak construction force of 700 workers.
- o Each plant will require 270 operational workers.
- o Direct miners have been calculated using state productivity data<sup>22</sup> where:  

$$\text{number of miners} = \frac{\text{Tons of coal consumed per day}}{\text{average tons mined per day per man}}$$
- o Each plant will require 140 contract service employees.
- o All indirect employment is based on the same direct/indirect ratios used for the Memphis site.
- o All indirect and contract service employment will be supplied from local metropolitan labor sources.

It is important to emphasize that these data must be integrated in the context of time and space. In the case of direct construction workers, for example, the largest peak reaches 3,500 in Kentucky and Tennessee. This would only occur, however, if all five plants in each state are constructed at the same time. In the ideal situation the plants would be built in series with construction on each new plant beginning every two years. In this situation, the peak workforce would only reach approximately one-third the 3,500 level at any one time. On the other hand, all plants will be operating at the same time once they have been completed. This results in the total operational force reaching 1,350 in Kentucky and Tennessee. It is likely, however, that plants will be dispersed throughout the state so that any one community may only be impacted by one operational workforce.

One of the major concerns related to construction employment is the availability of skilled labor. In the East, a potential shortage could develop in an area if all plants are constructed at the same time. This is particularly true in areas where contiguous states have multiple plants sited. In Kentucky and Tennessee, for example, the construction of ten plants simultaneously could place a strain on the skilled labor force. On the other hand, if construction schedules are spaced as in the ideal situation discussed earlier and plants are dispersed throughout the area, the demand for labor would be reduced considerably. In this latter case, the peak demand at any one time would probably be comparable to building a large fossil-fired power plant. The magnitude of impact will therefore depend on the siting and timing of plant construction. This also applies to some extent to design engineers and operational employees. An adequate supply should be available if plants are dispersed among labor markets of several large metropolitan areas. Also, any potential shortages could be overcome if plants are constructed in series thereby providing sufficient lead time to initiate training program to overcome any shortages of required skills that may occur.

In the West, construction and operation employment becomes more of a location problem than one of total availability. In Wyoming, for example, the relatively small industrial base may necessitate importing a larger proportion of skilled labor from larger metropolitan areas of other states.

Table 1.15. Project-related employment

|              | Construction |          |       | Operation |          |         |       | Mining |          |       |
|--------------|--------------|----------|-------|-----------|----------|---------|-------|--------|----------|-------|
|              | Direct       | Indirect | Total | Direct    | Indirect | Service | Total | Direct | Indirect | Total |
| California   | 2100         | 1725     | 3825  | 810       | 1200     | 420     | 2430  |        |          |       |
| Colorado     | 700          | 575      | 1275  | 270       | 400      | 140     | 810   | 111    | 155      | 266   |
| Delaware     | 700          | 575      | 1275  | 270       | 400      | 140     | 810   |        |          |       |
| Illinois     | 2100         | 1725     | 3825  | 810       | 1200     | 420     | 2430  | 466    | 652      | 1118  |
| Indiana      | 2100         | 1725     | 3825  | 810       | 1200     | 420     | 2430  | 298    | 417      | 715   |
| Kentucky     | 3500         | 2875     | 6375  | 1350      | 2000     | 700     | 4050  | 959    | 1343     | 2302  |
| Maryland     | 1400         | 1150     | 2550  | 540       | 800      | 280     | 1620  | 315    | 441      | 756   |
| New Jersey   | 1400         | 1150     | 2550  | 540       | 800      | 280     | 1620  |        |          |       |
| North Dakota | 700          | 575      | 1275  | 270       | 400      | 140     | 810   | 34     | 48       | 82    |
| Ohio         | 2800         | 2300     | 5100  | 1080      | 1600     | 560     | 3240  | 746    | 1044     | 1790  |
| Pennsylvania | 2100         | 1725     | 3825  | 810       | 1200     | 420     | 2430  | 1389   | 1945     | 3334  |
| Tennessee    | 3500         | 2875     | 6375  | 1350      | 2000     | 700     | 4050  | 1349   | 1889     | 3238  |
| Texas        | 1400         | 1150     | 2550  | 540       | 800      | 280     | 1620  | 134    | 188      | 322   |
| Wyoming      | 700          | 575      | 1275  | 270       | 400      | 140     | 810   | 59     | 83       | 142   |
| Utah         |              |          |       |           |          |         |       | 603    | 844      | 1447  |



Mining manpower must also be considered. Demand for miners will be highest in Pennsylvania at 1,390 followed by Tennessee at 1,350. While this is a similar demand in terms of total miners, the incremental increase is quite different. Specifically, the 1,390 figure for Pennsylvania represents approximately 4.3 percent of the average number of miners working daily in that state in 1976.<sup>22</sup> In Tennessee, the comparable percentage is about 28.1 percent. A situation similar to that in Tennessee also exists in Utah where the demand for only 600 miners amounts to approximately 23.1 percent of the 1976 mining workforce. In no case, however, should the project related demand for miners place a severe strain on the total mining industry manpower supply.

All indirect and service contract employees are expected to be supplied by the local metropolitan labor pools.

#### Population

Project related population in relationship to community facilities and services is generally indicative of a wide range of socioeconomic impacts. Population data related to construction, operation, and mining are therefore presented in Table 1.16. They have been derived using the following assumptions:

- o The ratio of nonmanual workers to total construction force was assumed to be the same for all plants as that used for the Memphis workforce.
- o All construction manual labor was assumed to be supplied by the local metropolitan labor force.
- o Construction nonmanual and operation migration factors were assumed to be the same as the Memphis case.
- o Seventy-five percent of all workers were assumed to be married with a family size of 3.2.
- o All demand for miners in the East was assumed to be met by the local metropolitan labor force.

It is impossible to quantify the magnitude of socioeconomic impact of these data without knowing the baseline characteristics of community facilities and services. It is possible, however, to identify relative indicators of impact by comparing project related population to a common base. In this case, project related population has been compared to the 1990 metropolitan population of each state. This was derived by applying the 1977 metropolitan percentage to the official U.S. Census Bureau population projections for 1990.<sup>25,26</sup> These percentages are shown in Table 1.16.

It is important to emphasize that those data are not a measure of socioeconomic impacts. First, the baseline population to be impacted would only be one metropolitan area with a population size considerably smaller than the state total in most cases. Also, project population has been summed for construction, operation, and mining when, in fact, they would be occurring at different times and places. The summation, however, yields numbers of sufficient size to more meaningfully compare relative values.

The data reveal that the only states in the East exceeding 0.1 percent are Delaware, Kentucky and Tennessee. In the case of Delaware, the figure is primarily a function of the lower population base. In Kentucky and Tennessee, however, the 0.2 percent is probably more reflective of the five plants that have been sited in each state. In the West, North Dakota and Wyoming reflect values of 0.7 and 0.8, respectively, although only one plant appears in each state. Population in Utah is a result of mining activity only.

The significance of these data have regional implications in terms of socioeconomic impact. In the East, project related population increases should only represent a small increment of baseline population since the U-Gas plants are expected to locate in Standard Metropolitan Statistical Areas. This will generally assure an adequate supply of such things as housing, medical facilities, public safety and utilities. Socioeconomic impact should be minimal. In the West, however, there are fewer metropolitan areas available for siting and urban centers are relatively smaller than those in the East. In Wyoming for example, the combined 1979 population for Casper, Cheyenne and Laramie was only about 103,500. This may be significant for two reasons. First, an urban area of that size in the West may not have a construction labor force large enough to support a large project. This results in a higher immigration rate of workers

and their families. Second, the community has fewer community facilities and services to accommodate this large influx of population. While the extent of socioeconomic impact will depend upon the specific siting of individual plants and the characteristic of related urban centers, these comparative data suggest that socioeconomics may be an important consideration in the impact analyses of U-Gas facilities in western areas.

**Table 1.16. Project-related population**

|              | Construction | Operation | Mining | Total | State metropolitan<br>population (1990)<br>( $\times 10^3$ ) | Project<br>percentage of<br>state |
|--------------|--------------|-----------|--------|-------|--------------------------------------------------------------|-----------------------------------|
| California   | 2,505        | 601       |        | 3,106 | 23,278                                                       | 0.1                               |
| Colorado     | 834          | 201       | 294    | 1,329 | 2,748                                                        | 0.1                               |
| Delaware     | 834          | 201       |        | 1,035 | 446                                                          | 0.2                               |
| Illinois     | 2,505        | 601       |        | 3,106 | 9,484                                                        | 0.1                               |
| Kentucky     | 4,173        | 601       |        | 3,106 | 3,793                                                        | 0.1                               |
| Maryland     | 1,671        | 1,003     |        | 5,176 | 1,793                                                        | 0.3                               |
| New Jersey   | 1,671        | 400       |        | 2,071 | 4,179                                                        | 0.1                               |
| North Dakota | 834          | 400       | 91     | 2,071 | 7,377                                                        | 0.1                               |
| Ohio         | 3,339        | 201       |        | 1,126 | 158                                                          | 0.7                               |
| Pennsylvania | 2,505        | 801       |        | 4,140 | 8,768                                                        | 0.1                               |
| Tennessee    | 4,173        | 601       |        | 3,106 | 9,802                                                        | 0.1                               |
| Texas        | 1,673        | 1,003     |        | 5,176 | 3,034                                                        | 0.2                               |
| Wyoming      | 834          | 201       | 156    | 1,191 | 147                                                          | 0.8                               |
| Utah         |              |           | 1,597  | 1,597 | 1,236                                                        | 0.1                               |

#### Occupational safety and health

##### Physical hazards

The most common causes of injuries occurring in virtually all industrial workplaces are falling from heights, slipping on wet floors, being struck by falling objects, and accidental contact with machinery. In many instances, these injuries result from human carelessness, malfunctioning equipment, or poor design. Other potential physical hazards to the well-being of workers in a coal conversion or combustion plant which should be readily controllable or preventable include excessive noise and heat and improper lighting. Control or prevention of these problems must be considered during plant design and modification. The levels of noise, heat, and illumination may vary on a plant-specific basis depending on utilized engineering techniques, and would have to be ascertained for each plant. The degree of danger is not expected to be any more significant for medium-Btu gasification facilities than for other production and manufacturing facilities.

##### Dust hazards

Coal dust in the medium-Btu gasification facility would need to be controlled. Lung damage has been observed in coal miners suffering advanced states of coal workers pneumoconiosis, initiated by an accumulation of coal dust in the lungs and the resultant lung tissue reactions. The most likely location that may present a problem would be the coal crushing and grinding facility, although any unloading or transfer point may be a source of exposure. If this operation is automated and individual workers are not exposed, no health hazard should exist.

Other types of dust exposures that may be considered potential hazards include filter pre-coal materials (e.g., asbestos, diatomaceous earth) and insulation materials (e.g., fibrous glass and mineral wool). The principal consequence of inhalation of the particulate forms (0.5 to 5.0  $\mu$ ) of these materials is pulmonary fibrosis. The level of exposure encountered in individual facilities will determine the extent of the hazard and, if necessary, properly fitted respiratory protectors can be used to reduce worker exposure on an interim basis when engineering controls are not effective.

### Chemical hazards

The assessment of fugitive emissions from commercial-scale, medium-Btu coal gasification facilities must be inferred from emissions of related industries, since little published information exists and no commercial-scale plant has been built. Related industries in the United States which involve thermal and catalytic processing of fossil fuels (e.g., the petrochemical processing and utilization industry) are known to generate in-products and emissions containing substances that are potentially hazardous to human health.

Since gasification reactors are operated in a temperature range comparable to the range utilized in conventional carbonization processes, many of the carcinogenic compounds (e.g., polycyclic aromatic hydrocarbons, aza-heterocyclic compounds) known to form during carbonization of coal are likely to form during coal gasification as well. The application of steam, pressure, and oxygen may affect the rate of compound production or the concentration of the compounds in the process streams, but would not be expected to prevent the production of these compounds.

### Transportation

As discussed in Section 1.4.4.5, the primary means of coal transport are rail and barge. In addition, for distances of up to 50 to 75 miles, truck transport is an option and for distances of several hundred miles or more, coal-slurry pipelines may be considered.<sup>27</sup> Impacts associated with coal transport by these modes include: transportation system capacity impact, energy consumption, air pollution, noise pollution, right-of-way acquisition, and safety.

Based upon the assumption that the average daily coal input to a unit plant would be 2,850 tons, the daily coal input for the 36 plants in the commercialization scenario would be 102,660 tons per day. In terms of transportation system requirements, moving this amount of coal would require use of 1,026 rail cars at 100 tons per car, or 69 barge loads at 1,500 tons per barge. In terms of truck transport, 102,660 tons of coal would be equivalent to 5,130 loads at 20 tons per load. The above figures represent approximately four percent of present rail car capacity when calculated on an annual capacity basis of 840 million tons or 2 percent of barges currently estimated to be handling coal.<sup>16</sup> The size of the coal truck fleet is not currently known and, thus, comparable percentages for truck transport cannot be calculated.

Energy consumption and air pollution impacts related to transportation would be dependent upon the transportation mode used and the distance traveled. These data are not included in the commercialization scenario and, thus, impacts cannot be calculated. Noise pollution impacts would depend upon the transportation mode utilized and the proximity of sensitive receptors. Since most gasification plants would be located in or adjacent to industrial areas, these impacts are not anticipated to be a major concern. The issue of safety is mode dependent and a function of the distances traveled.

### 1.4.7 Alternatives

Since the proposed action is the Federal government's assistance in the development and commercialization of the U-Gas medium-Btu process, alternatives to the proposed action should be discussed from two viewpoints. First, those alternatives should be considered that examine actions that would take the place of the MBG program in DOE and national policy programs. Second, those alternatives to the choice of the U-Gas process as one for subsequent commercialization should be examined. Both examinations assume that national energy policy, as it has evolved thus far, will continue in the same general course emphasizing increased coal use, reduced oil use, and development of synthetic fuels.

#### 1.4.7.1 Alternatives to the MBG program

In a recent policy document,<sup>27</sup> the Fossil Energy branch of the Department of Energy set forth three primary goals relevant to the proposed action. These goals were summarized as follows:

- o Increase national security.
- o Maintain an acceptable environment
- o Accomplish the above goals at acceptable economic and social costs.

In order to achieve these objectives, it is essential that the United States develop additional energy resources, including development of technologies to utilize coal, our most abundant resource, cleanly and efficiently. The specific rationale for the government's role in MBG

development is discussed in Sections 1.2 and 1.3 of this document.

The products of MBG processes can be used in four distinct markets, all of which are important in meeting the U.S. energy policy objectives.

- o Direct use for electricity generation in both combined-cycle applications and for combustion turbines.
- o Direct use as an industrial fuel gas.
- o As a synthesis gas for conversion to ammonia, methanol, acetic acid, ethanol, and ethylene glycol.
- o As a synthesis gas for indirect liquefaction and as a source of hydrogen for direct liquefaction.

One alternative to the present program would be for the government to take "no action." If the Department of Energy were to adopt the "no action" alternative, the objectives of the MBG program would either not be met or would have to be met by private industry. Although the economics seem to favor long-term industrial demand for MBG, the risks in the form of capital costs may preclude, or at least delay, private industrial venture. It is impossible to accurately predict the economic and environmental consequences of such delays. One possible result could be the increased use of direct combustion of coal to meet energy requirements.

Another outgrowth of the "no action" alternative would be a direct result of the U.S. economic and private industry structure. Data developed during research and development activities, as well as technological breakthroughs, are often considered proprietary by private industry. This tendency could result in an unavailability of data developed under private funding so that technology transfer might not occur as effectively as it might under Federal involvement.

Because of the multifaceted nature of the program, DOE has not identified an alternative that could meet all the program objectives. However, there are certain energy alternatives that might fulfill some program objectives. With respect to use of the medium-Btu product as industrial fuel gas or for upgrading to pipeline gas, underground coal gasification might serve as an alternative in certain areas. Enhanced unconventional gas recovery also serves as a potential alternative for production of pipeline quality gas. Regarding use of the MBG product for chemical production or indirect liquefaction, several liquid supply options could serve as alternatives, including increased domestic production, enhanced oil recovery, direct coal liquefaction, oil shale, and biomass. With respect to direct use for electricity generation, increased direct coal utilization is an alternative.

A description of the technologies included under each of these alternatives and an estimate of the potential contribution of these alternative to the nation's near-term (1985, 1990) and mid-term (2000) energy supply have been presented in Section 1.2.2. The environmental concerns associated with each alternative are noted as follows.

#### Underground coal gasification

Underground coal gasification offers a number of significant potential advantages, but some of these advantages have not yet been proved. DOE's in-situ gasification program is designed to show that, in addition to tripling our recoverable coal reserves, underground coal gasification minimizes health and safety problems associated with conventional coal extraction techniques since no mining is required. Furthermore, there is less surface disruption than with strip mining, less solid waste is brought to the surface, water consumption and atmospheric pollution are lowered, and capital investment and gas costs are reduced by at least 25 percent. The primary disadvantages of underground coal gasification are possible contamination of surface water and underground aquifers and subsidence of the surface.

#### Enhanced unconventional gas recovery

Enhanced unconventional gas recovery entails application of various drilling and stimulation techniques to eastern gas shale deposits, western tight sands deposits, and coal seams and geopressured aquifers. There are two major technologies for freeing gas trapped in shale

deposits: explosive fracturing and hydraulic fracturing. Explosive fracturing consists of detonating gelled nitroglycerine or some other chemical explosive in the well with or without a proppant-laden fluid to open or extend gas producing fractures. Hydraulic fracturing consists of pumping large quantities of water, foam or some other liquid into a natural gas well with a material to serve as proppant, usually sand, to hold fractures open allowing trapped gas to escape. Massive hydraulic fracturing is also the principal stimulation technique used in western tight sands formations.

In shale deposits, several thousand gallons of water would be required for each fracture. Since it is unlikely that wells would be drilled in highly urbanized areas, municipal water supplies could not be used; the most likely supplies would be nearby streams or groundwater sources. Although rainfall throughout the gas shale regions could deliver more than adequate supplies, some streams may not be able to deliver large volumes during the drier summer months. The use of existing water supplies during times of water shortages for the makeup of fracture fluids could cause shortages for other water users. Specific water withdrawal and consumption patterns of individual areas of development must be considered to determine if increases can be easily absorbed.

In tight sands formations, large volumes of water (several hundred thousand to several million gallons) would be required for stimulation fluid makeup. These quantities may be available from major water courses during wet seasons but may not during dry seasons. Additionally, strict water rights laws are in effect in western states and even small, one-time users may be required to get a permit. During drought conditions, recent users may not be allowed to withdraw water if senior appropriations cannot be satisfied.

The effects of drilling and stimulation operations on groundwater resources are perhaps the most complex to evaluate and, possibly, the most serious of potential physical impacts. The most significant potential groundwater problems could originate from saline water intrusion into fresh water aquifers as a result of fracturing activities. In addition, contact of fresh water aquifers with fracture fluids could contaminate potable water supplies. This potential impact should be given special consideration in the Northern Great Plains because the tight gas formations are much shallower (3000 ft.) than in the other basins (9000 ft.) and are therefore closer to groundwater supplies.

Impacts related to air quality would occur primarily during the construction phase of gas well development. Emissions from construction activities would be from three sources: vehicles, fugitive dust and the burning of refuse from site clearing. Although most air emissions would be small, preliminary modeling indicates the  $\text{NO}_x$  emissions may be of sufficient quantity to cause violation of air quality standards. However, because drill rigs are exempt from Federal and Colorado, Montana, Utah and Wyoming state air standards, such violation would not be punishable.

If the western gas sands resource areas experienced rapid and sustained growth, significant population influxes could occur. The effects of these increases could be severe because many areas of potential development are currently experiencing boom town conditions.

Methane is associated with all coal seams. In some cases, methane is present in porous strata above or below the coal, but, for the most part, gas is absorbed within the coal seams. Several techniques for methane recovery have been developed and, in a few cases, the recovered gas has been used locally. To date, however, no technique has been demonstrated commercially.

Coal seams may contain significant quantities of groundwater. This water would be produced with the methane and may contain undesirable dissolved solids. If so, this discharge may have to be treated before release to surface waters or be reinjected.

Availability of water for fracture fluid makeup would not be a problem except for very large fractures in western states during dry seasons. Also, water withdrawals may be affected by western water laws.

Damage to aquifers can occur if wells are not installed and operated with care. Possible causes include deficiencies in completion techniques, drill pit leakage, well casing corrosion and inadequate well plugging.

Impacts to air quality would be negligible as a result of developing the methane from coal resources.

Recovering energy from the geopressured brines will require extending existing technology to produce, handle and dispose of high flow rates of hot, saline water. In addition, working in the geopressured geothermal zones requires special equipment and delivery times may be long, requiring sufficient lead times for development planning.

Accidental releases of geopressured brines would adversely affect water quality. Of special interest are such parameters as ammonia, chloride, sodium, potassium, boron, zinc, and heat. Biota may be killed by thermal shock, adversely affected by salinity and/or pH changes or bio-accumulate metals.

Wetlands may be hydrologically modified from construction activities including dredging or subsidence resulting from fluid withdrawals. Potential changes include saltwater intrusion, decreased stormwater protection, decreased waste assimilation capacity, and desorption of toxic chemicals.

Adverse effects to groundwater would occur if geopressured brines were accidentally released or migrated to fresh aquifers. Boron would be especially detrimental to aquifers used for irrigation.

Reinjection of large volumes of brine is potentially a grave problem in the Gulf Coast. Brines would probably not be returned to the source strata but to shallower zones, some of which are already being used for injection of petrochemical wastes. These shallower strata may have characteristics which are not compatible with geopressured brines. Fluids may clog the strata, cause pressure buildups and reductions in permeability. This, in turn, may cause fracture of confining beds and release of contaminants.

The sheer volume of the fluid to be reinjected also represents a potential problem. Each reinjection well would handle more than 800,000 gallons/day. It is estimated that the R&D program (10 wells) alone would generate 6.14 billion gallons of brine each year, a 14% increase over the current volume of fluid being injected in Texas and Louisiana. Commercialization of the resource would result in 223 billion gallons per year production of brine by 2000, nearly five times that reinjection volume generated now in the two state area. Between 1985 and 2000, 1.33 trillion gallons of fluid would be generated, 2-1/2 times the total volume injected historically.

Massive withdrawals of fluids could create disruption of the equilibrium between the pressures in the pores and the rock matrix. Restoration of equilibrium can cause compaction of porous material. Such compaction could be transmitted to the surface and subsidence would occur. A mathematical model developed to estimate potential subsidence predicts a maximum of 33 feet. Such subsidence could in turn lead to fault activation. Such activation could cause ground movement and adversely impact surface structures.

Air pollution emissions would not have a significant effect on ambient air quality. Impacts would be minor and localized and air quality standards would not be violated.

#### Increased domestic oil production/enhanced oil production

The various stages of oil production include: exploration, production, refining and transport. The environmental residuals from exploratory work are considered minimal except in the instances of a blowout. Blowouts can occur during both exploratory and production stages resulting in the release of nondegradable organics and brine. The probability of such an occurrence can be greatly reduced through use of a blowout preventer. Another concern during drilling and production is that of fresh water aquifer contamination.

Refining operations require substantial volumes of cooling and process water and can result in the discharge of wastewater containing dissolved and suspended solids, nondegradable organics and biological and chemical oxygen demands. Air emissions from refinery operations generally include sulfur and hydrocarbon emissions. Control technologies are available for both air and water pollutants from refinery sources.

The transport of both crude and refined oil products is another potential source of oil spills and fugitive emissions. However, with proper maintenance, pipeline accidents occur relatively infrequently.

The environmental concerns associated with enhanced oil recovery techniques are to a large extent similar to those occurring as a result of primary and secondary recovery. Blowouts would not occur, however, in pressure depleted reservoirs. Additional sources of air pollution would be from the use of heater treaters to reduce the viscosity of heavy oils at the surface and from oil-fired steam generators used in steam injection. The various flooding techniques result in production of brines with hydrocarbon effluents and dissolved carbon dioxide or surfactants. These liquid wastes must be treated and disposed of so as not to be a source of surface water pollution. One technique is to reinject them into the reservoir and thus decrease the total water needed for production.

#### Direct coal liquefaction

The environmental pollutants produced by coal liquefaction processes are similar in type to those resulting from direct coal combustion or from gasification. Process wastewaters may contain phenols, cyanides, ammonia, sulfide, oil and suspended solids. Dissolved solids are contributed by boilers and cooling tower blowdown and demineralization. Air emissions sources are fuel combustion, sulfur recovery and storage. Typical emissions include particulates, nitrogen oxides and sulfur dioxide. Solid wastes include ash from coal combustion and sludges and sulfur products from air and wastewater treatment. Solid waste generation from coal liquefaction processes is considerable, with estimates of 3,200 tons to 5,300 tons per trillion Btu's processed.<sup>7</sup>

#### Oil shale

Primary environmental concerns are those of water availability, air quality and disposal of solid wastes. Shale mining operations would produce the types of residuals normally associated with any mining operation. However, the scale of surface shale retorting operations may well make shale mines the largest in the world.

Surface retorting operations require large volumes of water and generate large volumes of wastewater and substantial quantities of air pollutants. Water supply could be a critical environmental concern. Control technologies applied to the various wastewater and air pollution streams should be able to mitigate any potential problems. The generation of substantial volumes of solid wastes in the form of spent shale will pose a considerable transport and disposal problems.

In-situ retort processes will also result in generation of wastewater which will require at least primary treatment. The flaring of low-Btu product gas would result in considerable emissions of particulates, sulfur dioxide and hydrocarbons. Alternately, this gas could be used for power generation. No solid wastes would result from in-situ retorting as the spent shale would remain in place.

#### Biomass

Environmental issues concerning terrestrial biomass production center on: competition with food crops production for land, water and fertilizer; sediment loadings to waterways due to improper harvesting techniques; air quality problems from direct combustion of biomass by end users; and solid waste disposal. Biomass plantations are land, water and fertilizer intensive operations which may compete with food and fiber production. Clear cutting harvesting techniques result in soil depletion due to residue removal and can affect sediment loading in streams from accelerated runoff and erosion. Direct combustion of biomass, if uncontrolled, emit more air pollutants (nitrogen dioxide, carbon monoxide, and particulates) than does combustion of fossil fuels. This is problematic in the residential sector where pollution controls are not practical. Ash constitutes a solid waste disposal problem though it can be, in some instances, collected and returned to biomass plantations for use as fertilizer.

#### Direct coal utilization

Direct coal utilization produces sulfur and nitrogen oxides as well as particulates in varying quantities depending on the type of coal burned, the boiler design, and the boiler operating conditions. In the United States, fossil-fueled power plants produce about 24 percent of the annual particulate emissions, 65 percent of the sulfur oxides, and 29 percent of the nitrogen oxides. About two-thirds of these pollutants come from coal-fired plants.

Water pollutants result from boiler feedwater preparation, boiler blowdown, boiler tube cleaning, cooling tower blowdowns, ash transport, and miscellaneous sources such as leaks and spills. The major direct pollutant from coal combustion is the waterborn ash, which is sluiced from the boiler and discharged into surface water, usually settling ponds, where most of the ash sinks and can be removed. However, water soluble ash components and residual suspended solids also are discharged into navigable waters. Water pollution also occurs whenever rainwater runoff reaches surface water.

The large volume of solid wastes produced by coal combustion include mineral residue, sludge from water treatment, baghouse filtrates, char, heavy tar residues, and process reagents. After pollutants are collected with scrubbers, precipitators, and other systems, the resultant solid wastes, as well as slag and bottom ash from boiler operations, must be disposed of. The contaminating potential of toxic elements in solid wastes is of concern. In particular, waste components such as arsenic, mercury, selenium, sulfates, nitrates, and hydrocarbons could leach into water supplies. The solid residual produced in a fluidized-bed combustion system is of particular concern. Spent sorbent (mainly calcium sulfate) is discharged at the rate of about 1 ton of sorbent for every 4 tons of combusted coal. Ash is also a major volume solid waste. Massive quantities of coal ash also must be disposed of; the most common method used is land disposal, although a potential environmental problem occurs when water soluble components in the landfill leach into surface and groundwater systems. The Resource Conservation and Recovery Act of 1976 mandates that solid waste residues must be discarded in an environmentally acceptable manner to avoid problems from leaching, dusting, runoff, and air and water pollution.

#### 1.4.7.2 Alternatives within the MBG program

Alternatives to the development of the U-gas process within the MBG program include choosing an alternative process for the demonstration phase, and not having a demonstration phase at this time (the no action alternative). The basis for developing the U-gas process was discussed in Section 1.3.2. The favorability of the U-gas process over others is also discussed in Section 2.3.2 in the context of the Memphis location. The arguments, however, are applicable to the general U-gas development effort.

From a technical viewpoint, the U-gas technology to be demonstrated in the Memphis project offers substantial benefits over currently available technology. The alternative of no U-gas development program at this time would result in delay of such development. Without the MLGW plant, answers to questions regarding economics, technology readiness, and product suitability would be delayed.

A variety of alternatives can be developed by changing the level of commercialization, resulting in different levels of impact. The scenario developed in this report, however, is only hypothetical and is designed to indicate the types of problems that could accompany commercialization. Quantification of the impacts of an alternative level of development does not seem appropriate to that effort. It should be kept in mind, however, that the potential market for medium-Btu gas is much larger than that served by the present scenario. Because of the uncertainty of the exact nature in which a successful MBG program will affect the near-term market penetration of a commercial indirect liquefaction or pipeline gas industry, the scenario discussed in Section 1.4.3 does not include the impacts of additional indirect liquefaction plants that might be built by 1992.

#### 1.4.8 Environmental protection strategy

##### 1.4.8.1 Legislative requirements

One of the primary goals of the MLGW project is maintenance of environmental quality. Accordingly, all aspects of the project are planned to minimize environmental and social disruption.

Since the passage of the National Environmental Policy Act, Federal legislation has been implemented to prevent or mitigate the adverse impacts of almost every aspect of industrial and energy development. A list of standards and regulations that could affect commercialization of medium-Btu gas production is provided in Table 1.17. Many of these legislative actions require the acquisition of permits prior to construction and/or operation of controlled facilities. That is, program plans or plant designs must be far enough advanced to demonstrate eventual



compliance with specified environmental standards before permits for construction will be granted.

Another feature of many Federal regulations is that they allow for state program implementation and enforcement. These Federal mandates for state control generally allow states to impose standards for emissions levels at their discretion providing they are at least as stringent as the Federal standards. As with the Federal standards, however, ability to meet the state standards must be demonstrated before the applicable permits or licenses are issued.

The standards and regulations listed in Table 1.17 are those applying to the gasification facilities. In addition to these, for which the implementing regulations apply to all industrial and energy development, other Federal and state laws are intended to control the impacts of other aspects of the MBG program. For example, the Federal Coal Leasing Amendments Act of 1976, the Federal Land Policy and Management Act of 1976 and the Surface Mining Control and Reclamation Act of 1977 work together to restrict mining activities in areas that are environmentally sensitive or that would be better used for other purposes, such as for agriculture, and ensure that mined areas are ultimately restored to an equal or improved condition after mining is terminated.

#### 1.4.8.2 Environmental monitoring and review

The MLGW plant would be carefully monitored by MLGW from a point in time before plant construction through construction and operation to ensure that specific environmental standards are met and that process emissions are within the ranges predicted.

The plant pollution control systems are an integral part of the plant processes. Retention areas have been provided to prevent accidental releases to the environment. They also permit monitoring which would provide early identification of problems and may allow sufficient time for problem corrections without the need for shutdown.

Certification by EPA of all plant discharges would be sought at all project phases required by EPA. Additionally, operating procedures and operator training programs would be established to insure the effective utilization of the environmental and safety control equipment.

The environmental monitoring and review plan for the Memphis U-gas plant is discussed in Chapter 4, Section 4.5. The monitoring plan discussed here only briefly summarizes the material in Section 4.5. The emphasis in this section is on potential areas where departures from the monitoring plan of the Memphis plant may be required should commercialization be pursued.

#### Air quality

Air quality monitoring stations would be located at points where models predict maximum concentrations. Continuous and intermittent monitoring would be conducted on concentrations of all

Table 1.17. Federal and state requirements relative to the proposed project

| Standard or requirement                                                   | Responsible agency                  | Remarks                                                                                                 |
|---------------------------------------------------------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------|
| <b>Major standards and regulations applicable during construction</b>     |                                     |                                                                                                         |
| <b>Air</b>                                                                |                                     |                                                                                                         |
| National Ambient Air Quality                                              | State/EPA <sup>a</sup>              | Compliance enforced through permit program                                                              |
| State air pollution control regulations                                   | State                               | Requirements generally applicable to major construction activities                                      |
| Fugitive dust control                                                     |                                     |                                                                                                         |
| Open burning restrictions                                                 |                                     |                                                                                                         |
| <b>Water</b>                                                              |                                     |                                                                                                         |
| Water quality standards                                                   | State                               |                                                                                                         |
| Construction effluent quality                                             | EPA/State                           | Permit(s) required                                                                                      |
| Construction in navigable waters                                          | Corps of Engineers                  | Permit(s) required                                                                                      |
| Control of oil and hazardous materials                                    | EPA/Coast Guard, State              |                                                                                                         |
| <b>Solid waste</b>                                                        |                                     |                                                                                                         |
| Resource Conservation and Recovery Act                                    | EPA/State                           | Permit(s) required                                                                                      |
| State solid waste disposal regulations                                    | State                               | Permit(s) required                                                                                      |
| <b>Other</b>                                                              |                                     |                                                                                                         |
| Noise                                                                     | EPA                                 | Guidelines only                                                                                         |
| Endangered Species Act                                                    | DOI <sup>b</sup>                    |                                                                                                         |
| National Historic Preservation Act                                        | State/ACHP <sup>c</sup>             |                                                                                                         |
| Floodplains/wetlands management                                           | DOE/WR <sup>d</sup>                 | Executive Orders 11988 and 11990                                                                        |
| <b>Safety and health</b>                                                  |                                     |                                                                                                         |
| Safety and health regulations for construction                            | DOL <sup>e</sup> /OSHA <sup>f</sup> | 29 CFR 1926                                                                                             |
| Occupational Safety and Health Standards                                  | DOL/OSHA                            | 29 CFR 1910                                                                                             |
| <b>Major standards and regulations applicable during operation</b>        |                                     |                                                                                                         |
| <b>Air</b>                                                                |                                     |                                                                                                         |
| National Ambient Air Standards                                            | State/EPA <sup>a</sup>              | Compliance enforced through permit program.                                                             |
| Prevention of significant deterioration                                   | State/EPA                           | Limitations included in the permit.                                                                     |
| New Source performance standards                                          | State/EPA                           | Currently no specific standards for coal gasification. Standards applicable to certain unit operations. |
| State air pollution control regulations                                   | State                               | No specific standards for coal gasification; generally applicable to industrial emissions.              |
| <b>Water</b>                                                              |                                     |                                                                                                         |
| Water quality standards                                                   | State/EPA                           | Compliance enforced through permit program. No standards for most gasification processes.               |
| Effluent guidelines                                                       | EPA/State                           | No specific standards for coal gasification processes.                                                  |
| Spill prevention control and countermeasures plan; spill contingency plan | EPA/Coast Guard                     | Plan required.                                                                                          |
| State effluent quality standards                                          |                                     | No specific standards for coal gasification processes.                                                  |
| <b>Solid Wastes</b>                                                       |                                     |                                                                                                         |
| Resource Conservation and Recovery Act (RCRA)                             | EPA/State                           | Regulations have been promulgated                                                                       |
| State solid waste regulations                                             | State                               | No specific standards for coal gasification wastes; will probably be replaced by RCRA program.          |
| Noise                                                                     | EPA                                 | Guidelines only.                                                                                        |
| <b>Safety and health</b>                                                  |                                     |                                                                                                         |
| Occupational Safety and Health Standards                                  | DOL <sup>e</sup> /OSHA <sup>f</sup> | Standard industrial regulations. Standards specific to coal gasification currently under development.   |
| Toxic Substances Control Act                                              | EPA                                 | Applicability to project now being evaluated.                                                           |

<sup>a</sup> Environmental Protection Agency.<sup>b</sup> Department of the Interior.<sup>c</sup> Advisory Council on Historic Preservation.<sup>d</sup> Water Resources Council.<sup>e</sup> Department of Labor.<sup>f</sup> Occupational Safety and Health Administration.

criteria pollutants. Predictive models would be modified to reflect the empirical data. Facility stack emissions would be tested quarterly during plant operations.

#### Water quality

Surface and groundwater monitoring for plants in areas of the U.S. may require some modifications from the plan for the Memphis plant. Areas where water is scarce may require plant modifications that incorporate more recycle. All plants would meet NPDES permitting requirements and monitor consistent with those requirements. In parts of the country where leachability is great, more detailed and frequent monitoring may be required. Groundwater would need to be monitored at all sites and the specific techniques used would depend upon aquifer depth, purity, and use. Plants discharging into streams would require downstream sampling stations.

#### Solid waste disposal

Of more concern regarding water quality than the liquid effluent streams from gasification facilities are the methods of solid waste disposal. At the present stage of process development, the constituent makeup of the U-gas solid waste streams is not well defined. Therefore, the question of whether or not these wastes would fall under the jurisdiction of the Resource Conservation and Recovery Act has not been satisfactorily answered. Specific monitoring mechanisms would vary from site to site and would depend on such factors as ambient air quality and soil leachability.

#### 1.4.8.3 Occupation health: Generic consideration in risk analysis methodology

Because few commercial-scale conversion facilities now exist, health concerns arise primarily from existing information and studies on related coal-use processes and from bench- or pilot-scale experiments. The major health and safety risks associated with coal-use technologies include accidental death, injury, and chronic effects (e.g., cancer, respiratory disease).<sup>28</sup> Although both the general public and specific occupational groups may be subject to such risks, individual occupational risks are expected to be greater because occupational doses are likely to be greater than those to the general public. Worker selection may bias against the most sensitive individuals if there is any correlation between ill health and susceptibility. However, risk to workers is likely to be of significantly greater concern than that to the public even though the public may be comprised of more sensitive individuals. Preliminary evaluation suggests that major health and safety concerns for coal-conversion technologies are probably chronic health effects caused by occupational exposure to toxic substances and particulates from emissions, process stream leaks, spills, and maintenance operations.<sup>28</sup>

Generally a major concern with coal-conversion processes is the potentially high exposure to carcinogenic polynuclear aromatics (PNAs) [e.g., B(a)P],<sup>29</sup> however, high-temperature combustion of these compounds as in this particular process reduces the potential exposure to PNAs. Coal-conversion processes involve hundreds of other organic compounds in complex mixtures as well as inorganic materials. Inorganic materials include sulfur compounds, trace metals and trace-metal compounds, and radioactive materials--basically everything in coal plus anything produced in the conversion process. Many of these compounds may be carcinogenic or may act as co-carcinogens. However, accumulated evidence suggests that cancer incidence is reduced if exposures to PNA, coal tar pitch volatiles, and benzene-soluble particulates are reduced.<sup>28,29</sup> The best form of health protection for workers is to rank health concerns and then attempt to reduce exposure to relevant toxic materials. Occupational monitoring and off-site sampling for fugitive emissions would be implemented. These activities would support a regularly scheduled occupational industrial-health program as the plant comes on-line so that potential problems may be identified promptly and ranked as to their relative importance.

Exposures in modern coal conversion facilities are expected to be much lower than in earlier coal-use technologies. Because most modern facilities are closed systems, emissions will result mainly from leaks, accidents, or emergency venting of tars, chars, and soots. However,

potential exposure varies widely from technology to technology, and continual monitoring is essential. A general approach for ensuring adequate occupational protection is discussed below, although in specific occupational settings, attention to industrial hygiene will be of special concern.

The fundamental question asked in health assessments is whether operation of coal-conversion facilities increases human health and safety risks to unacceptable levels. A detailed, quantitative analysis based on general assessment approach would be valuable.<sup>28,29</sup> However, uncertainty about potential numbers and quantities of chemicals produced during coal-conversion processes and uncertainty about biological effects from potential emissions precludes quantitative use of such an analysis. Studies using the several assessment approach have focused on the preoperational health assessment of a Foster-Wheeler/Stoic low-Btu gasifier,<sup>29</sup> and on environmental assessments of small-scale, fixed-bed coal gasifiers as industrial fuel.<sup>28</sup>

A quantitative health assessment methodology is now being applied to several preoperational assessments. The objective of preoperational assessments is to determine before the facility design specifications are finalized whether the impact on occupational health is likely to be of concern. A second line of defense in the prevention of health effects would be to provide assessments after the design has been finalized but before the plant is on-line. Changes at that time would be more expensive than the former approach but not as expensive as ameliorative implementation of changes after start-up, and/or financial compensation for a decrease in the quality of health to workers. Environmental sampling and biotesting of leaked pollutants and stack emissions will be required when the facility is actually operational. But based on these preoperational assessments, significant health and safety controversies may be anticipated unless appropriate actions are taken. Industrial hygiene measures such as identification of indicator compounds (Section 4.4) that may be continuously monitored to ensure health protection and a vigorous clinical program to monitor for early diagnoses, or disease or injury must be major features of any health protection program.

Assessment is viewed as the integrating component of comprehensive health and environmental studies. Standards (e.g., maximum permissible concentrations, exposure, doses) that should not be exceeded are set by various regulatory bodies. In practice the activity is deemed acceptable if measured or estimated exposure does not exceed guidelines or standards. Unfortunately, methodological differences are a major problem in deriving exposure guidelines. Unless a methodological framework is developed, identifying specific needs for acquisition of data in support of an assessment or relating existing data to extrapolation models will be difficult.

It is reasonable to assume that guidance will eventually be developed by regulatory agencies. However, if the acceptability of a technology is to be judged in the absence of exposure guidance (standards), best estimates must be derived as an integral part of assessment. The necessity of "deriving" guidance, when it does not exist, generates an assessment scheme that considers all available biological effects information from the processes and compounds in question and/or from surrogate processes and compounds; and pinpoints key needs for additional studies and/or monitoring.

Major components of a technology health-risk analysis are presented schematically in Fig. 1.2. Risk assessments for synfuels may be discussed by using the generic framework of Fig. 1.2 with the components defined as follows:

#### Technology description

Technology descriptions are process designs for fuel cycles or fuel-cycle components, including input, intermediate and product streams, and environmental control technology. Process descriptions should include enough detail to identify potential releases that could affect occupational health. Materials of potential concern must be identified as the technology description is being developed. The list of "suspect" agents for synfuel technologies is based on information about related processes and about biological, chemical, and physical measurements from bench-, pilot-, and demonstration-scale experiments. The biological data base used to select materials of concern is discussed further under health-effects assessments.

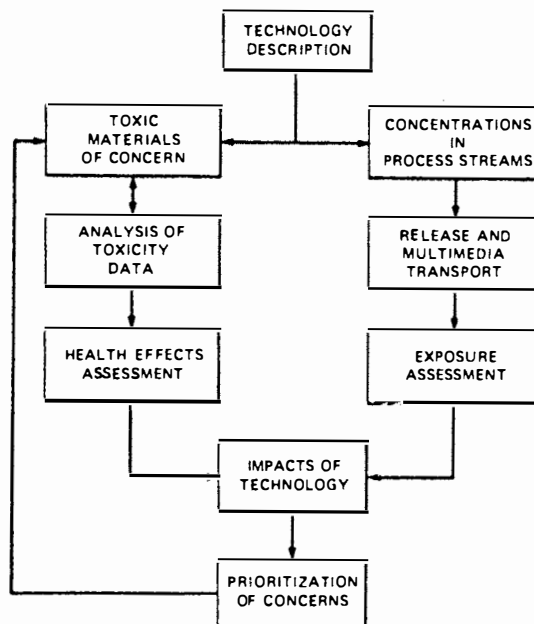


Fig. 1.2. Scheme for technology assessment.

#### Exposure assessment methodology

Exposure assessment attempts to predict qualitatively and quantitatively the concentration of toxic materials in space and time interfaced with target populations. Inputs to an exposure assessment (see Fig. 1.2) are:

- a. Source term--Identification of toxic materials and their concentrations in process streams, including chemical and physical characteristics and profiles of classes of compounds (i.e., a sample that includes representative members of a given class). Process streams include effluent, emission, and product streams. Mass flow rates of toxic materials will be essential input to any reliable source term.
- b. Multimedia transport--Results from studies of (1) atmospheric and aquatic transport and chemical/biological transformation and (2) aquatic and terrestrial food chains. Calculated results of multimedia transport models would have to include soil and sediment fate. Multimedia transport considers media interaction and direct exposure.

The chemical and physical characteristics of toxic materials in air, food, and water at the interface with target populations will differ from initial characteristics associated with the source term.

- c. Occupation exposure assessment--Identification of employees at risk. Life-style, age, sex, gene pool, and previous occupational experience can dramatically affect the composite sensitivity of individual employees at risk.

### Health effects assessment

Ideally, a health-effects assessment would estimate the health risk from exposure to hazardous material(s). Risk refers to mortality or morbidity in humans. More classically, risk is a conditional probability that is the probability of a specific effect given the probability of an exposure. Health-effects assessment involves interpreting toxicity data derived from studies of various levels of biological organization, to quantify response mechanisms which can be used to estimate human health risk. The process is represented schematically in Fig. 1.3. The process involves identification of concerns, data procurement, and information gathering and analysis. Major types of available biological data at the various levels of biological organization are:

- a. Human studies--Clinical surveillance and epidemiological studies on occupational groups exposed to materials from related processes that may be of concern for coal gasification technologies.
- b. Animal toxicological studies--Dose-response relationships for tumorigenicity, life-span shortening, reproductive alteration, teratogenicity, and mutagenicity for materials of concern. Major parameters would include exposure route, exposure rate, and interspecies comparisons of mechanistic response and metabolic factors, dose distribution, and organ damage or neurotoxicity. Mathematical and/or conceptual models of dose-response and relevant extrapolations will be useful in predictive applications.
- c. Cellular level studies--Useful for comparisons of mutagenesis/toxicology of synfuels vs. natural petroleum. These data can also be useful for designing studies focused on evaluating both complex mixtures and pure compounds, elucidating in-vitro and in-vivo cytogenetics, quantifying somatic cell transformations, and serving as potential bioassay systems for estimating the impact of human exposures.
- d. Subcellular studies--Provide data on metabolism, repair processes, complex mixture synergism or antagonisms, and information on chemical, physical, or biological modifications that may occur between source and target.
- e. Structure-activity studies--Based on the idea that molecular structure and/or physical properties of certain materials make them genotoxic, it is logical to use these traits to define a list of "suspect" agents, but as indicated in Fig. 1.3, human health effects assessed or quantified on such evidence would be unreliable at present.

Health-effects assessment (Fig. 1.3) must consider bioeffects data at all levels of biological complexity when attempting to arrive at "best possible" estimates of human-health risk as a function of exposure or dose. Generally, reliable estimates cannot be achieved because basic biological knowledge is lacking. Risk is discussed in relative or comparative terms, and dose-response models are wholly descriptive. Modelers in the descriptive or conceptual sense and those who have attempted mechanistic models find that available biological effects data are not collected to test any particular holistic concept; furthermore, available data can often be "fitted" by several models. Little can be concluded from using these models if their results differ by orders of magnitude when extrapolated to low-level doses. Health-risk analysis clearly requires strong elements of professional judgment from many disciplines.

### Health-risk assessment

Health-risk assessment consists of two main components--exposure assessment and health effects dose-response assessment. These components combine to describe estimated impacts of the materials of concern on human health. Initially, the list of materials of concern associated with a given technology may be long. This necessitates several successively more rigorous applications of the entire risk assessment process in order to prioritize materials of concern on the basis of their potential human-health impacts. Worst-case assumptions about multimedia transport (that lead to estimates of exposure) and extrapolation of toxicity data (that lead to health effects assessments) can be used in first applications. Materials judged to be of minimal impact under worst-case assumptions can usually be eliminated from further consideration, and the most important data needs can be identified for more quantitative assessments of exposure and health effects. The prioritized materials of concern can then be evaluated using more realistic assumptions. This process of repetition and "feedback" with the aim of identifying and ordering substances of most concern allows for effective technology-control modifications that focus on occupational concerns. The assessment methodology (illustrated in Figs. 1.2 and 1.3) provides the framework for coal-conversion assessments. Research needs are already

apparent, especially those related to estimation of health risks. Health risks must be estimated from existing epidemiological, toxicological, and theoretically derived data (i.e., the product of dose-response modeling) supplemented by short-term toxicity data. Such supplemental data are particularly important for the coal-conversion program because, in many cases, process samples will be complex mixtures of compounds for which few or no toxicological data exist. Within the scope of the current studies, data should be obtained so that the toxicities of the complex mixtures can be bracketed by the better-known toxicities of individual reference compounds. At this time, it is very difficult to predict whether untested complex mixtures will act in an additive, synergistic, or even a neutralizing (i.e., mixture has less affect than either component administered individually) manner. Therefore, it is important to continue studies that investigate biological response mechanisms and also those that investigate the various factors deriving from temporal-, component- and dose-affected exposure schedules.

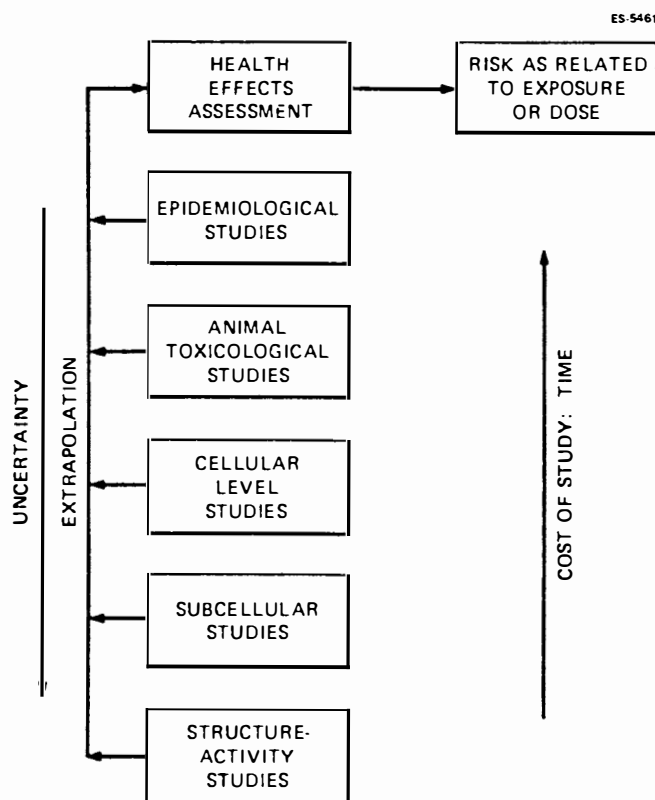


Fig. 1.3. Health risk analysis.

In practice, the effective health-protection program must be based on continual monitoring with remedial measures to ensure continued compliance with emission guidelines over the mechanical life cycle of each facility. The emission level could be greatly affected over time by mechanical wear, process-stream corrosion, maintenance techniques, and retrofitted design modifications.

#### 1.4.9 Unavoidable adverse impacts

Regardless of control technologies and impact mitigation techniques utilized, commercialization of the medium-Btu gasification program will result in some unavoidable adverse effects.

##### 1.4.9.1 Air

Localized degradation of air quality would unavoidably occur as a result of coal development and utilization. Some increase in sulfur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, trace elements, hydrocarbons and respirable particulates would occur in the vicinity of gasification facilities even though emission controls were employed. However, air quality standards would have to be met in order to meet permitting requirements, and appropriate air quality requirements, in effect, would be maintained.

##### 1.4.9.2 Water

Although large volumes of water will be required for other coal gasification facilities, impacts from medium-Btu gasification plants are expected to be less than for other coal conversion technologies. This is primarily because these plants will be constructed to accommodate pre-existing industrial markets; therefore, what are usually referred to as conjunctive developments will not occur. Water supplies should be adequate for plants east of the Mississippi River. For the California plants, most requirements can be met with ocean water. The plants in the West (North Dakota, Wyoming and Colorado) may put pressure on existing water supplies when considered in the framework of the overall synthetic fuels program. Water may be physically available to appropriate locations in the West, but it may already be committed to farm or ranch use or claimed for other purposes.<sup>30</sup>

The water related impacts of increased coal mining (i.e., aquifer disruption, acid mine drainage, etc.) are well documented in the literature. Some degree of impact will unavoidably occur in meeting coal requirements of a commercial medium-Btu industry. However, at the full level of commercialization projected for 1992, coal requirements will amount to less than five percent of domestic production in 1979. Impacts to water supplies and quality resulting from program related mining increases should be minimal.

Although gasification facilities will be designed to meet existing effluent limitation standards, some water quality deterioration may be unavoidable. Effluents from all facilities would ultimately reach major water courses with large capacities for pollutant dispersion and dilution.

##### 1.4.9.3 Soils

Soil fertility would be unavoidably decreased in many areas as a result of activities associated with coal gasification facilities. Surface mining, facility construction and solid waste disposal would all result in disturbance of topsoil. Even reclamation activities following surface mining will result in soil compaction and probably the burying of fertile soils. Toxic materials present in lower soil levels would be brought to the surface or mixed with the soils. New soils may unavoidably be formed with characteristics quite different, and in many cases less productive, than the original soils.

The disposal of ash from the facilities and mining wastes could cover large areas of topsoil making these areas permanently useless for productive purposes. Leaching from disposal sites could also adversely affect soil productivity.

##### 1.4.9.4 Topography

Topography would be unavoidably altered by construction and mining activities. Actual plant locations would be marked generally by leveling of all topographic features. Major changes in topography would accompany surface mining of coal, depending on the degree of reclamation. Similarly, underground mined areas could be adversely affected by ground subsidence and the creation of spoil piles.



#### 1.4.9.5 Flora and fauna

The diversity, density and composition of plant and animal species would be unavoidably altered in areas of mining and construction of gasification facilities. Locations for the facilities would have to be selected keeping in mind the protection of endangered plant and animal species. It should be anticipated that all native species will be removed from actual facility sites; however, the sites of construction will be relatively small and most animal species should be able to relocate in adjacent areas. Ponds and streams that are removed or altered by mining and construction activities will unavoidably experience some or total species loss. In addition, noise from coal mining activities as well as construction and operation of the gasification facilities could adversely affect local species behavior, particularly reproduction and migration functions.

#### 1.4.9.6 Socioeconomic values

Increased coal mining and construction activities associated with the gasification facilities located in the eastern part of the country should result in only moderate changes in population because of the large pre-existing labor pools. Impacts in the West are much more difficult to predict. Those directly related to the coal gasification plants, as located in this statement, would be expected to be minimal. However, these facilities represent only a small part of the total industrial and energy related growth anticipated in this area over the coming decades. As a result of this development, "boom towns" could occur and some disruption of local lifestyles may be unavoidable. A large increase in population would, to some degree, change living patterns in impacted communities and could result in increased social and economic problems. The potential impacts would depend upon the relative size of the existing communities and the rate of growth, the existing infrastructure, and the adequacy of advanced planning for the growth.

Land use patterns would be unavoidably altered because of the land requirements for plant sites, mining sites, waste disposal sites, roads, railroads, utility and pipeline corridors, and associated services. Some of this change would be permanent. Agriculture, grazing, forest and recreational lands would be removed from their existing uses. These impacts will be much more severe in the West than in the East because of the much lower level of existing development.

Substances that are harmful to human health could be produced in the gasification facilities. The impacts of the release of these substances to the environment, even in compliance with Federal and state laws, cannot be accurately predicted. Chronic human health effects could be unavoidable.

#### 1.4.10 Irreversible and irretrievable commitment of resources

The commercialization of medium-Btu gasification to meet energy goals for 1992 will result in a major commitment of non-renewable resources. The principal resources committed would be the coal and water required to support the industry.

##### 1.4.10.1 Coal

Using the representative coals selected for each of the postulated gasification facilities will result in an annual coal commitment of approximately 34 million tons. Assuming that the facilities have an average plant life of 20 years, the total commitment of coal to the commercialization program would be approximately 680 million tons over the life of the program. Even under the low oil price scenario, the Energy Information Administration<sup>9</sup> projects an annual coal production of 1,305 million tons as early as 1990. Conservatively using this figure for 1992 would mean that the annual commitment of coal to the gasification program would be only 2.6 percent of total domestic production.

##### 1.4.10.2 Water

Water is generally considered to be a renewable resource and is not usually considered to be irreversibly committed. However, in water scarce western regions, any substantial withdrawal of water from the supply systems should be regarded as resulting in potentially major impacts. Only about 50 percent of the water withdrawn for individual gasification facilities will be returned to the water courses and its makeup will be substantially different than before its withdrawal. To the extent that water will be required for gasification plants, it must be

regarded as unavailable for other productive uses such as agriculture, and, therefore, committed for the life of the program. Disturbance of aquifers could occur during mining and they would be irreversibly changed. The chemical quality of water in some aquifers would be irreversibly changed as, for example, when freshwater beds are dewatered and later infiltrated by lower-lying saline waters. Leachates from waste disposal piles could also cause irreversible changes to groundwater quality.

Drainage patterns would be changed by mining and construction activities. These changes could lead to irreversible alterations to surface water hydrology.

#### 1.4.10.3 Other resources committed

Fuels, electric power, lubricants, explosives, machinery, structural materials, capital, manpower, and services required for coal development and construction of the gasification facilities would be irretrievably lost to other uses. Large amounts of sand, gravel, clinker and other aggregate materials would be used in the construction of mine and plant facilities and would not be recoverable. Deposits of these materials mined with the overburden and mixed with other spoil would also be irretrievably lost. An inestimable amount of mineral resources could also be irreversibly committed to the extent that dilution with coal mining spoils prohibits economic recovery. The operation of the plants would irreversibly consume or change the physical or chemical form of process additives. These would include mineral additives, chemicals, catalysts, water treatment chemicals and petroleum products used to maintain and operate mechanical equipment.

The following materials would be committed to the commercialization of medium-Btu gasification and irretrievably lost to other purposes.

| <u>Material or Resource</u> | <u>Annual Commitment</u>     | <u>Cumulative Commitment Based on 20-Year Plant Life</u> |
|-----------------------------|------------------------------|----------------------------------------------------------|
| Coal*                       | 33.95 MM tons                | 679 MM tons                                              |
| Water                       | 32.04 x 10 <sup>9</sup> gals | 640.8 x 10 <sup>9</sup> gals                             |
| Electricity                 | 12,816 MW                    | 256,320 MW                                               |
| Natural Gas                 | 136.8 MM ft <sup>3</sup>     | 2,736 MM ft <sup>3</sup>                                 |
| Phosphate                   | 108 tons                     | 2,160 tons                                               |
| Selexol Solvent             | 730.8 tons                   | 14,616 tons                                              |
| Sodium Carbonate            | 16,423.2 tons                | 328,464 tons                                             |
| Potassium Carbonate         | 813.6 tons                   | 16,272 tons                                              |
| Sulfuric Acid               | 8,053.2 tons                 | 161,064 tons                                             |
| Caustic (50% NaOH)          | 212.4 tons                   | 4,248 tons                                               |
| Amine                       | 1.8 tons                     | 36 tons                                                  |
| Hydrazine                   | 75.6 tons                    | 1,512 tons                                               |
| Corrosion Inhibitor         | 774 tons                     | 15,480 tons                                              |
| Dispersant                  | 414 tons                     | 8,280 tons                                               |
| Chlorine                    | 536.4 tons                   | 10,728 tons                                              |
| Activated Carbon            | 1,800 tons                   | 36,000 tons                                              |
| Hydrated Lime               | 162,648 tons                 | 3,252,960 tons                                           |
| Polymer                     | 23.76 tons                   | 475.2 tons                                               |
| Phosphoric Acid             | 118.8 tons                   | 2,376 tons                                               |
| Sulfur Recovery Catalyst    | 741.6 tons                   | 14,832 tons                                              |
| Tail-gas Treatment Catalyst | 115.2 tons                   | 2,304 tons                                               |
| Methanation Catalyst        | 190.8 tons                   | 3,816 tons                                               |
| United G3/C Catalyst        | 114 tons                     | 2,880 tons                                               |
| United C72 Catalyst         | 219.6 tons                   | 4,392 tons                                               |

#### 1.4.10.4 Land

A major commitment of land would be required for the full commercialization of medium-Btu gas production. Construction of 36 facilities, each requiring 134 acres would remove 4,824 acres from other productive uses. It should be noted that gasification facilities would most likely be built in pre-existing industrial areas.

Land lost to other uses during strip mining of coal would be 1,558 acres per year for all 36 facilities. Over the 20 year life of the plants, 31,160 acres would be disturbed due to strip mining. All of this land will be subject to reclamation in accordance with Federal and state legislation.

Solid waste generated by the gasification plants will require considerable land areas for disposal. Initial disposal will occur at the plant sites but additional land may be required eventually. Factors affecting the amount of land needed include the ash and sulfur content of the coal feed to each gasification facility and the proximity of the facility to the coal source. If the plant is close to the coal mining area, some of the solid waste generated could be returned to the mine.

#### 1.4.10.5 Loss of biological values

Accompanying the loss or alteration of land values would be a loss of biological values. Even on those areas which are reclaimed, it is doubtful that total reestablishment of the native plant community would be possible, especially on severely disturbed mined areas. Strip mining would eliminate a portion of this life support community which would result in an irreversible impact on flora and fauna in the area.

Primary productivity would be decreased on lands permanently converted or seriously disturbed by mining. Secondary productivity and food webs would be disrupted forcing changes in the reproductive and behavior patterns of animals.

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## 2. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

### 2.1 INTRODUCTION

Environmental consequences of the proposed action and its alternatives are presented and compared in this section. Reasonable alternatives available to the DOE can be grouped according to three categories: to proceed with the proposed action, to modify the proposed action, or to take no action.

Under the alternative to proceed with the proposed action, it is assumed that the project will continue through phase II — final design, procurement, and construction — as well as phase III — operation for 20 months. At that time, depending on the success of phase III, the project could experience three fates: continued operation for a 20-year lifetime, mothballing, or decommissioning. Impacts of the continued operation option are summarized in Sect. 2.3.1.1; impacts of mothballing and decommissioning are given in Sect. 2.3.1.2.

Under the modified action alternative, changes could be made to the plant design, a different site could be selected, or the action could be deferred. Plant design alternatives are discussed in Sect. 2.3.2.1. Impacts of plant construction and operation at alternative sites are presented in comparative form in Sect. 2.3.2.2. Impacts resulting from a delay of action are given in Sect. 2.3.2.3.

The no-action alternative is discussed in Sect. 2.3.3.

### 2.2 DESCRIPTION OF THE PROPOSED ACTION

#### 2.2.1 Plant description

The demonstration facility has been designed to manufacture a medium-Btu gas (MBG) ( $300 \pm 30$  Btu/ft<sup>3</sup>) from western Kentucky No. 9 coal. A portion of the industrial fuel gas is further converted to substitute natural gas (SNG). A simplified schematic of the plant is presented in Fig. 2.1. A more detailed schematic is given in Appendix B.0.4.

Washed coal [5 cm (2 in.) x 0] will be delivered to the demonstration plant by barge. As-received coal is conveyed to an active storage pile of 14-d capacity, and additional coal is transferred to a reserve pile of up to 90-d capacity. The coal from the active pile is crushed, dried, and stored in a coal storage silo under a nitrogen atmosphere to prevent spontaneous combustion.

Coke is obtainable in the proper size range of 0.64 cm (0.25 in.) x 0 for feed to the gasifier. This size range does not require coke crushing. The coke will be delivered by truck and deposited in a coke reclaiming area. Coke is dried and stored in a coke storage silo that is also maintained under a nitrogen atmosphere.

The coal or coke is loaded into pressurized lock hoppers for feeding to the gasifier. Coke is used to preheat the gasifier during startup, after which coal is fed to the process.

The U-gas gasifier is a fluidized-bed unit that reacts coal, steam, and oxygen to generate a gas containing mainly carbon monoxide, carbon dioxide, and hydrogen, with small amounts of hydrogen sulfide, other sulfur compounds, and between 0.3 and 60 ppmv hydrogen cyanide. The gasifier is operated such that ash particles in the fluidized bed will agglomerate into larger, dense solids that fall out through a venturi in the bottom of the bed into a quench basin at the bottom of the gasifier. The demonstration plant will be equipped with four gasifiers, three of which will be in operation and one on reserve.

Entrained ash and coal fines are removed from the product gas by a cyclone-type separator and by the gas cooling and scrubbing unit, which also removes some HCN. The cooled gas is next compressed to 13.5 kg/cm<sup>2</sup> (192 psig) for delivery to the gas treatment unit, followed by distribution to the industrial fuel gas (IFG) pipeline system.

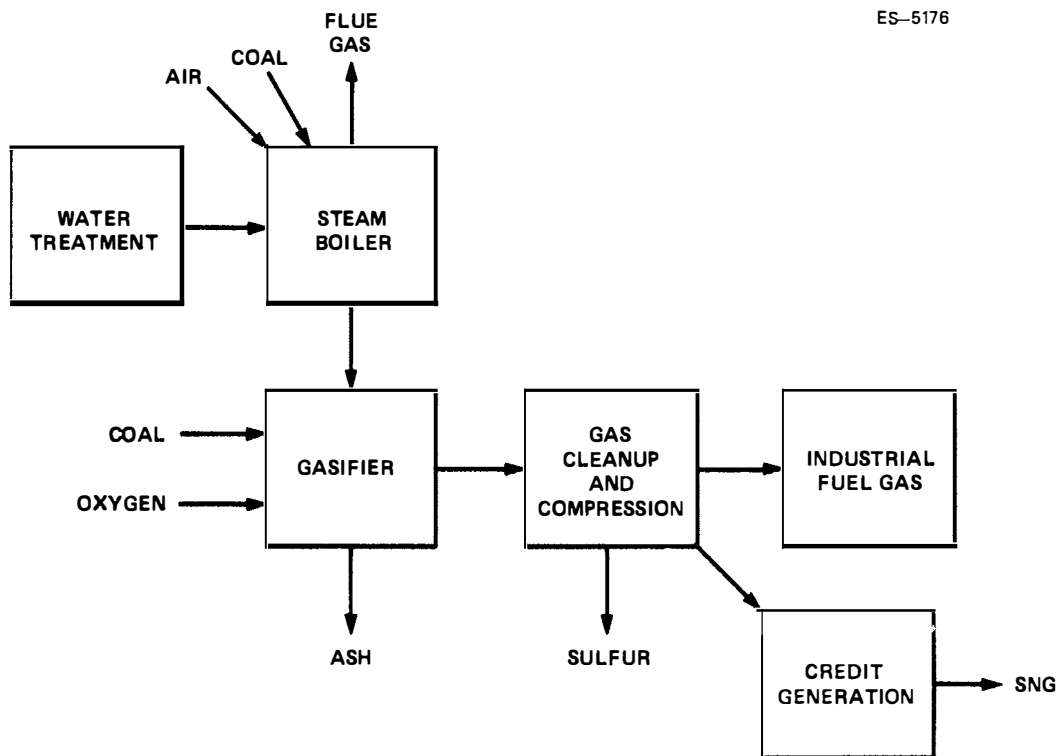


Fig. 2.1. Simplified flow diagram of the IFGDP.

Gas treatment is necessary to remove environmentally unacceptable cyanides and sulfur compounds from the IFG product. The demonstration plant will employ the Selexol process, which uses a proprietary solvent to absorb selectively hydrogen sulfide, carbonyl sulfide, hydrogen cyanide, and some carbon dioxide from the fuel gas. The sulfur compounds will be recovered as elemental sulfur by further treatment in Claus and Beavon-Stretford units.

The product gas will be transported by pipeline beneath Lake McKellar to the independent IFG distribution system. Approximately 10% of the industrial gas will enter a credit generation unit, where the gas is methanated to SNG (950 Btu/ft<sup>3</sup>) and is discharged to the existing natural gas distribution system. The credit generation system includes compression, shift conversion, and CO<sub>2</sub> removal by the Benfield process; a zinc oxide guard chamber; methanation by the Conoco process; and gas drying. Credits generated can later be withdrawn in the form of natural gas and adjusted to IFG quality when the plant is not producing sufficient IFG to meet demand. Carbon monoxide content of credit gas will be limited to 0.1% by design.

Based on a coal feed rate of 3155 tons/d, the demonstration plant has been designed to produce 50.5 m<sup>3</sup>/s (154 × 10<sup>6</sup> scfd) of IFG, 1.4 m<sup>3</sup>/s (4.33 × 10<sup>6</sup> scfd) of SNG, and 100 tons/d of sulfur. Prior to transportation, the sulfur by-product is stored as a liquid.

The demonstration plant uses auxiliary equipment to supply steam, power, oxygen, and nitrogen requirements of the coal gasification and gas treatment sections of the plant. Other services, such as waste treatment and disposal, feedwater treatment, and waste heat removal, are also provided.

Two coal-fired auxiliary boilers together generate 95,254 kg/h (210,000 lb/h) of high-pressure [463°C, 63.3 kg/cm<sup>2</sup> (865°F, 900 psig)] steam for use in back-pressure turbines that drive such process equipment as compressors and pumps. The turbine exhaust steam [6.0 to 8.8 kg/cm<sup>2</sup> (85 to 125 psig)] will be used in the gasifiers and for process heat requirements. The boilers have low-NO<sub>x</sub> burners and flue gas recirculation.

The demonstration plant oxygen and nitrogen requirements will be met by a cryogenic air separation plant. Process oxygen will be used for coal gasification [66,650 kg/h (146,940 lb/h)] and wastewater treatment [204 kg/h (450 lb/h)].



Nitrogen uses include gas treatment [674 kg/h (1485 lb/h)] coal preparation and feeding [4425 kg/h (9757 lb/h)] and (intermittently) reactor purge.

Mechanical-draft evaporative cooling towers are provided (see Sect. 2.2.1.5).

Wastewater treatment and solid waste storage facilities are discussed in subsequent sections.

A plot plan of the facility is shown in Fig. 2.2.

#### 2.2.1.1 Water supply

Raw water is supplied by MLGW from its own mains. There is no intake structure. Input rate is approximately 0.1 m<sup>3</sup>/s (2,710,000 gpd).

#### 2.2.1.2 Wastewater treatment

The treated wastewater stream is made up of process wastewater (0.035 m<sup>3</sup>/s) (gas-scrubbing blowdown, sour water, stripping condensate, and methanator condensates), cooling tower blowdown, coal pile runoff, ash pile runoff, process area storm drainage, and boiler-feedwater preparation wastes. These streams receive individually tailored treatments before release. A schematic flow diagram of the wastewater treatment system is given in Fig. 2.3. Table 2.1 gives the feed stream composition to wastewater treatment, and Table 2.2 gives the system water balance. Sanitary sewer waste is processed off the site.

Process wastewaters are treated for removal of char fines and organic contaminants. Char and ash fines in the gas-scrubbing blowdown are removed by clarification and filtration and sent to the auxiliary boiler for use as a supplemental fuel. The clarified blowdown and the other condensates receive a series of physical, chemical, and biological treatments consisting of steam stripping, lime flocculation and clarification, recarbonation, pressure filtration, ozonation and oxygenation, biological pressure filtration, and two parallel trains of activated carbon adsorption. The redundant use of oxygenation and biological treatment ensures adequate removal of organic contaminants.

The cooling tower blowdown is treated in an electrolytic chromate-destruct unit, which converts chromium and zinc to insoluble hydroxide precipitates. The chromate-destruct system is an electrochemical process that operates on a continuous, once-through basis, with no holdup or reaction time needed beyond that of the electrochemical cell itself. As designed, the system contains three separate electrochemical cells and electrodes, each complete with its own instrumentation, piping, and power supply. The total system is designed to produce an acceptable effluent even during backwashing of a cell (backwashing is accomplished in about 15 min once each day). Thus, the design of the chromate-destruct unit inherently contains a sizable degree of redundancy. In the unlikely event that the chromate-destruct system becomes completely inoperative, the cooling tower could continue to function for periods of up to a few days without plant shutdown by allowing the concentration cycles to build up to higher than design levels and accepting the increased corrosion rate. The clarified blowdown stream will be treated by air flotation for recovery of oil and grease if present.

Collected coal pile runoff from the underdrain system above the Hypalon liner is neutralized, aerated, and clarified to remove heavy metals and to control pH and total suspended solids (TSS). Process area drainage will be collected for treatment by air flotation for recovery of oil and grease and for removal of some suspended solids. The slop oil recovered by air flotation will be sold to a reclaimer. Boiler-feedwater preparation wastes will be high in total dissolved solids (TDS) but generally of the same composition as the raw water fed to the plant. This stream is neutralized before disposal.

Initial studies suggest that the quality of the gasifier ash leachates (see Appendix C.2.2) does not meet current Resource Conservation and Recovery Act (RCRA) criteria (May 19, 1980) for hazardous waste and will not require treatment; consequently, there are no current plans for ash pile runoff treatment. However, leachates will be monitored prior to release, and treatment will be applied to the leachates if necessary.

Treated wastewater collects in a waterproof-lined effluent holding basin (sized for a 6-h detention time under the maximum treatment flow) prior to discharge. Under conditions of heavy rainwater runoff, all flow in excess of the holding basin design flow is diverted to the rainwater storage basin where it will be stored for later treatment. This system has been designed to handle flows related to maximum rainfalls for the area. The normal discharge rate will be 56 liters/s (887 gpm). Effluent characteristics have been listed in Sect. 2.2.1.4.

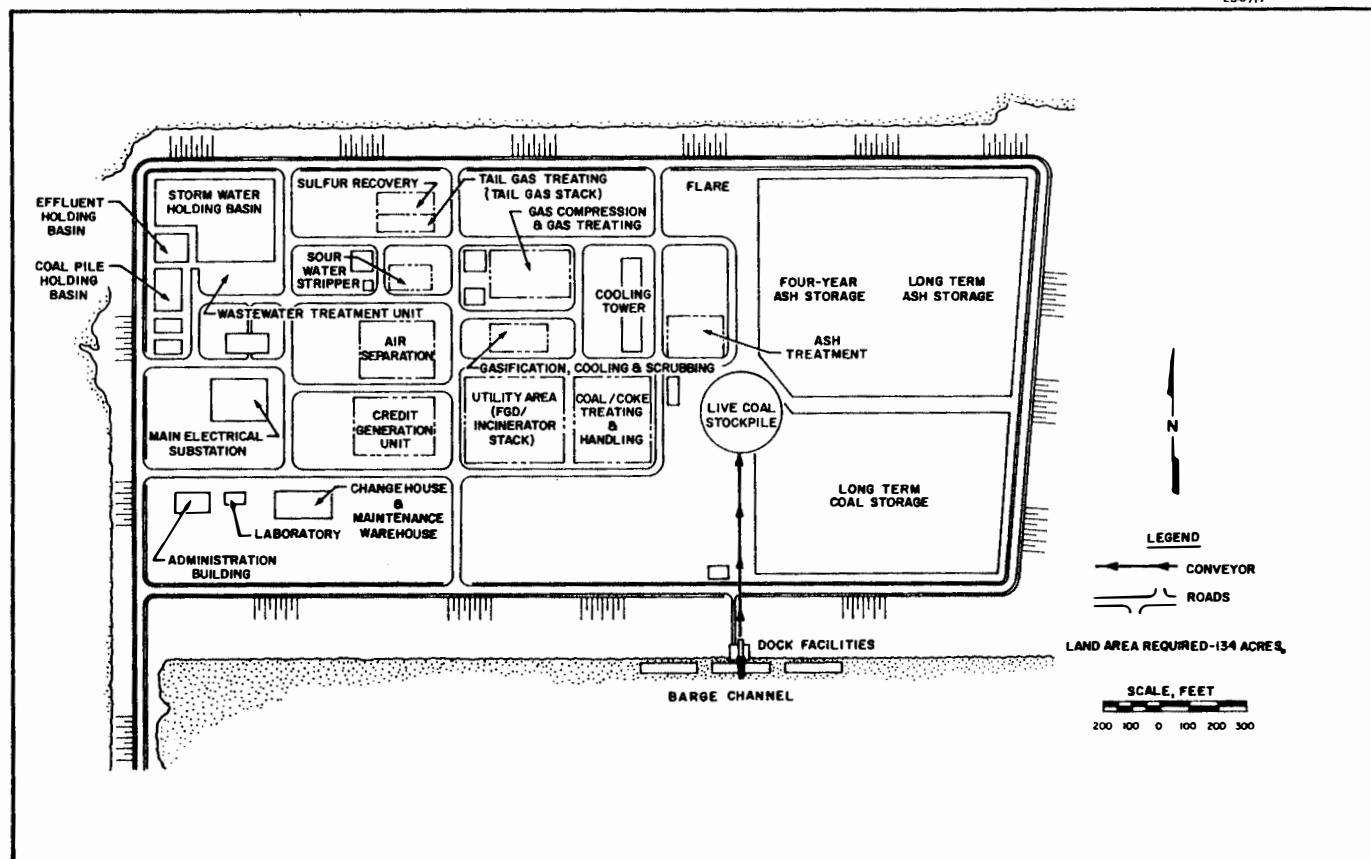
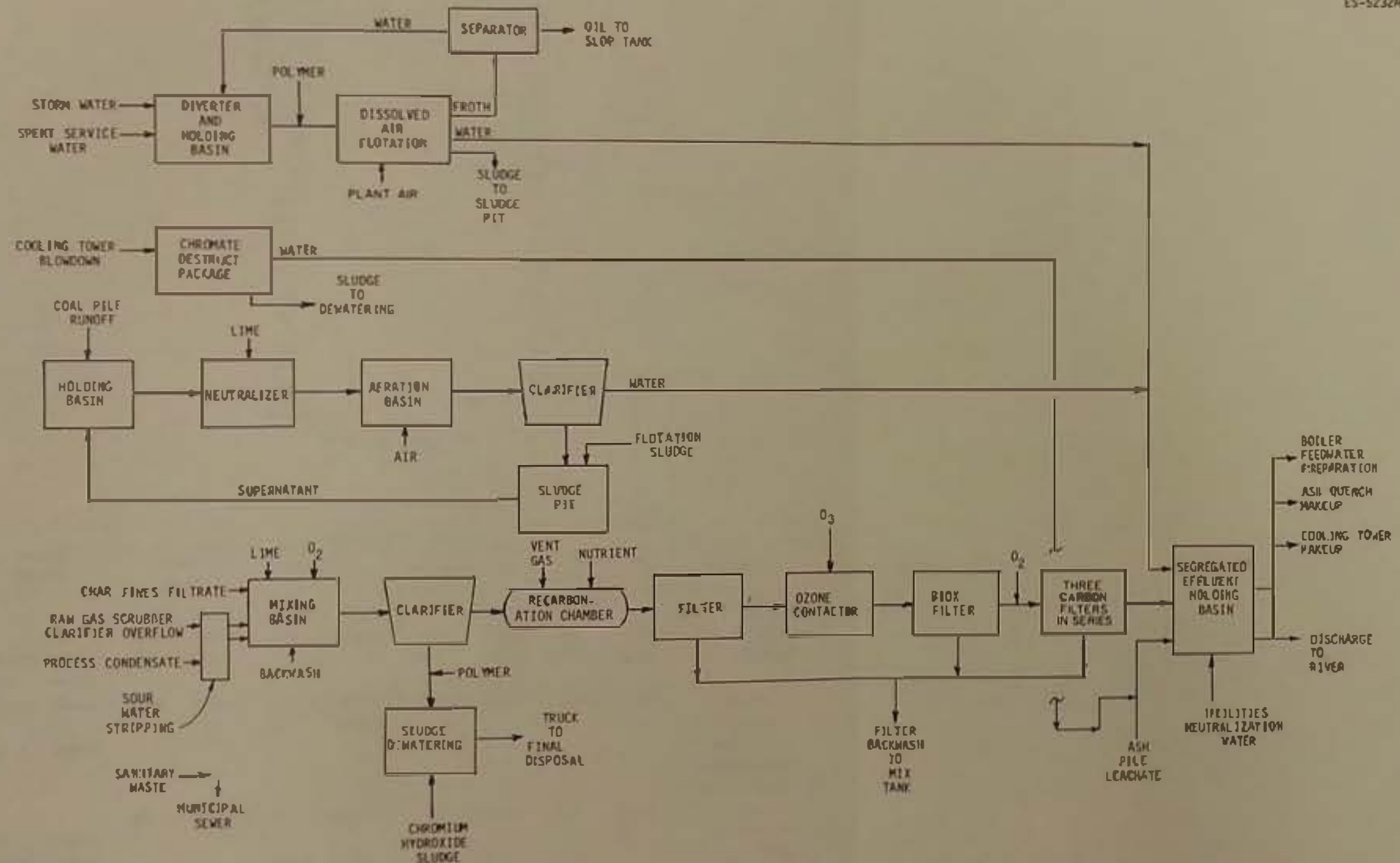


Fig. 2.2. Plot plan.



## Flow rates for the wastewater treatment design

|                                     |                                            |
|-------------------------------------|--------------------------------------------|
| Entering diverter and holding basin | Stormwater (normally no flow)              |
| Entering chromate destruct          | Service water (8.2 liters/s)               |
| Entering holding basin              | Cooling tower blowdown (174 liters/s)      |
| Entering mixing basin               | Coal pile runoff (normally no flow)        |
| Entering municipal sewer            | Chlorine filtrate (3.08 liters/s)          |
| Leaving sludge dewatering           | Clarifier overflow (15.7 liters/s)         |
| Entering holding basin              | Slipped acid water (15.9 liters/s)         |
| Leaving holding basin               | Sanitary waste (3.0 liters/s)              |
|                                     | In sludge truck to disposal (0.07 liter/s) |
|                                     | Utilities neutralization (4.2 liters/s)    |
|                                     | Boiler blowdown (not stored)               |
|                                     | To feedwater prep (2.6 liters/s)           |
|                                     | To ash quench (2.3 liters/s)               |
|                                     | To cooling tower (0.2 liters/s)            |
|                                     | To river (36.0 liters/s)                   |

Fig. 2.3. Wastewater treatment flow diagram.



**Table 2.1. Wastewater inlet composition and range**

| Component           | Concentration (mg/liter) |
|---------------------|--------------------------|
| TDS                 | 2000 to 3000             |
| TSS                 | 200 to 300               |
| COD                 | 200 to 300               |
| BOD <sub>5</sub>    | 100 to 200               |
| Oil and grease      | 10 to 20                 |
| TOC                 | 50 to 100                |
| NH <sub>3</sub> - N | 20 to 30                 |
| SCN <sup>-</sup>    | 10                       |
| H <sub>2</sub> S    | 10                       |
| Phenols             | 20                       |
| Cn <sup>-</sup>     | 5                        |
| Ag                  | 0.01                     |
| As                  | 0.05                     |
| Be                  | 0.01                     |
| Cd                  | 0.1                      |
| Cr                  | 0.1                      |
| Hg                  | 0.1                      |
| Ni                  | 0.05                     |
| Pb                  | 1.0                      |
| Sb                  | 0.1                      |
| Se                  | 0.2                      |
| Tl                  | 0.05                     |
| Zn                  | 0.5                      |
| Priority organics   | <0.1                     |
| pH                  | 6 to 9                   |

Source: ER, Table 2-18, p. 2-69.

**Table 2.2 Normal incinerator charge and discharge streams**

| Component        | Charge streams [kg/s (lb/h)] |         |                          |          |                         |          |                     |         | Discharge<br>flue gas |          |
|------------------|------------------------------|---------|--------------------------|----------|-------------------------|----------|---------------------|---------|-----------------------|----------|
|                  | Feed hopper<br>vent gas      |         | CO <sub>2</sub> vent gas |          | CO <sub>2</sub> off-gas |          | Product<br>fuel gas |         |                       |          |
| Hydrogen         | 0.0067                       | (53)    | 0.0026                   | (21)     | 0.0008                  | (6)      | 0.0115              | (91)    |                       |          |
| Carbon monoxide  | 0.0762                       | (605)   | 0.0543                   | (431)    | 0.0021                  | (17)     | 0.1317              | (1,045) |                       |          |
| Nitrogen         | 0.2550                       | (2,024) | 0.1882                   | (1,494)  |                         |          | 0.0035              | (28)    | 2.3505                | (18,655) |
| Oxygen           |                              |         |                          |          |                         |          |                     |         | 0.1149                | (912)    |
| Carbon dioxide   | 0.0638                       | (506)   | 1.5450                   | (12,262) | 3.3616                  | (26,679) | 0.1087              | (863)   | 5.5886                | (44,354) |
| Hydrogen sulfide |                              |         |                          |          | 0.0005                  | (4)      |                     |         |                       |          |
| Sulfur dioxide   |                              |         |                          |          |                         |          |                     |         | 0.0009                | (7)      |
| Carbonyl sulfide |                              |         |                          |          |                         |          |                     |         |                       |          |
| Carbon disulfide |                              |         |                          |          |                         |          |                     |         |                       |          |
| Methane          | 0.0073                       | (58)    | 0.0144                   | (114)    | 0.0004                  | (3)      | 0.0123              | (98)    |                       |          |
| Nitrogen oxides  |                              |         |                          |          |                         |          |                     |         | 0.0063                | (50)     |
| Water            |                              |         | 0.0030                   | (24)     | 0.5073                  | (4,026)  |                     |         | 0.8300                | (6,587)  |
| Total            | 0.4113                       | (3,264) | 1.8076                   | (14,346) | 3.8726                  | (30,735) | 0.2678              | (2,125) | 8.8912                | (70,565) |

### 2.2.1.3 Water discharge facility

Excess treated wastewater from the effluent holding basin is sent to the outfall in the Mississippi River. The discharge is through a 46-cm (18-in.) pipeline as shown in Fig. 2.4. The output will vary between 56 liters/s (887 gpm) and 212 liters/s (3356 gpm), depending on the volume of storm-water runoff discharged.

The wastewater pipeline will be placed in a dredged trench extending to a submerged outfall. The outfall will be located 3.05 m (10 ft) below the low-water reference plane in the Mississippi River and 15.2 m (50 ft) from the corresponding shoreline. The waterline will discharge into the river at a downstream angle of 45°.

### 2.2.1.4 Analysis of final liquid discharge

The treated wastewater from the effluent holding basin is discharged to the Mississippi River at a pH of between 6.0 and 9.0 and a temperature of between 26.7°C (summer) and 18.3°C (winter).

The outfall stream and critical streams within the treatment plant will be monitored to ensure that the conditions specified in the NPDES permit are not violated either by equipment malfunction or operator error. The concentration levels of polycyclic aromatic hydrocarbons (PAHs) in the waste effluent from the plant are expected to be relatively low. The high temperatures and high carbon conversions characteristic of the U-gas gasification process minimize the formation of tars, oils, and PAH species.<sup>1</sup> Polycyclic aromatic hydrocarbon levels in the U-gas pilot plant raw-gas scrubber effluent were measured and found to be low. When treated by the proposed bio-oxidation and carbon method, the PAH levels in the treated process wastewater are expected to be below those levels considered to be hazardous maximum acute toxicity effluents (MATE).<sup>2</sup> The use of granular activated carbon is widely recognized as an effective treatment method for removing PAHs. Together with ozonation and the biological activity it promotes on the carbon surface, even higher removals can be expected. Biodegradation has been demonstrated to be over 80% for a number of PAH compounds.<sup>3</sup> Further details concerning PAH concentrations in process wastewater are given in Appendix B.0.1.

The only significant liquid effluent from construction activities will be the drainage of dredged fill materials into Lake McKellar. The  $4.6 \times 10^6 \text{ m}^3$  ( $6 \times 10^6 \text{ yd}^3$ ) of fill material will consist of sands from the Mississippi River and are not expected to pose siltation problems. Potential impacts from silt releases will be mitigated through the use of a settling basin in the construction area. Elutriate tests performed on the Mississippi River sediment indicate that ammonia present in the decant water from site buildup may exceed water quality criteria for water not classified for domestic use but will be diluted to below criteria levels on discharge. Because the ammonia will be rapidly diluted and degraded, it is unlikely to present a hazard to aquatic biota.

### 2.2.1.5 Process cooling

A mechanical-draft evaporative cooling tower containing five cells will be used for the removal and dissipation of 143 MWt/h ( $487 \times 10^6 \text{ Btu/h}$ ) of process waste heat. The cooling system will have a circulation rate of 2.23 m<sup>3</sup>/s (35,360 gpm) and will operate at five cycles of concentration. The makeup stream, at a rate of 0.072 m<sup>3</sup>/s (1150 gpm), will be supplied primarily by the MLGW Davis pumping station. In an effort to conserve city water, 22 gpm of clean condensates from utilities and air separation areas will enter the makeup stream. Also, design revisions have been made which will provide for the recycle of up to 110 gpm of treated process wastewaters of acceptable quality. These streams are treated storm-water runoff, which are low in organic components. Once the operating results establish the properties of plant wastewaters, additional treated effluents may supply a portion of the cooling system makeup, if their quality is suitable; complete treatment for all inorganic/organic contaminants would be provided.

Moisture and drift emissions from the cooling tower are described in Sect. 2.2.1.11. The cooling water contains additives for corrosion inhibition as well as for algicide and biocide purposes. Its composition is

| <u>Component</u>                                          | <u>Concentration (mg/liter)</u> |
|-----------------------------------------------------------|---------------------------------|
| Total dissolved solids                                    | 600 to 1000                     |
| Total suspended solids                                    | 100 to 200                      |
| Chemical oxygen demand (COD)                              | 50 to 300                       |
| Hexavalent chromium                                       | 5 to 15                         |
| Zinc                                                      | 3 to 10                         |
| Free available chlorine                                   | 0 to 5                          |
| Biocide (2,2-dibromo, 3-nitrilopropionamide and residues) | <30                             |
| Total organic carbon (TOC)                                | 15 to 100                       |
| Oil and grease                                            | 5 to 15                         |

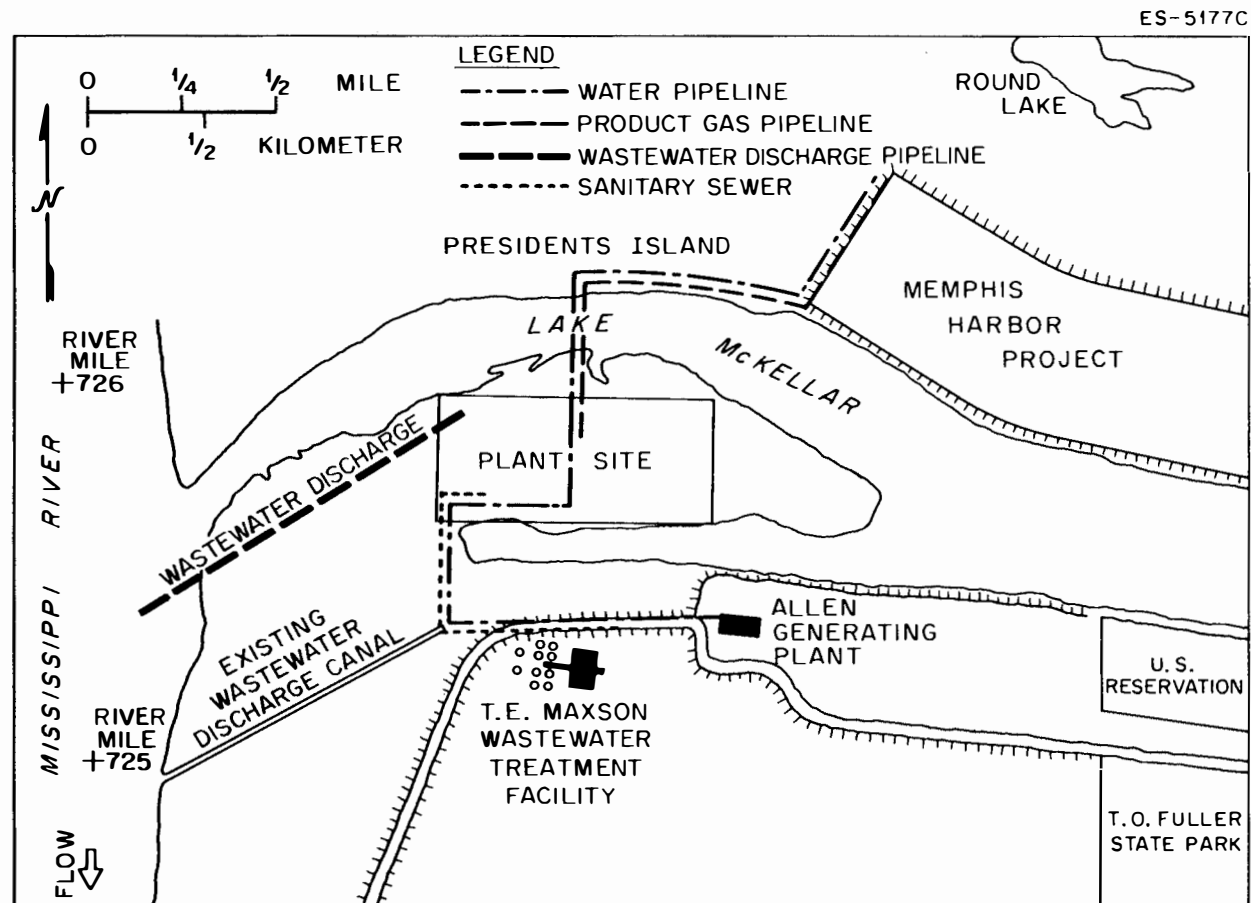


Fig. 2.4. Location of offsite water, wastewater, and sanitary sewer pipelines and product gas pipeline. Source: ER, Fig. 2-6, p. 2-11.

Evaporation of cooling water results in increased solids content. To maintain this content at levels shown in the above table, a blowdown stream is directed to wastewater treatment.

#### 2.2.1.6 Coal unloading and storage system

Barges will be unloaded by rotary bucket equipment having minimal dust emission characteristics. Coal will be moved from the barge-unloading area to the coal storage areas by covered belt conveyor. The active storage pile (14-d coal inventory) will occupy 0.6 ha (1.4 acres). The long-term storage pile (30- to 90-d coal inventory) will occupy 1.5 to 4.6 ha (3.8 to 11.4 acres). The coal storage areas will be subject to wind erosion and dusting but will be controlled by surfactants on the active coal pile and a crusting agent on the long-term storage pile. These areas are in the southeast corner of the plot plan (Fig. 2.2).

The normal potential uncontrolled fugitive emissions from the coal and coke supply, handling, preparation, and storage system are estimated to be 120 tons per year of coal dust. The employment of control technologies (including wet suppression surfactants on the live coal pile, crusting agents on the dead coal pile, fabric filters for silos, and covered conveyors) is expected to significantly reduce normal coal dust emissions. There is an ongoing review of fugitive emissions as part of the prevention of significant deterioration (PSD) permitting procedure. Because of the small inventory of coke, which will be stored in a silo, the particulate emissions from coke storage are insignificant.

The coal storage areas will be equipped with 36-mil Hypalon liners, a 0.6-m (2-ft) sand blanket over the liners, and an underdrain system. The collected coal pile runoff will be neutralized, aerated, and clarified to remove heavy metals and to control pH and TSS.

Details of the liner, underdrain, and sump system are described in Sect. 2.2.1.8.

#### 2.2.1.7 Coal preparation facility

Raw coal is conveyed from coal storage and is fed to a dryer mill, where the coal is simultaneously crushed as required and is dried at controlled temperature by contacting an air and coal fines combustion gas. Dried 6-mm (0.25-in.) top-size coal is separated in cyclones from the moist drying gas, and the coal is stored in the coal silo. Fines from the moist drying gas are removed by passing the gas at controlled temperature through a filter, and filtered gas is recycled to the dryer mill. To maintain a balance on the water evaporated from the coal, a portion of the recycled moist gas is routed to the flue-gas-scrubbing system in flue gas desulfurization (FGD) (Sect. 2.2.1.11). Conveyors in the preparation facility are enclosed for loss prevention.

The coal silo is sized for a surge capacity of 12 h and, like the coke silo, is maintained under a nitrogen atmosphere to minimize the possibility of spontaneous combustion. Coal from coal silos is conveyed to the coal feeding system, which consists of a series of three consecutive hoppers: (1) a receiving hopper, (2) lock hoppers, and (3) two injection hoppers. Each of the four gasifiers has its own feeding system. During operation, the lock hoppers are pressurized with nitrogen, and the injection hoppers are pressurized with IFG. Coke is used to preheat the gasifier during startup, after which coal is fed to the process.

Coal fines recovered in the dryer mill filter and coke fines recovered from the coke dryer exhaust filter are used inside the plant as fuel. These fines are used to supplement fuel needs in either the dryer mill or in the steam generation boiler of the plant steam generation system. Excess fines are transported to the coal silo for storage.

To minimize fugitive emissions, the following dust collection and suppression systems are provided in this part of the plant. Dust collection systems consist of filters with an over 99% removal efficiency, fans, and dust pickup ducting in the coal crushing and drying system as well as in the vent systems for the dried coal and coke silos and the lock hoppers.

#### 2.2.1.8 Solid waste storage system

The solid wastes produced by the demonstration facilities include agglomerated ash from coal gasification, fly ash and bottom ash from steam generation, sludge from FGD, sludge from wastewater treatment, and spent catalysts from various process modules. The plant will landfill only nonhazardous solid wastes on site. Any hazardous wastes will be trucked off site within 90 d of generation, as is required by the State of Tennessee. While on site in temporary storage, the waste will be contained in leak-proof tanks and handled in accordance with RCRA. This waste will be disposed of at an EPA-approved facility, such as "Chemical Waste Management of Alabama," located near Livingston, Alabama, about 434 km (270 miles) from the site. Storm water falling on nonhazardous solid waste landfills will be collected as leachate and monitored and discharged with plant wastewater. The leachate will be treated in the wastewater treatment system if monitoring indicates it to be necessary.



Initial studies [using current RCRA criteria, 40 CFR Part 261 Subpart C (45 FR 33122, May 19, 1980)] indicate that the gasifier ash is nonhazardous and that its leachates will not require treatment. The waste does not meet Subpart B criteria to designate it "acute" or "toxic" hazardous waste; it is not ignitable by the Environmental Protection Agency's (EPA's) definition; it is not corrosive, unstable, or explosive; and the RCRA toxicity standards (greater than 100 times the interim primary drinking water standards for the criteria elements) are not exceeded. No current plans exist for ash pile leachate treatment. However, leachates will be monitored and, if necessary, routed to wastewater treatment (see Appendix C.2.2) prior to release. Proposed trigger levels to initiate treatment are based on Tennessee Effluent Standards and U.S. EPA aquatic life water quality criteria, as follows:

| <u>Frequency parameters</u> | <u>Species</u>              | <u>Expected leachate quality, mg/liter</u> | <u>Trigger level,* mg/liter</u>                       |
|-----------------------------|-----------------------------|--------------------------------------------|-------------------------------------------------------|
| Daily 24-h composite        | Mn                          | <0.1                                       | 10                                                    |
|                             | Fe                          | <0.07                                      | 10                                                    |
|                             | Oil and grease              | <2.0                                       | 30                                                    |
| Weekly 24-h composite       | As                          | <0.03                                      | 1.0                                                   |
|                             | Ba                          | <0.25                                      | 5.0                                                   |
|                             | Cd                          | <0.003                                     | 0.01                                                  |
|                             | Cr                          | <0.005                                     | 3.0                                                   |
|                             | Pb                          | <0.01                                      | 0.1                                                   |
|                             | Hg                          | <0.0008                                    | 0.05                                                  |
|                             | Se                          | <0.008                                     | 0.01                                                  |
|                             | Ag                          | <0.004                                     | 0.05                                                  |
| Monthly 24-h composite      | Organic priority pollutants | Less than detectable                       | Less than EPA water quality criteria for aquatic life |

\* All trigger levels are equivalent to Tennessee Effluent Standards for General Industry except as noted.

Nonhazardous solid wastes, including sludge from chromate destruct, will be disposed of in onsite landfills. The waste disposal area will be divided into a short-term, storage-landfill facility, covering the first four years of operation, and a long-term landfill. It is anticipated that most of the nonhazardous solid wastes will be commercially valuable. Therefore, it is likely that most of this waste will be sold, and, consequently, there will be no need for long-term disposal of all nonhazardous solid wastes. Should no market develop, the long-term landfill, as shown in Figs. 2.2 and 4.7, can accommodate the volume of solid waste generated over about nine years of plant operation. If landfilling of nonhazardous solid wastes is required over the lifetime of the plant, either the long-term disposal area will be enlarged or the waste will be transported off site. Transportation by barge would require approximately one barge cluster per month or 15 trucks per day. No offsite, nonhazardous solid waste disposal area has been identified. The disposal areas will be enclosed in dikes at the plant grade level of 71 m (233 ft) above mean sea level. The bottoms of the short-term and long-term landfills will be at a 69-m (227-ft) elevation. The short-term landfill will be equipped with a 0.6-m (2-ft) protective layer of sand, a 36-mil Hypalon liner, and a subdrain collection system. Hypalon, a synthetic rubber (chlorosulfonated chlorinated polyethylene) developed by DuPont in the early 1960s for specialty applications, is the recommended liner material for the coal storage areas and the short-term gasifier ash storage area. The alternatives, PVC materials, are less resistant to the low pH leachate expected from the coal areas.

The design includes a 0.6-m (2-ft) layer of protective sand, a 36-mil Hypalon liner, and an under-drain collection system. Burying the membrane has numerous advantages: protection from heat, sun, and mechanical damage so that chemical changes would occur at a much lower rate, and tears in the liner will be effectively precluded. Finally, if any stress should develop in the liner because of shrinkage, chemical change, absorption, or extraction, the liner will be clamped between the earth on top and the earth below and will therefore resist dimensional change.

Hypalon liners are practically impermeable (less than  $10^{-12}$  cm/s), and the expected lifetime is in excess of 50 years.

The short-term liner area will be sloped, with the low end at a 69-m (227-ft) elevation and the high end at a 70-m (229-ft) elevation. Leachate will flow along the liner through both the sand layer and a gravel barrier into the 3- by 4-m (10- by 12-ft) concrete sump with a pump inlet at the 69-m (227-ft) elevation. Dual 0.01 m<sup>3</sup>/s (150-gpm) pumps and 15-cm (6-in.) discharge lines are provided in the solid waste storage rainwater sump. The sumps, pumps, and pipelines are freeze

protected. A grating covers the sump. The subdrain system will have a separate (telltale) sump so that detection of liner leaks will be facilitated. A tight shutoff sluice gate isolates the subdrain (telltale) drain sump from the main rainwater sump.

Details of the ash disposal sump construction are shown in Fig. 4.5.

The short-term landfill will allow evaluation and testing of the ash with the intent of marketing it commercially.

The experience gained from the operation of the short-term facility will aid in determining the design requirements for the long-term landfill. The storage areas are located in the northeast portions of the plot plan (Fig. 2.2).

The gasifier ash will be segregated from the FGD sludge, boiler ash, and other wastes in the short-term landfill. This measure will allow the marketing and sale of the ash for construction or other purposes. If no market develops for the wastes, no efforts will be made to segregate the wastes in the long-term landfill.

The solid wastes from the demonstration facilities are

Gasifier agglomerated ash, 22,490 kg/h (49,583 lb/h)

| <u>Composition</u> | <u>Emission</u> |             |
|--------------------|-----------------|-------------|
|                    | <u>kg/h</u>     | <u>lb/h</u> |
| Ash                | 16,080          | 35,452      |
| Water              | 4,498           | 9,917       |
| Carbon             | 1,237           | 2,727       |
| Sulfur             | 360             | 793         |
| Nitrogen           | 225             | 496         |
| Hydrogen           | 90              | 198         |

Sludge from FGD, 3479 kg/h (7670 lb/h)

| <u>Composition</u>              | <u>Emission</u> |             |
|---------------------------------|-----------------|-------------|
|                                 | <u>kg/h</u>     | <u>lb/h</u> |
| CaSO <sub>3</sub>               | 1900            | 4190        |
| H <sub>2</sub> O                | 1470            | 3240        |
| Na <sub>2</sub> SO <sub>3</sub> | 95              | 210         |
| Ash                             | 14              | 30          |

Sludge from wastewater treatment, 453 kg/h (1000 lb/h)

| <u>Composition</u> | <u>Emission</u> |             |
|--------------------|-----------------|-------------|
|                    | <u>kg/h</u>     | <u>lb/h</u> |
| H <sub>2</sub> O   | 318             | 700         |
| CaCO <sub>3</sub>  | 75              | 165         |
| Suspended solids   | 61              | 135         |

Sludge from chromate destruct, 167 kg/h (325 lb/h)

| <u>Composition</u>  | <u>Emission</u> |             |
|---------------------|-----------------|-------------|
|                     | <u>kg/h</u>     | <u>lb/h</u> |
| H <sub>2</sub> O    | 103             | 227         |
| Suspended solids    | 19              | 42          |
| Fe(OH) <sub>3</sub> | 15              | 33          |
| Cr(OH) <sub>3</sub> | 8               | 18          |
| Zn(OH) <sub>2</sub> | 2               | 5           |

Used activated carbon will be processed on site, in a furnace, for reuse. Nonhazardous spent catalysts in the maximum amount of 39.2 tons per year will be landfilled on site according to the resource inputs shown in Appendix B.0.3. Most of this is bauxite from Claus conversion. The nickel catalysts would probably warrant reclaiming (off site) because of value.

#### 2.2.1.9 Acid-gas removal and sulfur recovery

Gas treatment is necessary to remove environmentally unacceptable sulfur compounds and cyanides from the gasifier output. The demonstration plant will employ the Selexol process, which uses a proprietary solvent to absorb selectively hydrogen sulfide, carbonyl sulfide, HCN, and some carbon dioxide from the fuel gas.

The sulfur compounds are concentrated in the off-gas streams of the Selexol process and the sour-water stripper. These acid-gas streams are treated in a Claus sulfur-recovery process, which destroys HCN and converts 96 to 97% of the gas-sulfur content of the gas to pure liquid sulfur at a rate of 100 tons/d. Even at this level of recovery, the Claus tail-gas has an unacceptable sulfur content; the tail-gas will therefore be treated in a Beavon-Stretford process wherein most of the remaining hydrogen sulfide is absorbed in a reagent solution and oxidized to elemental sulfur. The treated tail-gas has less than 10 ppm hydrogen sulfide and less than 200 ppm total sulfur. The Claus and Beavon-Stretford combination gives an overall sulfur recovery of over 99.95%. The composition of the treated tail-gas is given in Sect. 2.2.1.11. Its CO<sub>2</sub> content is high enough that a vent gas heater is provided to give adequate plume rise for dispersion of residual gaseous pollutants.

The vent-gas outlet is continuously analyzed for H<sub>2</sub>S to detect any malfunction in the environmental control equipment. Any excessive concentrations are immediately brought to the operator's attention to be corrected.

#### 2.2.1.10 Flare system

The smokeless plant flare operates on a pilot continuously fired by natural gas. Vents and safety valves in the various process units are piped into the flare. The flare will be used for disposal of off-specification gases generated during startup, shutdown, and abnormal operating sequences. The flare incorporates best available design features for safety and public health protection:

1. a continuous flame monitor with alarm,
2. remotely operated flame ignitors to allow for quick ignition in the event the pilot is extinguished,
3. multiple pilots to increase ignition probability, and
4. a flame stability retention ring to inhibit blowoff.

The flare handles 21 m<sup>3</sup>/s (45,000 scfm) of gasifier product gas during temporary operating conditions (startup and shutdown of a gasifier). It also handles 71 m<sup>3</sup>/s (150,000 scfm) of product gas if diversion of product from the pipeline is necessary because of the inability of the pipeline to accept the gas.

See Appendix B.0.2 for source parameters of the flare.

#### Controlled combustor

The controlled combustor system provides for the routine incineration of combustible vapors and gases during periods of normal plant operation and under temporary operating conditions. In the controlled combustor, various selected gas streams containing atmosphere-polluting contaminants (e.g., sulfur compounds, carbon monoxide, combustible hydrocarbons, and ammonia) are destroyed. Because controlled combustion is also required during operating upsets or during intermittent discharges, some additional streams are directed to the controlled combustor.

The controlled combustor system provides a means of destroying trace hydrocarbons, combusting carbon monoxide, and converting sulfur compounds into sulfur dioxide in various process vent gases. The controlled combustor is designed so that the vent-gas is contacted with an excess amount of air at a minimum residence time of 1 s and produces an 815°C (1500°F) minimum flue gas temperature before air preheat. A high degree of turbulence is provided to ensure the thorough mixing of combustibles with oxygen.

The heat available from the combustion of wastes is not always sufficient to make the controlled combustion process self-supporting. Product IFG is normally burned as required to make the operation self-sustaining. The maximum required IFG feed rate is 0.268 kg/s (2125 lb/h) corresponding to a maximum heat input rate of 25.6 MW (87.5 x 10<sup>6</sup> Btu/h). The normal heat input rate is 7.5 MW (25.7 x 10<sup>6</sup> Btu/h). During startup and emergency operations, natural gas supplies the necessary fuel value.

The primary air needed to combust the fuel gas is preheated in a heat exchanger by using the controlled combustor flue gas as the heating medium. Secondary air needed for the combustion of the off-gases is also preheated in a similar fashion. Quench air enters the controlled combustor at ambient conditions as required to maintain the combustor flue gas temperature at or below 980°C (1800°F). Combustion air is supplied by a motor-driven blower (included in the controlled combustor package) for all requirements including primary, secondary, and quench air.

After heat exchange with the combustion air, the flue gases are mixed with the moist flue gases at about 54°C (130°F) from FGD and are dispersed to the ambient atmosphere through the stack. To maintain good dispersion of the stack effluents, under all atmospheric conditions, a minimum effluent temperature of 121°C (250°F) is necessary. The controlled combustor operates continuously, and its flue gas supplies this heat under all operating conditions.

Streams normally routed to the controlled combustor during plant operation include

- Off-gas from the credit generation Benfield unit. The process basically removes carbon dioxide and the bulk of the sulfur compounds present in the product gas feed stream. The off-gas is rich in carbon dioxide and water vapor, with residual amounts of hydrogen sulfide present.
- Vent gas from the feed lock hoppers in coal preparation and feeding feeds the controlled combustor on regular cycles. The hoppers are pressurized with a combination of product gas and nitrogen. A portion of this gas is sent to the controlled combustor during loading of the coal feed.
- Carbon dioxide-rich vent-gas from gas treatment, produced from the two-stage Selexol process. This gas, containing carbon monoxide and traces of reduced sulfur compounds, is continuously fed to the controlled combustor.

Streams discharged to the controlled combustor during temporary operating conditions include

- An emergency load from sulfur recovery, which is combusted in the controlled combustor during upset conditions when the sulfur recovery system cannot accept feed. This vent-gas stream is rich in hydrogen sulfide, carbonyl sulfide, and ammonia. Incineration of sulfur recovery feed is restricted to 0.5 h or less. Longer periods of time (up to 3 h) will be handled by flaring gasifier output.
- Gas from emergency condition tail-gas treatment, which will be vented if the Beavon package is shut down. This vent-gas stream is rich in carbon dioxide, nitrogen, and water.
- If the fines recycle to the gasifier is not operating, a vent stream containing carbon monoxide as the major pollutant will be sent to the controlled combustor from coal gasification.

#### 2.2.1.11 Analysis of air emission sources

##### Normal operations

Atmospheric emissions from normal operations include the following sources:

- dust losses from coal supply and preparation,
- treated sulfur-recovery tail-gas,
- plant flare pilot combustion gas,
- scrubbed boiler flue gas, including controlled combustor off-gas, and
- cooling tower evaporation and drift.

Coal will be moved from the barge unloading area to the coal storage areas by covered conveyor. The storage areas will be subject to wind erosion and dusting.

The normal potential uncontrolled fugitive emissions from the coal and coke supply, handling, preparation, and storage system are estimated to be 120 tons per year of coal dust. The employment of control technologies (including wet suppression surfactants on the live coal pile, crusting agents on the dead coal pile, fabric filters for silos, and covered conveyors) is expected to control normal coal dust emissions. Because of the small inventory of coke maintained at the site and stored in a silo, the particulate emissions from coke storage are insignificant.

Treated tail-gas from the Stretford sulfur recovery process has less than 10 ppm hydrogen sulfide and less than 200 ppm total sulfur, representing best available control technology (BACT) for this application. The emissions of the treated tail-gas stream are

| <u>Component</u>                                             | <u>Emission</u> |             |
|--------------------------------------------------------------|-----------------|-------------|
|                                                              | <u>kg/h</u>     | <u>lb/h</u> |
| H <sub>2</sub> S                                             | 0.23            | 0.5         |
| CO <sub>2</sub>                                              | 0.91            | 2           |
| CS <sub>2</sub>                                              | 0.05            | 0.1         |
| CO                                                           | 9.1             | 20          |
| NO <sub>x</sub>                                              | 5.9             | 13          |
| Balance (CO <sub>2</sub> , N <sub>2</sub> , H <sub>2</sub> ) | 23,926          | 52,710      |

The controlled combustor system accommodates the lock-hopper vent gases, the CO<sub>2</sub> vent gas from gas treatment, and the CO<sub>2</sub> off-gas from credit generation.

The heat available from the controlled combustion process is not sufficient to make the process self-supporting. As is described in Sect. 2.2.1.10, product fuel gas is normally burned at the rate of 0.268 kg/s (2125 lb/h) (Table 2.2) to make the process self-sustaining.

The flue gases from the controlled combustor are mixed with the flue gases from the FGD unit. The combined flue gases are then dispersed to the ambient atmosphere by means of a stack. To maintain good dispersion of the stack effluents, a minimum effluent temperature of 121°C (250°F) is necessary. The controlled combustor flue gas supplies this heat under all operating conditions.

During normal operations, the plant flare operates on a pilot continuously fired by natural gas. Under these conditions, the emission of sulfur dioxide, carbon monoxide, nitrogen oxides, hydrocarbons, and particulates are each under 0.0045 kg/h (0.01 lb/h). The flare receives the discharge from vents and safety valves in the various process units. As discussed in Sect. 2.2.1.10, the flare will be used for disposal of off-specification gases generated during startup, shutdown, and abnormal operating sequences. The flare will combust these gases with an efficiency of over 99%.

If uncontrolled, the auxiliary coal-fired boilers would emit large quantities of particulates and sulfur dioxide. The demonstration plant will feature either a fabric filter baghouse or an electrostatic precipitator to remove 99.4% of the fly ash from the flue gas. Current plans call for the particulate-free flue gas to be treated for sulfur dioxide removal by either the Food Machinery Corporation (FMC) double-alkali process or the Chiyoda Thoroughbred process. Ninety percent of the sulfur dioxide is removed by either of these processes. Boilers will be design guaranteed at  $\leq 0.29$  kg (0.63 lb) NO<sub>x</sub> per 10<sup>9</sup> J (10<sup>6</sup> Btu) input, which is below the Tennessee NSPS of 0.32 kg (0.7 lb) for NO<sub>x</sub> per 10<sup>9</sup> J (10<sup>6</sup> Btu). The maximum atmospheric emissions from the FGD unit combined with the vent gases from the controlled combustor are

| Component                                                    | Emission |         |
|--------------------------------------------------------------|----------|---------|
|                                                              | g/s      | lb/h    |
| SO <sub>2</sub>                                              | 37.2     | 295     |
| NO <sub>x</sub>                                              | 58.0     | 460     |
| CO                                                           | 3.4      | 27      |
| Particulates                                                 | 4.4      | 35      |
| Hydrocarbons (as CH <sub>4</sub> )                           | 0.8      | 6       |
| CO <sub>2</sub>                                              | 31,250   | 248,080 |
| Balance (N <sub>2</sub> , H <sub>2</sub> O, O <sub>2</sub> ) | 61,110   | 484,665 |

The cooling tower will be a source of water vapor and drift particulates. The evaporation rate will be 208,400 kg/h, or 57.4 liters/s (459,500 lb/h, or 918 gpm). The drift loss will be approximately 0.05% of the circulating water flow, or 1.1 liters/s (17.7 gpm). Drift consists of droplets of cooling water that are entrained in the cooling tower exhaust. Therefore, the drift will have the same composition as the circulating water as given in Sect. 2.2.1.5.

The total air emissions are summarized below.

| Component                          | Emission   |      |
|------------------------------------|------------|------|
|                                    | kg/s       | lb/h |
| SO <sub>2</sub>                    | 0.0372     | 295  |
| NO <sub>x</sub> as NO <sub>2</sub> | 0.0596     | 473  |
| CO                                 | 0.0059     | 47   |
| Particulates                       | 0.0044     | 35   |
| Hydrocarbons (as CH <sub>4</sub> ) | 0.0007     | 6    |
| NH <sub>3</sub>                    | 0.0001     | 1    |
| COS                                | 0.0003     | 2    |
| HCN                                | Negligible |      |
| CS <sub>2</sub>                    | 0.00001    | 0.1  |
| H <sub>2</sub> S                   | 0.00006    | 0.5  |

#### Effluents from construction

Construction activities have the potential for affecting air quality in the immediate vicinity of the proposed site. Atmospheric emissions include (1) fugitive dust and particulates from staging and construction activities and (2) hydrocarbons, oxides of nitrogen, and carbon monoxide from vehicular traffic. The expected maximum emissions based on the third edition of AP-42 from the operation of heavy equipment and vehicles are

| <u>Component</u>                   | <u>Emission rate</u><br><u>kg/s (tons per year)</u> |
|------------------------------------|-----------------------------------------------------|
| Nitrogen oxides (NO <sub>x</sub> ) | 54.1 (214.7)                                        |
| Carbon monoxide (CO)               | 11.0 (43.7)                                         |
| Hydrocarbons                       | 2.7 (10.7)                                          |
| Exhaust particulates               | 2.2 (8.9)                                           |

#### Effluents from temporary operating conditions

The primary source of pollutant emissions will be the products of combustion (SO<sub>2</sub>, NO<sub>2</sub>, and particulates) resulting from the flaring of process gases. Emissions during abnormal operating conditions are summarized below.

| <u>Source</u>                            | <u>Emission</u>                                                                  |
|------------------------------------------|----------------------------------------------------------------------------------|
| Effluent from startup of gasifier        | 21.2 m <sup>3</sup> /s (45,000 scfm) to flare<br>(off-specification product gas) |
| Effluent from shutdown of gasifier       | 21.2 m <sup>3</sup> /s (45,000 scfm) to flare<br>(product gas)                   |
| Diversion of gas from pipeline           | 70.8 m <sup>3</sup> /s (150,000 scfm) to flare                                   |
| Startup/shutdown of sulfur-recovery unit | 2.9 m <sup>3</sup> /s (6200 scfm) to controlled<br>combustor                     |

The emission rates of NO<sub>x</sub> and particulates are dependent on the gas composition and operating conditions of the flare and cannot be predicted from currently available design information. Sulfur dioxide emissions will be less than 2.2 kg/s (4.9 lb/s), corresponding to the release of all the sulfur in the gasifier feed. This value is extremely conservative. Hydrocarbon emissions will be limited to 6.75 kg/h (15 lb/h) during sulfur recovery unit emergencies, and the design maximum emission rate is 9.0 kg/h (20 lb/h). Emissions from startup operations are minimized by a phased startup sequence for each gasifier. This includes a refractory heatup period under oxidizing conditions firing natural gas-air, followed by low-sulfur (0.8% S) coke heating and combustion, again under oxidizing conditions and using low-volatile fuel. Flue gas particulate removal occurs at 121°C (250°F) prior to flaring. After achieving 1024°C (1875°F) in the gasifier, gasification reactions on coke begin. Emission hazards of organometallics and PAH are thereby avoided. Once temperature and pressure are suitable for operating downstream sulfur removal equipment, gasification on coal begins.<sup>4</sup>

Catalyst decommissioning and replacement is done at intervals of three to five years and does not give emission increases of any pollutants. Nitrogen purging is used on Claus/Beavon catalysts to remove H<sub>2</sub>S, which is fed to the controlled combustor. N<sub>2</sub> purging is used on credit generation catalysts to sweep combustible vapors which are fed to the flare.

During the life of the plant, it is possible that process heat exchangers may fail and allow gases containing carbon monoxide and hydrogen sulfide to enter the cooling water. As part of normal design procedures, however, each exchanger is individually designed with materials of construction and corrosion allowances. Additionally, regularly scheduled maintenance procedures will be performed and parts replaced as needed to prevent such a failure. Finally, gas-monitoring probes at the cooling tower itself will provide a fast and effective detection backup in the unlikely event a failure should occur. In that event, the affected exchanger will be isolated and bypassed. If the faulty heat exchanger cannot be isolated, major leaks would require plant shutdown.

#### 2.2.1.12 Barge facility

Coal will be delivered to the plant by 1500-ton barges.

Docking facilities on the south side of the plant (see Fig. 2.2) are sized to handle clusters of 9 or 16 coal barges at one time. The facilities include a string of dock/mooring cells fabricated from interlocking steel sheet piling, each cell filled with river-run sand and gravel and capped by a 30-cm-thick (12-in.) reinforced concrete slab.

Facilities to unload individual coal barges are located at the midway point in the mooring cell line and are accessible from shore via trestle roadway. Fugitive emissions of dust will be controlled through the application of a foam-type chemical surfactant at the barge unloader.

### 2.2.1.13 Conveyors

Within the plant, coal will move on covered belt conveyors from the barge-unloading area on the south side of the plant through the sampling station to the live storage pile and on to the coal preparation area. Coke used in the plant will be delivered by truck. The alignment is shown in Fig. 2.2.

To minimize fugitive emissions, all coal and coke conveyor systems will be partially enclosed by top and side coverings, using hoods that extend down to the conveyor supports. All transfer points are enclosed with platework. Deck plates are used between the carrying and return runs of the belt, and wind guards are provided for conveyors located outside.<sup>5</sup>

### 2.2.1.14 Transmission lines

Electric power will be provided by MLGW. An overhead 161-kV transmission line will be constructed to accommodate the expected demand of 45 MW during operation. The transmission line will extend along the access road from the Allen Generating Plant. Telephone lines will follow the same route.

### 2.2.1.15 Product storage

No liquid hydrocarbon products are produced at the MLGW project. Gaseous products are dispatched through pipelines. Liquid sulfur by-product is shipped out by tank truck. Storage for sulfur is provided on site for 15 d at 100 tons/d. Standard commercial systems (as recommended by the Sulfur Institute) for prevention of the loss of sulfur will be used.

### 2.2.1.16 Pipelines and rights-of-way

The product IFG will be transported by pipeline beneath Lake McKellar to the independent IFG distribution system. About 10% of the IFG is methanated on site to form SNG and is discharged to the existing natural gas distribution system.

The product rates are

|                        |                        |                               |
|------------------------|------------------------|-------------------------------|
| Industrial fuel gas    | 50.5 m <sup>3</sup> /s | (154 x 10 <sup>6</sup> scfd)  |
| Substitute natural gas | 1.4 m <sup>3</sup> /s  | (4.30 x 10 <sup>6</sup> scfd) |

Water will be supplied to the demonstration plant from the Memphis municipal water supply system. Two pipelines are proposed, with independent capacities to supply 0.175 x 10<sup>6</sup> m<sup>3</sup>/s (4 x 10<sup>6</sup> gpd) from the existing distribution system. A 41-cm-diam (16-in.) pipeline will supply a maximum flow of 233 liters/s (3700 gpm) from a connection to the existing distribution system at Presidents Island, whereas the other 41-cm-diam (16-in.) pipeline will supply a maximum flow of 139 liters/s (2200 gpm) from a connection at the Allen Generating Plant.

A 20-cm-diam (8-in.) sanitary sewer pipeline will extend to the T. E. Maxson Wastewater Treatment Facility. Process wastewaters and rainfall runoff from process areas will be treated and discharged via a 46-cm-diam (18-in.) pipeline into the Mississippi River. The wastewater pipeline will be placed in a dredged trench and will extend to a submerged outfall.

A 41-cm-diam (16-in.) pipeline will be constructed to supply SNG to the existing MLGW system. The pipeline will be buried a minimum of 1.06 m (3.5 ft) underground.

At present, the distribution system for the IFG product has not been finalized. The conceptual distribution system is 39 km (24 miles) and extends across Lake McKellar to Channel Avenue on Presidents Island. Class M piping will be used for maximum reliability and integrity.

Crossing Lake McKellar will require dredging a length of about 270 m (885 ft). In the navigation channel, the tops of the pipes will be at least 6 m (20 ft) below the low-water reference plane. Both the water supply and IFG pipeline will be constructed in the same time period and located in a common right-of-way. Submerged lengths will be anchored with concrete weights to avoid obstruction of river traffic. Construction of the pipelines will conform to dredging requirements of the U.S. Army Corps of Engineers. The actual submerged length of pipelines will be determined in conjunction with these requirements.

Access to the site will be made along a public road, 9 m (30 ft) in width, to be constructed west of the Allen Generating Plant. The access road will curve north at the T. E. Maxson Wastewater Treatment Facility discharge channel and extend north along the western boundary of the site. The access road will provide routing for the power and telephone lines and the natural gas, water, and sewer pipelines.

A railroad spur up to 305 m (1000 ft) long is contemplated along the existing levee to enable off-loading of equipment during construction. This spur would connect to the existing spur that services the Maxson facility. Service of the rail spur will be discontinued after construction.

#### 2.2.1.17 Pollution control during construction

Drainage of dredged fill material (Sect. 4.1.6.1) and rainfall erosion into Lake McKellar will be mitigated by use of a settling basin in the construction area. About  $4.6 \times 10^6 \text{ m}^3$  ( $6 \times 10^6 \text{ yd}^3$ ) of sandy fill material is involved.

All construction debris will be removed by truck to a commercial sanitary landfill.

Portable toilets for the work force will be emptied by pumper tank truck and discharged to the city sewage treatment system.

To the maximum extent practical, wood from site clearing will be sold or chipped and then sold rather than burned.

Water spray will be used for fugitive dust control on roadways prior to paving. Grass seeding will be used on open areas.

Onsite topsoil will be reclaimed prior to filling the site with dredged material.

Construction heating will use propane-fired equipment, with minimal impact.

#### 2.2.1.18 Hazards identification

The process used to identify the hazards in the proposed facility was to examine the project literature and to discuss with the project design team their design philosophy, the design criteria, and measures taken to deal with hazards. It is recognized that such a facility will inherently contain many normal industrial hazards; because of their number, careful attention must be given during the design phase to ensure that reasonable protection is afforded onsite personnel. This survey has not focused on the normal or usual industrial hazards; rather, an attempt has been made to identify hazards whose potential effect or likelihood of occurrence is greater than usual.

At an early stage in the evolution of a facility design, it is not possible to predict accurately the likelihood of occurrence of an accident. Identification of and subsequent design attention to a potential accident should mitigate against occurrence. Further, corrective actions taken during the startup phase of a program will generally significantly reduce the likelihood of accidents. Table 2.3 indicates the type of accidents considered and the general classes of causes that might precipitate such accidents.

Table 2.3 Cause and accident codes

| Code | Cause                                                                                              | Code | Accident                   |
|------|----------------------------------------------------------------------------------------------------|------|----------------------------|
| 1    | Process boundary breach due to normal pressure-temperature stresses, erosion, corrosion            | 1    | Explosion                  |
| 2    | Process boundary breach due to abnormal process conditions (process upsets, operator error)        | 2    | Fire                       |
| 3    | Equipment malfunction (excessive wear, improper installation, maintenance, ignition sources, etc.) | 3    | Hazardous material release |
| 4    | External loadings (onsite or offsite vehicles, missiles from in-plant accidents, etc.)             |      |                            |

Table 2.4 summarizes qualitatively the hazards identification effort, on a plant area basis, of the events considered in each plant section. However, the summation presents considerations at the component level. At the component level, the design conditions are nominal, and the intention is to design to national consensus standards (ASME, for instance). On a broad basis,



Table 2.4 Initial hazards survey, MLGW gasification project

| Plant section            | Cause/accident <sup>a</sup>            | Effect                                                                                                                                                                                                        | Likelihood | Remarks                                                                                                                                                                                                                                                                          |
|--------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 310<br>Air Separation    | 1/2, 2/2, 3/2                          | Fires are possible, but their magnitude is not expected to be significant                                                                                                                                     | Low        | This is a conventional air separation plant. Maximum storage capacity is 12-h supply. Maximum pressure is a nominal 125 psig                                                                                                                                                     |
|                          | 1/1, 2/1, 3/1                          |                                                                                                                                                                                                               | Low        | Secondary fires are possible. A 125-psig system does not constitute a significant hazard                                                                                                                                                                                         |
| 390<br>Tail Gas Treating | a. 1 → 4/2                             | a. Local fires                                                                                                                                                                                                | a. Low     | This system is a conventional gas treating system. The design parameters of pressure, temperature, materials are nominal                                                                                                                                                         |
|                          | b. 1 → 4/1,3                           | b. Significant quantities released probably would not occur with a major rupture of the process boundary. Numerous hazardous materials involved. See process description for magnitudes                       | b. Low     |                                                                                                                                                                                                                                                                                  |
| 460<br>Flare             | 1 → 4/1 → 3                            | Fires or explosions would have local effect only. Direct or indirect release of flammable, toxic, and explosive gases. Quantity of such release not determined but can be minimized by prompt operator action | Low        | Perhaps the most likely source of an accident would be oxygen suck-back after a hot flare, but an automatic purge system will be utilized to mitigate against this accident occurring                                                                                            |
| 430<br>Utility Area      |                                        |                                                                                                                                                                                                               |            |                                                                                                                                                                                                                                                                                  |
| 1. Incineration          | 1. 3/1-3                               | 1. Loss of flame or other malfunctions could lead to an explosion and/or release gases to atmosphere                                                                                                          | 1. Low     | 1. This is a conventional, continuous operation process. The ability to control inputs to this plant section should mitigate against significant releases to the environment                                                                                                     |
| 2. Steam generation      | 2. 1 → 3/1,2                           | 2. Explosion and fire with onsite effects                                                                                                                                                                     | 2. Low     | 2. This is a conventional steam plant which has many inherent industrial hazards. Offsite impacts are not likely                                                                                                                                                                 |
| 3. Raw water storage     | 3. No significant accidents postulated |                                                                                                                                                                                                               |            |                                                                                                                                                                                                                                                                                  |
| 4. BFW treatment         | 4. 1 → 3/1-3                           | 4. Potential for the release of high-pressure fluids, several hundred (about 300) gallons of toxic and explosive materials (hydrazine, amine)                                                                 | 4. Low     | 4. This is a conventional BFW process. Many normal industrial hazards exist. Significant offsite effects are not considered likely                                                                                                                                               |
| 5. Stack gas cleanup     | 5. 3/3                                 | 5. Release of uncleaned gas to the environment                                                                                                                                                                | 5. Low     | 5. No hazardous materials involved in the cleanup process. The amount of gas that might be released does not appear to pose a significant hazard                                                                                                                                 |
| 220<br>Credit Generation | a. 1,4/1 → 3                           | a. Potential to release all contents of this plant section, plus inputs to this plant section for several minutes                                                                                             | a. Low     | a. These are very low probability initiating events. Specific attention should be given to design to ensure this plant section can be quickly isolated from the balance of the plant and the Memphis pipeline gas system                                                         |
|                          | b. 3/2                                 | b. Local fires                                                                                                                                                                                                | b. Medium  | b. During transition phases of operation, startup and shutdown primarily, leaks at coupling points such as flanges are to be expected. The magnitudes of such leaks are not expected to be significant, and, given prompt attention, any fires that occur can be readily managed |

Table 2.4 (continued)

| Plant section                | Cause/accident <sup>a</sup>          | Effect                                                                                                          | Likelihood | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 410<br>Coal/Coke Handling    | a. 3/3                               | a. Particulates in very small quantities may become airborne                                                    | a. Medium  | This plant section involves conventional processes and equipment. The ready availability of combustibles and ignition sources produces an overall medium likelihood for accidents, but the significance of such accidents is estimated to be small                                                                                                                                                                                                                                    |
|                              | b. 3/2                               | b. Local fires can occur but should be easily controlled                                                        | b. Medium  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              | c. 3/1                               | c. Release of all contents with subsequent fires                                                                | c. Low     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 380<br>Sulfur Recovery       | 1 → 4/2<br>1 → 4/3                   | Local fires; release of hazardous materials including hydrogen sulfide, carbonyl sulfide, and sulfur            | Low        | Most of the causes considered are potential threats to the process boundary. The hazards are significant, but the process uses an established design. Individually, the accidents considered are not of high probability                                                                                                                                                                                                                                                              |
| 450<br>Cooling Tower         | No significant accidents postulated  |                                                                                                                 |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 440<br>Waste Water Treatment | No significant accidents postulated  |                                                                                                                 |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 370<br>Sour Water Stripping  | 2/3, 3/3, 4/3                        | Release of contaminated water, H <sub>2</sub> S, various solids                                                 | Low        | This is basically a cleanup operation. Quantities of hazardous materials are not significant                                                                                                                                                                                                                                                                                                                                                                                          |
| 420<br>Ash Treatment         | No significant accidents anticipated |                                                                                                                 |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 470<br>Ash Storage           | Flooding                             | Release of contaminated water and particulates to environment                                                   | Low        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Coal Storage                 | Flooding                             | Release of contaminated water and particulates to environment                                                   | Low        | See remark above                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                              | 3/2                                  | Release of particulates to environment                                                                          | Medium     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 490<br>Dock Facilities       |                                      |                                                                                                                 |            | No significant hazards associated with this plant section                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 350<br>Gas Compression       | a. 1, 3/1                            | a. Explosions, per se, will have local effects. See item c for offsite effects                                  | a. Low     | This is a conventional gas compression system. Nominal industrial hazards exist. Beyond the break-in phase, accident potential, especially for fires, should be significantly reduced. The worst accident that can be envisioned would be one in which the maximum scrubbed raw gas production (640,000 lb/h) is vented directly to the environment. The ability to isolate this plant section should keep the magnitude of such a release to that which would occur in a few minutes |
|                              | b. 1, 3/2                            | b. Local effects                                                                                                | b. Medium  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              | c. 1, 3/3                            | c. Release of unclean gas containing high levels of toxic gases (primarily H <sub>2</sub> S) to the environment | c. Low     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

Table 2.4 (continued)

| Plant section                                    | Cause/accident <sup>a</sup> | Effect                                                                                                                                                | Likelihood | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>360</b><br><b>Gas Treatment</b>               | a. 1, 3/1                   | a. Explosions, per se, would have local effect. See item c for offsite effects                                                                        | a. Low     | a. This is a conventional process with numerous normal industrial hazards. Experience with such units mitigates against significant accidents                                                                                                                                                                                                                                                                                    |
|                                                  | b. 1, 3/2                   | b. Local effects                                                                                                                                      | b. Medium  | b. See note a. Numerous sources of combustible materials (leaking seal, etc.) and ignition sources pose, primarily during the break-in phase, a medium fire hazard. Design attention needed to ensure adequate ability to isolate this plant section from the industrial gas distribution system                                                                                                                                 |
|                                                  | c. 1, 3/3                   | c. Release of unclean gas containing high levels of toxic gases (primarily H <sub>2</sub> S) to the environment                                       | c. Low     | c. See note a. Ability to rapidly isolate this system should mitigate against a significant offsite hazard                                                                                                                                                                                                                                                                                                                       |
| <b>320</b><br><b>Coal/Coke Treating and Feed</b> | a. 2 → 3/2                  | a. Hazard to onsite personnel                                                                                                                         | a. Medium  | a. This is a conventional coal/coke process with many usual industrial hazards. Two pulverizers, eight parallel feed systems, with numerous ignition sources integrate to a medium likelihood for fires, but attention to these hazards in the design phase will mitigate against significant accidents. It is a low-pressure, low-temperature system                                                                            |
|                                                  | b. 2 → 3/1                  | b. Hazard to onsite personnel                                                                                                                         | b. Low     | b. See note a                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                  | c. 2 → 3/3                  | c. Release of flammable and toxic gases (CO) to the environment                                                                                       | c. Low     | c. This could occur subsequent to an explosion or major equipment failure. Transport gas feed (22.5 K lb/h) and desulfurized U-gas feed (1300 lb/h) could vent to the environment for a few minutes until operator action isolates the system                                                                                                                                                                                    |
| <b>330</b><br><b>Coal Gasification</b>           | a. 1 → 3/1                  | a. This postulated accident is discussed in the MLGW Environmental Report, Vol. 1, page 2-163                                                         | a. Low     | a. The general design criteria for which the gasifier is designed are nominal. The process temperature (1860°F), in conjunction with the process constituents, poses a significant hazard. Special attention to instrumentation and controls must be given to protect against an operator error or upset condition that could lead to a major breach of the process boundary. Fires and a significant release of hazardous gases |
|                                                  | b. 1 → 3/2                  | b. Primarily a hazard to onsite personnel                                                                                                             | b. Low     | b. During startup this type of accident may have a moderate incidence rate. Prompt action by operating personnel mitigates against this type of accident becoming a significant problem                                                                                                                                                                                                                                          |
|                                                  | c. 1 → 3/3                  | c. Primarily a hazard to onsite personnel                                                                                                             | c. Low     | c. This accident is most likely to be a consequence of a or b                                                                                                                                                                                                                                                                                                                                                                    |
| <b>340</b><br><b>Gas Cooling and Scrubbing</b>   | a. 1 → 3/1                  | a. Release of large quantity of steam and/or hazardous gases and fire due to self-ignition. Total raw gas input to this system is approx 640,000 lb/h | a. Low     | a. Basically there are three gas cooling and scrubbing units in parallel. Effects locally would be severe, but offsite effect should be limited to contents of the component (or train) involved plus the inputs to that component for a few minutes until isolation can be achieved                                                                                                                                             |
|                                                  | b. 1 → 3/2                  | b. Leaks of high-pressure raw gas will lead to fires                                                                                                  | b. Low     | b. Incidence of local, small fires may be high during startup operations but should not be a significant problem later                                                                                                                                                                                                                                                                                                           |
|                                                  | c. 1 → 3/3                  | c. See Remarks                                                                                                                                        | c. Low     | c. The likelihood of this accident, independent of a and b, is not considered high                                                                                                                                                                                                                                                                                                                                               |

<sup>a</sup>See Table 2.3 for cause and accident codes.

natural phenomena such as seismic events, floods, and wind, and impacts of offsite vehicles onto the site pose major hazards, but such events have a very low probability of occurrence. The project criteria for natural phenomena appear to be adequate.

Where a low likelihood has been assigned, the intent is to imply a probability range of  $10^{-5}$  or less per year. Many of the design details are not sufficiently developed to permit a low likelihood conclusion; for such cases, a medium likelihood was assigned and is intended only to imply that a probability of something greater than  $10^{-5}$  per year should be assumed until specific knowledge of the design is known.

## 2.2.2 Description of the proposed site

### 2.2.2.1 Location

The proposed Allen site is located in Shelby County and the city of Memphis, Tennessee, approximately 13 km (8 miles) west-southwest of the downtown area. The site consists of 54 ha (134 acres) on a peninsula 1.2 km (0.75 mile) east of the Mississippi River.

### 2.2.2.2 Air quality

Winds are fairly brisk in the Memphis area, averaging 14.8 km/h (9.2 mph). Precipitation is abundant, averaging 124.7 cm (49.1 in.) annually, and is evenly distributed throughout the year. Air quality on the site itself has not been monitored. All of Shelby County has been classified by EPA as a nonattainment area for ozone, while metropolitan Memphis [approximately 9 km from the proposed site] is classified as a nonattainment area for carbon monoxide. Presidents Island, located across Lake McKellar from the proposed site, is designated as nonattainment for TSP. The proposed site is itself designated as attainment for CO, TSP, SO<sub>2</sub>, and NO<sub>2</sub>. Monitoring studies performed by MLGW at locations where the air quality impacts of the plant are expected to be greatest found better air quality than the EPA designations imply (see Sect. 3.1.1.2).

### 2.2.2.3 Hydrology

The Allen site lies in the 100-year floodplain near the confluence of the Mississippi River and Lake McKellar. The site frequently is submerged when the Mississippi is at flood stage. During the 100-year and project-design floods, the existing site would be inundated by 7 and 10 m of water, respectively (Sect. 3.1.2.1). An alluvial aquifer underlies the site. The principal aquifer in the region is the 500-ft sand that supplies all of the water needs of the city of Memphis, and it would be the source of water needed by the proposed plant.

### 2.2.2.4 Water quality

Throughout the vast watershed of the Mississippi River, industrial, urban, and agricultural effluents cause localized water quality degradation. The severity of these problems is reduced, however, by the Mississippi's enormous dilution capacity. The quality of the river's water in the vicinity of Memphis is inferior to the water quality upstream and downstream from the city. This degradation results from urban and industrial sources of pollution in the Memphis area. These sources include the Maxson Wastewater Treatment Facility near the Allen site, which consistently fails to meet Federal and State effluent standards. Lake McKellar water quality historically has been poor, although substantial gains have been made in the last ten years in controlling effluent discharges into the lake. Groundwater in the area fails to meet EPA secondary standards for drinking water because of its excessive iron and manganese content.

### 2.2.2.5 Aquatic ecology

A baseline monitoring program was initiated in 1978 to sample biota in the Mississippi River and Lake McKellar near the Allen site. Most of the fish species encountered were warm water rough and forage species such as the gizzard shad. Only a small number of sport fish were found in the river, although sport species such as largemouth bass, channel catfish, sunfish, and crappie seemed somewhat more prevalent in the lake. These monitoring studies did not encounter any species included on the list of threatened and endangered species maintained by the U.S. Fish and Wildlife Service (USFWS).

#### 2.2.2.6 Geology and soils

The proposed site is located on the floodplain of the Mississippi River and is underlain by approximately 46 m (150 ft) of sand and gravel alluvium. Surface elevations over most of the area are about 61 m (200 ft), although a dike and a mounded dredge spoil on parts of the site attain an elevation of about 65 m (215 ft). The site is located in seismic risk zone 3, a zone in which major destructive earthquakes may occur. Soils on the Allen site are silty to sandy and are well drained to excessively drained (Sect. 3.1.5).

#### 2.2.2.7 Land use

The site is currently owned by MLGW and is zoned for heavy industrial use. It is covered by bottomland forest and meadow and until recently was used by the U.S. Army Corps of Engineers for the annual disposal of dredge spoil from the Lake McKellar barge channel. Near the site are the Allen Generating Plant, the T. E. Maxson Wastewater Treatment Facility, wooded bottomlands, and agricultural fields on which the principal crop is soybeans. The T. O. Fuller State Park and the adjoining Chucalissa Indian Village are recreational areas about 2 km east-southeast of the proposed site. Several existing and planned industrial parks are located near the proposed site, including the Presidents Island Complex, the Pidgeon Industrial Area, and the Rivergate Industrial Complex.

#### 2.2.2.8 Terrestrial ecology

The area to be affected on and near the proposed site consists of approximately 43 ha (108 acres) of medium-age floodplain forest, 16 ha (40 acres) of meadow, and 4 ha (10 acres) of nonvegetated land and water area (ER, Table 4-5 and Sects. 3.1.7 and 4.1.7). The floodplain forest is dominated by black willow. More mature bottomland forest, which is dominated by box elder and sugarberry, occurs in several areas within 3 km of the site.

About 28 ha (70 acres) of the floodplain forest on the site is considered by the USFWS to be low- to medium-quality wetland because of low food availability for wildlife. This low quality results, at least in part, from annual deposition of sediments from dredge spoils.

Wildlife of concern in the area of the site includes bobcats, cottontail rabbits, white-tailed deer, racoons, swamp rabbits, wild turkeys, American kestrels, marsh hawks, Mississippi kites, six-lined racerunners, and others (Sects. 3.1.7 and 4.1.7). No Federally endangered or threatened species are located in the impact area of the project (Sect. 4.1.7 and Appendix B.3.1). The Mississippi kite, a State endangered species, uses the site area for foraging during the breeding season but does not nest at the site. Five other species of threatened or other special status on the Tennessee species list occur on the site (Sect. 3.1.7.2).

#### 2.2.2.9 Economic, social, and cultural features

The 1980 population of Shelby County, Tennessee, was estimated to be 772,523. The city of Memphis, with an estimated 1980 population of 644,838, is one of the 20 largest cities in the United States. Shelby County and Memphis are located in the Memphis Standard Metropolitan Statistical Area (SMSA), which had a total estimated 1980 population of 927,772. The civilian labor force within the SMSA is 417,045, of which 351,908 are located in Shelby County. The unemployment level is about 6%. Median income in Shelby County is estimated to be \$12,428.

Both public and private service sectors have capacities that would permit some expansion in demand without creating a need for new revenues, a decline in the quality of public and private services, or the need for new development. Residential choice opportunities are diverse and abundant. Already, there is rail transportation to the immediate vicinity of the site. Direct access roads to the site need some upgrading or traffic control activities to meet projected increases in demand.

### 2.3 ALTERNATIVES

#### 2.3.1 Proposed action

##### 2.3.1.1 Summary of impacts

This section summarizes the environmental impacts of the proposed plant design at the proposed site.

### Air quality

Vehicle exhaust and fugitive dust emissions during construction will have a small short-term adverse effect on ambient air quality in the area of the site. Ground-level pollutant concentrations resulting from vehicle exhausts, however, are below ambient air quality standards. In addition, most of the fugitive dust emissions will be controllable because the fill material will be kept wet.

During the operational phase of the project, criteria pollutants emitted from the facility include TSP, sulfur dioxide, oxides of nitrogen, CO, and hydrocarbons (Sect. 2.2.1.11). Coal dust emissions will be insignificant beyond 100 m of the plant under typical meteorological conditions, although strong winds would carry these dust particles farther. Sulfur dioxide emissions during routine operation would not result in violations of air quality standards. Nonroutine emissions (such as during plant startup and emergency venting) would be higher but are not expected to violate air quality standards. Nitrogen dioxide emissions are likely to have negligible effects on air quality. Hydrocarbon emissions will be controlled by the controlled combustor and the flare.

### Hydrology

Since the Allen site is located within the Mississippi River floodplain and subject to annual flooding, the site can be used for the project only if it is filled above flood level. Plans include raising the site by as much as 9 m (30 ft) to protect the project from flood hazards. This action will reduce the floodplain's temporary water storage capacity. The result of the floodplain modification is a small but unavoidable increase in flood elevations in Lake McKellar along the Ensley Levee and the southern edge of Presidents Island. The added risk of flood damage caused by the project is quite small, however, since flood protection structures already in place would provide adequate protection against the increased flood elevations (Sect. 4.1.2).

Groundwater is available in sufficient quantities to supply the construction and operation needs of the project without reducing water availability to other users. At the same time, the quality of the groundwater in the alluvial aquifer could be compromised by leachate from the plant's coal storage and solid waste disposal areas. These areas are being designed to minimize this risk — including the installation of impermeable liners, thorough compaction of the ground beneath the liners, and the use of monitoring systems to detect potentially harmful seepage.

### Surface water quality

Construction impacts on the water quality of the Mississippi River consist primarily of localized short-term perturbations (turbidity, increased levels of some chemicals, and increased oxygen demand of sediments) resulting from dredging. Lake McKellar may be adversely affected by site preparation operations (buildup and grading) and product gas pipeline construction because of inflowing sediment and perhaps ammonia in dredge fluids. The barge turning basin may suffer impacts from dredging, similar to those described above.

Wastewater discharge to the Mississippi River will be the most important potential impact occurring during demonstration plant operation (Sect. 4.1.3.2). With dilution of the wastewater in a mixing zone, the impact to river water quality would be small incremental loadings of those constituents for which ambient concentrations exceed water quality criteria for water uses for which the affected reach of the river is classified. These uses do not include domestic use. Wastewater discharge will be permitted under the National Pollutant Discharge Elimination System (NPDES), administered jointly by the Tennessee Department of Public Health, Water Quality Division, and the EPA. Coal spillages and increased turbidity may result from increased barge traffic in Lake McKellar's turning basin. Periodic maintenance dredging may result in short-term perturbations in this same area.

### Aquatic ecology

Aquatic habitat may be eliminated or modified by all construction activities (dredging, installation of wastewater discharge structure and product gas and water supply pipelines, site preparation, and barge dock construction). The most significant impact will be loss and degradation of medium-quality aquatic habitat in the turning basin in Lake McKellar.

Outside of the mixing zone, operational impacts from wastewater discharge into the Mississippi River are anticipated to be minor. Increased barge traffic and periodic maintenance dredging may modify localized portions of aquatic habitat in the barge turning basin.

### Geology and soils

Before construction activities begin, the site will receive approximately  $4.6 \times 10^6 \text{ m}^3$  ( $6.0 \times 10^6 \text{ yd}^3$ ) of hydraulically dredged fill material. Filling is necessary to raise the process areas from their current elevation of about 62 m (203 ft) to 71 m (233 ft) in order for the plant to lie above the project design flood level. This filling and grading is unavoidable if the site is to be used for industrial development. The impact on topography cannot be avoided or mitigated (Sect. 4.1.2).

Because of the site's potential for settlement and soil liquefaction, several corrective measures will be required to stabilize the foundation. Prior to emplacement of the fill, additional soil boring and sampling will be conducted. Depending on the results of these studies, soils with poor supportive properties will be relocated on site. The foundation will be compacted by vibroflotation to a depth of 15.4 m (50 ft).

Structure foundations are being designed in accordance with building code recommendations for seismic risk zone 3. The preliminary design includes a factor of safety of 3.0 for foundations bearing on soil. Final foundation design is included in phase II of the project. If a seismic event results in the release of contaminants, potential sinks for these materials are Lake McKellar, the Mississippi River, and the alluvial aquifer.

All soils currently on the site would be covered by emplacement of the fill. Occurrence of a major flood prior to completion of the fill could result in erosion of the fill already in place. This erosion would require replacement of lost fill. Upon completion, soil losses can be minimized by using vegetative cover, riprap, or paving to protect the site.

### Land use

Use of the site for the proposed facility will prevent the site from being used by the U.S. Army Corps of Engineers for the annual disposal of dredge spoils from the Mississippi River and Lake McKellar. At the present time, the Corps has discontinued this use of the site and has begun using an area to the west of the proposed site. Also, benefits provided by the floodplain forest (support of many wildlife species, storage and slow release of floodwaters, water quality maintenance through sediment entrapment, and groundwater recharge) will be lost.

Use of the site for the proposed facility is consistent with the site's heavy industrial zoning classification and will preclude other potential uses of the site. Most of the offsite facilities (pipelines, utility lines, and an access road) will be on existing rights-of-way, under water, under city streets, or in common rights-of-way and will have little effect on land use. Emission of air pollutants may have slight adverse effects on soybean yields in the vicinity of the facility, although these impacts may be so small that they are undetectable.

### Terrestrial ecology

Onsite and offsite construction will disturb 63 ha (156 acres), including 43 ha (106 acres) of medium-age floodplain forest, 16 ha (40 acres) of meadow, and 4 ha (10 acres) of nonvegetated land and water area. The proposed project consequently would contribute to the losses of floodplain forests that have occurred in the United States (Sect. 4.1.7). Mature bottomland forests in the area would not be affected. Operation of the facility will contribute slightly to the effects of air pollutants on vegetation.

Important wildlife species would be virtually eliminated from the site but would continue to exist in areas surrounding the site. No endangered or threatened species listed by the Federal government will be affected (Sect. 4.1.7 and Appendix B.3.1). The Mississippi kite (listed by Tennessee as endangered) and the six-lined racerunner and swamp rabbit (listed by Tennessee as needing special management due to scarcity of their habitat) will experience loss of breeding habitat, although the kite does not appear to nest on the site.

### Economic, social, and cultural impacts

The IFGDP will provide direct employment for 600 to 700 persons during the construction phase and for 410 persons during operation. Secondary service jobs indirectly supported by the project may number 570 during construction and 483 during operation. To a large extent, these secondary jobs will not be newly created ones. Most service sectors in the Memphis area have enough surplus capacity to provide the infrastructure services that are required by the IFGDP work force. Consequently, secondary benefits may be largely industrial output and income expansion rather than new secondary jobs. Because of the size and diversity of the Memphis economy, any added employment opportunities will be filled by local residents. In-migration caused by the project would be

negligible, compared with the population of the Memphis area without the project. No significant strains on the housing stock and community infrastructure of the Memphis area are likely.

The MLGW facility will provide industrial fuel to a number of its existing customers in the Memphis area. MLGW officials estimate that within 5 years of facility construction from 7 to 14 satellite industries that could utilize the MLGW product gas will move to the area. If new industries do locate in the area, the area's economy will grow.

Construction activity at the Allen site would increase traffic on adjacent roads by 15 to 20% over current conditions. The increased traffic load, especially from trucks, and the construction activity on Mitchell Road may cause minor traffic problems necessitating some traffic control measures.

The Allen site has been surveyed by a professional archaeologist and judged to be void of pre-historic or historic relics. A copy of a letter from the State Historic Preservation Officer is included in Appendix B.4 as evidence of compliance with the National Historic Preservation Act. Selection of the proposed site should not significantly affect the visual amenities associated with nearby Fuller State Park and the Chucalissa Indian Village.

#### Health effects

A preliminary risk assessment has been performed based on data related to the composition of the raw gas from the U-gas pilot plant. Identified materials of concern include CO, NH<sub>3</sub>, H<sub>2</sub>S, COS, CS<sub>2</sub>, HCN, PAHs, tars and oils, phenols, mercaptans, thiophenes, amines, carbonyls, and trace elements. Based on the relative concentrations of the constituents in the raw gas stream and the relative threshold limit values (TLV) of these constituents, it is conservatively concluded that controlling emissions of CO and H<sub>2</sub>S to below their respective TLVs will ensure that all other materials of concern will be well below appropriate TLVs (Sect. 4.4). Because residence times in the demonstration plant gasifier are longer than residence times in the pilot plant gasifier, it is expected that relative concentrations of materials of concern will be lower in the demonstration plant than those considered in this analysis. However, to ensure that the plant design, monitoring programs, and mitigation measures are adequate to ensure occupational and public health, a detailed risk assessment, as described in Sect. 1.4.B.3 will be performed prior to plant operation.

#### 2.3.1.2 Alternative fates

The proposed action can be approved, rejected, or modified, or a decision may be delayed until some future date. If the project is approved, final design and construction will occur during a period of approximately four years (phase II). Following a 20-month-long demonstration-operation period of phase III, MLGW shall have the right to purchase the proposed facility. During this postphase III period, the MLGW facility could experience three potential alternative fates: continued operation at the demonstration plant capacity, mothballing, or total decommissioning. Expansion of the gasification plant to a larger capacity after the demonstration period, although possible to a very limited extent, was not considered a likely alternative because of space limitation at the site. Therefore, no additional impacts are expected as a result of commercial operation at the proposed plant.

During continued operation, the processing facilities will continue to operate as a commercial venture after the demonstration period, with minimal modification. The plant capacity will continue to process 3155 tons/d of coal, producing  $4.3 \times 10^6$  m<sup>3</sup> (154 million scf) of medium-Btu gas (300 Btu/scf) and  $0.12 \times 10^6$  m<sup>3</sup> (4.3 million scf) of high-Btu pipeline gas (950 Btu/scf), for an assumed operational period of 20 years.

#### Mothballing and decommissioning

Mothballing the demonstration plant implies that it would be shut down for an indefinite period of time. All production operations at the facility would cease, although there would be little or no disassembly of the equipment at the site.

There are several reasons why the plant might be mothballed. If, for example, the production process proves to be technically feasible in most, but not all, respects, it may be necessary to shut down the plant until the technological problems are solved. Alternatively, the plant may prove to be technically feasible but not economically viable at the product and input prices prevailing when the demonstration phase ends. In this case, the plant might be shut down for the short term with the expectation that future market prices would make commercial operation worthwhile.



Should the proposed facility prove to be technically or economically unsuccessful over the long term, the plant would be decommissioned. Production operations would cease, and the site would either be restored to the extent feasible or converted to another industrial use. Since it is impossible to speculate about the nature of other industrial uses, the analysis presented here is limited to the impacts of the site restoration option only.

Continued operation at the demonstration plant capacity is addressed in Sect. 4.1 and summarized in Sect. 2.3.1.1. Therefore, impacts associated with this fate will not be repeated here; rather, the thrust of this analysis is to highlight the major issues that would be faced under the mothballing and decommissioning fates. These issues are discussed below in greater detail. Reference is made to impacts of continued operation where appropriate.

#### Air quality

As a result of mothballing or decommissioning, both direct source and fugitive emissions associated with the operation of the demonstration plant would be eliminated. However, short-term fugitive dust emissions can be anticipated during decommissioning of the demonstration plant. The impact of these emissions will be similar to those experienced during the construction of the demonstration plant.

It is not currently clear whether an indefinitely mothballed demonstration plant would be maintained in the State's emissions inventory or whether other future emission sources would have to consider the emission from the mothballed plant in their permitting process. If the mothballed plant is maintained on the emissions inventory, the remaining PSD increment for other emission sources would be smaller, which could affect future industrial development.

#### Water quality

During normal plant operations, runoff and leachate from potentially contaminated areas (coal storage, main process areas, ash disposal, and product loading areas) will be collected and pumped to wastewater reclamation facilities for treatment prior to discharge or reuse within the plant. During the mothballing period, the wastewater treatment system may be shut down. If necessary, during the mothballing period or during decommissioning activities, runoff will be collected and pumped to the T. E. Maxson Wastewater Treatment Facility for treatment prior to being discharged.

The RCRA of 1976 requires the continued groundwater monitoring of hazardous waste disposal sites during and after disposal operations. Although studies of the pilot plant ash indicate that it is nonhazardous, if further research conducted during the demonstration period concludes otherwise, suitable treatment and monitoring programs will be adopted. If it is determined that the RCRA applies, then continuous monitoring will be conducted if the plant is mothballed or decommissioned. If the groundwater monitoring program detects that leachate has penetrated the protective liners provided at the disposal site, the leak will be located and the liner will be repaired. Leachate will be sent to the Maxson Wastewater Treatment Facility.

#### Ecology

The termination of facility emissions to the environment as a result of mothballing or decommissioning would have a general beneficial impact on local ecological systems. However, if uncontrolled, the water quality impacts on Lake McKellar resulting from site runoff could have adverse effects on aquatic biota. During the mothballing period or after decommissioning, herbaceous meadow vegetation similar to that originally found on the site could likely be established.

#### Land use

Currently there are no other identified competing uses for the proposed site; however, mothballing the proposed demonstration plant would preclude other development opportunities for the site.

The land used for the processing facility and for solid waste disposal would be available for alternative uses after facility decommissioning. This availability is important because the site is in a prime industrial location. Proper closure of the waste disposal areas would be required to enable the future productive use of these areas.

## Socioeconomics

Most of the permanent operational labor force of 270 and the service staff of 140 employed during the demonstration period will be terminated if the facility is mothballed or decommissioned; however, to decommission the facility, a work force somewhat smaller than the number of persons employed during construction of the demonstration plant will be required for a short time.

If the demonstration plant is mothballed or decommissioned, the industries developed to support the facility would suffer economic loss.

Because only minor expansion of community services would be required to support the demonstration plant, only minor impacts on community services would be anticipated if the demonstration plant were mothballed or decommissioned.

### 2.3.2 Modified action

#### 2.3.2.1 Plant design alternatives

The demonstration plant is to facilitate the development of advanced technology for converting high-sulfur, agglomerating bituminous coals into more environmentally acceptable fuels. The purpose of the proposed facility is to provide evaluations of the technical, economic, and environmental issues associated with the scale-up and future commercialization of the U-gas coal gasification process.

Based on preliminary design data, characteristics of gaseous, liquid, and solid waste streams created by construction and operation were summarized in Sect. 2.2.1. Alternatives were identified and evaluated for the areas of liquid waste treatment, solid waste disposal, acid gas removal, control of sulfur emissions, control of particulate emissions, waste heat removal, alternative plant fuels, gas stream incineration, coal transportation alternatives, and alternative sources of plant makeup water.

#### Liquid waste treatment

The proposed plant will generate liquid wastes that will require treatment before reuse or disposal. The factors affecting the selection of treatment processes are regulatory restrictions and guidelines, process water quality requirements, water availability, and the costs and performance of available treatment processes. The goals of the waste treatment processes are to achieve acceptable effluent quality and to limit treatment costs to reasonable levels. To aid in the selection of suitable waste treatment processes, the waste streams have been grouped according to contaminant content and treatment requirements. These groups are identified in Table 2.5. The process wastewater group will include all waste streams unique to the gasification-gas-cleanup processes. The remaining wastewater streams (i.e., cooling tower blowdown, coal and ash pile runoff, process area floor and storm drainage, and feedwater treatment brines) are comparable to those produced at conventional steam-electric generating plants. Sanitary wastes generated at the plant will be treated in the municipal sewer system.

Alternative treatment methods for each liquid group are listed in Table 2.5. The individual processes may be selected to give a number of plant-wide wastewater treatment configurations tailored to mitigate the aquatic impacts of plant operation. Configurations may range from treatment for regulatory compliance to treatment for zero-effluent discharge.

The proposed liquid waste treatment systems (preferred alternative) for the demonstration plant include combined physical-biological treatment of process wastewater, zinc and chromate precipitation treatment of cooling tower blowdown to remove heavy metals, neutralization and clarification of coal pile runoff, and air flotation and clarification of floor and process area storm drainage. No treatment is currently planned for ash storage area runoff and for high TDS blowdown solutions from boiler feedwater preparation; however, these streams will be routed to the effluent holding basin where they will be monitored and treated if necessary.

Potential treatment alternatives exist for the process wastewater, ash pile runoff, and cooling tower blowdown streams. On a plant-wide basis, zero-effluent discharge is a significant alternative to the proposed configuration. Implementation of alternative processes would affect the demonstration plant in the areas of energy and chemical consumption, solid residuals and gaseous emissions, and capital costs. Therefore, consideration of such interacting factors is necessary in the selection of acceptable alternatives.

Process wastewater treatment. Process wastewater prior to treatment will contain toxic organics, heavy metals, TDS, and TSS. The preferred treatment (physical treatment followed by biological oxidation) will destroy all but a trace of the organics and will substantially reduce TSS, whereas TDS may be only slightly reduced. As an alternative, the potential for release of toxic organics

Table 2.5. Major wastewater streams and alternative treatment processes

| Stream (and contaminants)                                                                 | Treatment method                                                                                                                                                                                                | Remarks                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Process wastewater, 550 gpm<br>(TDS, TSS, ammonia, cyanide,<br>organics and heavy metals) | 1. Combined biological-physical treatment (lime flocculation—clarification, filtration, ozonation—oxygenation, biological filtration, carbon adsorption), effluent discharged to Mississippi River <sup>a</sup> | Biologic destruction of most of toxic organic and inorganic carbon compounds; less energy intensive, but more difficult to control and is sensitive to plant upset conditions; requires additional land; some control of heavy metals                                                                                                                                                                      |
|                                                                                           | 2. Multieffect evaporation                                                                                                                                                                                      | All nonvolatile solids concentrated in brine; energy intensive process; product water suitable for recycle; brine disposal problem                                                                                                                                                                                                                                                                         |
|                                                                                           | 3. Combined biological-physical treatment (similar to No. 2 but with desalting of effluent to allow recycle of water; desalting is via reverse osmosis, electrodialysis, ion exchange, evaporation, etc.)       | Biological destruction of toxic carbon compounds, other solids concentrated as brine or slurry; increases cost and complexity of plant; reduces chance of toxic organic release to environment                                                                                                                                                                                                             |
| Cooling-tower blowdown, 280 gpm<br>(TDS, TSS, free chlorine,<br>chromium, zinc)           | 1. Treatment and discharge to Mississippi River (chromate destruction, onshore treatment, and subsurface discharge) <sup>a</sup>                                                                                | Meets NSPS rules for pH (6–9), free chlorine (0.2 ppm average, 0.5 ppm maximum), <sup>b</sup> and chromate removal (below detectable limits)                                                                                                                                                                                                                                                               |
|                                                                                           | 2. Substitution of alternate biocides and corrosion inhibitors for chlorine, chromium, and zinc: BrCl, ClO <sub>2</sub>                                                                                         | Uncertain regulatory picture discourages development of alternative corrosion inhibitors; corrosion-resistant cooling system design would increase cost of plant                                                                                                                                                                                                                                           |
|                                                                                           | 3. Zero blowdown; sidestream softening and desalting via reverse osmosis, electrodialysis, evaporation, ion exchange, etc.                                                                                      | High TDS operation makes desalting more economic, but requires corrosion, resistant alloys, inhibitors; and water conditioners for proper operation; high-efficiency drift eliminators may be required to limit vegetation impacts; capital, maintenance, and energy costs dependent on desalting process chosen; waste brine may require evaporation to small volume before disposal in lined impoundment |
| Ash pile runoff, 20 gpm<br>(pH, TDS, TSS, oil and<br>grease)                              | 1. Untreated discharge to Mississippi River <sup>a</sup> with capacity to treat if necessary                                                                                                                    | Initial tests suggest leachate is nonhazardous<br>Would satisfy NSPS for pH, TSS, and oil and grease                                                                                                                                                                                                                                                                                                       |
|                                                                                           | 2. Simple physical-chemical treatment (lime neutralization, clarification, and pH adjustment)                                                                                                                   | Treated effluent used as makeup water for the cooling system, bottom ash transport and flue gas desulfurization systems; produces more sludge than simple physical-chemical treatment; soluble salts not removed by process                                                                                                                                                                                |
|                                                                                           | 3. Chemical softening (lime-soda treatment), recycle to process users                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                            |
| Coal pile runoff, 15 gpm<br>(pH, TDS, TSS, organics)                                      | 1. Neutralization, aeration, clarification, discharge to Mississippi River <sup>a</sup>                                                                                                                         | Meets NSPS                                                                                                                                                                                                                                                                                                                                                                                                 |
| Floor drainage and process area<br>runoff, 125 gpm (TSS, oil and<br>grease)               | 1. Chemical treatment, and air flotation, discharge to Mississippi River                                                                                                                                        | Reliable operation at low cost; recovered oil sold for reclaiming                                                                                                                                                                                                                                                                                                                                          |
|                                                                                           | 2. Equalization basin, clarifier, chemical treatment, and filtration                                                                                                                                            | Characteristic same as for item 1 (immediately preceding) but higher in cost                                                                                                                                                                                                                                                                                                                               |

<sup>a</sup>Proposed alternative.<sup>b</sup>New proposed standard of 0.14 ppm total residual chlorine (FR Oct. 14, 1980).

could be eliminated by recycling the treated wastewater to the gasification-gas-cleaning processes. To do this, the dissolved solids content of the biologically treated recycle stream would be reduced by a desalting process such as reverse osmosis or evaporation. Desalting processes are generally both capital and energy intensive and produce waste brines or leachable solids that require isolation from groundwater and surface water.

Ash pile leachate treatment. Initial studies on the leaching characteristics of the gasifier ash (Appendix C.2.2) suggest that the leachate (contained by an impermeable liner) from the ash storage area will be nonhazardous and suitable for river discharge without treatment (Sect. 2.2.1.3).

Leachate will, however, be monitored for quality. If it is found that treatment before discharge is required, the stream will be routed to wastewater treatment prior to its being discharged.

Cooling tower blowdown treatment. The proposed cooling system of the demonstration plant will employ wet evaporative cooling towers. Evaporative losses cause the buildup of soluble and suspended solids in the cooling water. In the preferred system, the blowdown or release of a portion of the cooling water is used to control contaminant buildup. However, water-conditioning agents, biocides such as chlorine, and corrosion inhibitors such as chromium and zinc are also removed with the blowdown. Alternative treatment methods for these wastes include the use of alternative biocides and corrosion inhibitors, blowdown treatment for removal of chromium and zinc, and zero-blowdown operation.

Chromium and zinc may be eliminated from the blowdown by the substitution of alternative corrosion inhibitors. Nonchromate inhibitor systems, while generally available, have not proven to be satisfactory. The use of corrosion-resistant alloys could reduce the use of corrosion inhibitors but could impose penalties in capital and maintenance costs.

The preferred blowdown treatment methods for the removal of chlorine, chromium, and zinc are as follows: (1) residual chlorine may be destroyed by adding small quantities of a reducing agent such as sulfur dioxide to the blowdown stream; (2) electrolysis and lime softening are used to precipitate chromium and zinc as insoluble hydroxides (ion exchange methods have also been employed in this service) and (3) the chromate removal system by Andco, Inc., will reduce chromate levels to meet the no detectable amount limitations of the New Source Performance Standards (NSPS). (See also Appendix A, Response to EPA Comment No. 46.)

By providing corrosion-resistant components and suitable desalting processes, the cooling tower can be operated in a zero-blowdown mode, in which soluble and suspended solids are removed from the cooling system as brines or sludges. This alternative will create greater quantities of solid waste because there is a general removal of TDS rather than the specific removal of regulated pollutants. The increased TDS and TSS will also increase the impacts of cooling tower drift losses. The capital and operating costs are greatly increased with this system. However, where wastewater is used as a cooling system makeup, the concentrating effect of the cooling tower may aid in the treatment of high-volume wastes.

Zero liquid effluent discharge. Through judicious choices of waste-treatment processes and optimal plant water use, the proposed plant could operate in a zero liquid effluent mode. Through redesign, the component processes described in Table 2.5 and the alternatives described above may be applied in a zero liquid discharge configuration. In the preliminary design phase, the zero-discharge option applied to this plant was examined and found to have a capital cost increase of about \$5.5 million and an annual operating cost increase of about \$1.5 million, over the base-case design described in Sect. 2.2.1.2. Zero-discharge plant design is a reasonable choice in arid western sites with scarce water resources and the ability to use solar evaporation ponds; however, the annual rainfall at Memphis is 124.4 cm (49 in.). The capital and energy inputs of a zero-discharge system at the Memphis site would be a significant burden on the economics and on the thermal efficiency of the demonstration plant. Also, the reduction in liquid effluent would be offset by increases in solid residues and atmospheric releases. The solid wastes would contain large quantities of leachable salts and would probably require hazardous waste disposal.

#### Solid waste disposal

The proposed plant will produce a wide variety of solid wastes including gasifier ash, boiler ash, boiler fly ash, FGD sludge, water treatment sludge, and spent catalysts. The solid waste facilities incorporated into the plant design must provide environmentally safe handling and storage of all solid process wastes and by-products generated during the life of the project. The plant will landfill only nonhazardous solid wastes on site. Any hazardous wastes will be trucked off site within 90 d of generation as required by the State of Tennessee. While on site in temporary storage, the waste will be contained in leak-proof tanks and handled in accordance with RCRA. This waste will be disposed of at an EPA-approved facility, such as "Chemical Waste Management of Alabama," located near Livingston, Alabama, about 270 miles from the site. Storm water

falling on solid waste landfills will be collected as leachate, monitored, and discharged with plant wastewater. The leachate will be treated in wastewater treatment if monitoring indicates it to be necessary.

Preliminary results of gasifier ash-leaching studies indicate that the ash agglomerates are not hazardous wastes as defined by RCRA. The gasifier ash represents about 74% of the total solid waste production of the plant. Over the 20-month demonstration period, about 286,000 tons of gasifier ash will be produced. Over the 20-year life of the plant, approximately  $3.9 \times 10^6$  tons of gasifier ash will be produced. This gasifier ash alone would cover the available solid waste storage area [approximately 16 ha (40 acres)] to a depth of as much as 15 m (50 ft), depending on the degree of compaction attainable. Steam generation ashes and FGD sludges will also have significant storage volume requirements (Sect. 2.2.1.8).

Several significant alternatives exist for the management of solid wastes of the types and quantities produced by the proposed plant. Major disposal concepts include dry landfills, disposal ponds, commercial utilization, and offsite disposal. Design alternatives that may be incorporated into the major disposal concepts include mixed or segregated disposal and impoundment liners. These alternatives are summarized in Table 2.6.

Table 2.6. Major solid waste streams and alternative treatment processes

| Stream<br>(and contaminants)                       | Treatment method                                 | Remarks                                                                           |
|----------------------------------------------------|--------------------------------------------------|-----------------------------------------------------------------------------------|
| Gasifier ash, 25 tons/h                            | 1. Dry landfill on site <sup>a</sup>             | Conventional practice for nonhazardous waste                                      |
|                                                    | 2. Commercial utilization, all or part           | MLGW will seek markets, first four years                                          |
|                                                    | 3. Offsite disposal                              | Better flood protection; requires more transportation and energy consumption      |
| Boiler fly ash and bottom ash, 4 tons/h            | 1. Dry landfill on site                          | Sluice water adds to leachate processing load                                     |
|                                                    | 2. Wet ponding                                   | Conventional power plant practice; more storage area and embankments required     |
|                                                    | 3. Commercial utilization, part only             | Scale of operations probably too small                                            |
|                                                    | 4. Codisposal in Allen Generating Plant ash pond | Warrants further feasibility study; pipeline required                             |
| Gypsum from FGD, 4 tons/h (soluble sodium sulfate) | 1. Dry landfill on site <sup>a</sup>             | See "Gasifier ash" above                                                          |
|                                                    | 2. Commercial utilization                        |                                                                                   |
|                                                    | 3. Offsite disposal                              |                                                                                   |
| Chromate destruct sludge                           | 1. Dry landfill onsite <sup>a</sup>              | Codisposal with ash may improve sludge consistency but affects ash marketability  |
|                                                    | 2. Offsite disposal                              | See "Gasifier ash" above.                                                         |
| Wastewater treatment sludge                        | 1. Dry landfill onsite <sup>a</sup>              | Ongoing treatability studies will determine hazardous/nonhazardous nature         |
|                                                    | 2. Offsite disposal                              | Sludge trucked offsite to EPA approved facility if determined hazardous in item 1 |

**Dry landfills.** Dry landfilling is suitable for wastes that may be transported by truck, conveyor, front-end loader, or similar means and for wastes that are structurally stable (i.e., the surface will support heavy equipment operations). Deposited solids may be compacted and covered with soil to minimize water and wind erosion and particulate releases. Landfill impoundments may be designed for hazardous or nonhazardous storage operations. Seepage control for dry landfills is simplified by the absence of a liquid layer over the stored solids so that there is little or no hydraulic head, or pressure, acting on the bottom of the impoundment. Long-term stabilization of the landfill may be accomplished by applying a clay or soil cover and establishing vegetation or riprap over the surface.

Environmental effects of dry landfills relate to (1) particulate and runoff releases during operation, (2) seepage of leachates into groundwater and surface waters, (3) land use and aesthetic impacts, and (4) potential long-term release of solids through disruption of the impoundment by natural forces such as erosion, seismic activity, and differential settlement of foundation and waste materials.

et ponding. Wet ponding is in common use in conventional coal applications for fly ash and bottom ash disposal. Ash is transported as a slurry from the plant to the storage pond, where it settles to the bottom. The maintenance of ponded water over the deposited ash precludes dust release but increases the potential for the seepage of contaminants into the groundwater. The use of wet ponding at the site would require larger storage areas, additional embankments, and the redesign of liners employed for seepage control. The use of water as the transport medium would result in the generation of additional liquid wastes. During the ash-sludging operation, scale-forming chemicals are leached from the ash, and the continued recycle of the pond water results in excessive concentrations and scaling of the ash-transport system. The method available to control the concentrations of scaling agents include replacement of spent water with fresh water (blowdown) and the various forms of water softening and demineralization treatment.

At the completion of project operations, the ponds would be drained and covered with an impermeable soil cap and revegetated as in the dry storage counterpart. However, the saturated condition of the ash may render the construction of the cap difficult, and settling could result in premature failure of the cap.

Commercial utilization. Gasifier ash, steam generation fly and bottom ash, and FGD sludge, have potential for commercial utilization. Some spent catalysts may be reclaimed. For example, approximately 16.3% of the coal ash collected in 1975 was utilized for commercial purposes. The majority of the utilized ash was of the coarser bottom ash and boiler slag fractions, which are similar in nature to the gasifier ash agglomerates. Commercial applications of coal ash include road aggregate, soil stabilizers, construction fill, lightweight aggregate, and cement supplements. The FGD sludge from the FMC double-alkali scrubber contains calcium sulfite and has been applied to farmlands to improve soil sulfur content.

The MLGW proposes to market gasifier ash, fly ash, bottom ash, and FGD sludge throughout the life of the short-term waste storage area (four years). If little or no demand develops for these wastes, separate storage areas for ash and sludge will not be maintained in the long-term storage area. Shipment of solid waste by-products off site would result in additional traffic and dust impacts. However, these impacts would be offset by the reduction of the solid waste inventory at the site. It is unlikely that total utilization of plant solid wastes will occur; thus, this alternative would not eliminate the need for long-term storage of solids on the site.

Offsite disposal. An alternative to disposing of nonhazardous solid wastes on site is to dispose of them off site. This action could be necessary, to some extent, if some of the waste could not be utilized commercially, and it could be beneficial where the offsite disposal area demonstrates superior isolation of the wastes from groundwater and surface water and protection from the disruptive forces of earthquakes, flooding, erosion, and differential settlement. The transport of wastes would result in increased energy consumption and would result in additional dust and traffic impacts over those of onsite disposal; note that the waste volume is about 0.1 of the feed coal volume. Any viable alternative sites would be reasonably accessible and would be similar in size to the waste disposal area of the proposed plant but would not be subjected to severe zoning or land use restriction.

Segregated versus mixed storage. Mixed storage of wastes in a common landfill or pond-type impoundment offers operational simplicity and low cost. Mixing ash and sludges may improve sludge consistency and yield long-term mechanical stability unachievable by using sludges alone. Such stabilization could relieve land use restrictions on the disposal area after closure. For example, several existing methods of codisposing power plant ash and FGD sludge utilize pozzolanic reactions to convert sludge to high-compressive strength fill material.

However, environmental and economic factors could make partially or completely segregated waste disposal desirable. In codisposal, including leachable or hazardous solids in the common impoundment would require upgrading overall impoundment liners and operating practices to meet proposed RCRA waste management standards. Placing such wastes in a separate hazardous waste impoundment would permit less costly disposal practices to be used in the common impoundment for nonhazardous wastes. If wastes are codisposed, waste incompatibility (the hypothetical interaction of different waste forms to generate noxious gases or leachates) would also make segregation desirable. Separate storage is advisable for commercially useful gasifier (and boiler) ashes for which being contaminated by sludge admixture could limit their marketability.

The short-term waste storage area for the initial four years of operation of the proposed plant will provide separate storage of gasifier ash and FGD scrubber sludge. Boiler fly ash is currently considered by EPA under RCRA as a special waste and will be codisposed with the gasifier residue. Because of the potential for heavy-metal and toxic organic content, wastewater treatment sludges are presumed to require separate storage. Compared to the common landfill approach, land requirements increase for long-term disposal (after the initial four years of plant operation) when separate disposal of the different residues is selected. More land is needed in this instance because of the amount of storage area lost to the additional embankments and access routes required. Offsetting the additional land use would be the separate disposal of the different waste

materials, which would allow better control of runoff-water quality, because individually tailored wastewater treatment procedures could be applied where needed.

Impoundment liners. Liners are installed in impoundments where necessary to limit seepage into groundwater or surface waters. The commonly used liner types suitable for use in the impoundments of this plant include synthetic membranes and compacted clay. Both these liner types are repairable in service, and their service life is a function of installation quality. It is possible, then, to choose the more suitable liner for this project based on each option's cost and the local availability of suitable low-permeability clay. Other materials suitable for diking process/storage areas for forming water storage basins are asphalt paving or concrete. These materials offer rigidity and abrasion resistance in the above-ground applications, but this property is of lesser value in below-ground applications. Asphalt or concrete would cost more than clay or polymeric liners but would not offer any additional performance advantage. In the case of potential later damage by heavy equipment operations on the filled area, the rigid materials would be more susceptible to cracking and groundwater contamination by leachate.

Synthetic membranes of polymeric (plastic) materials demonstrate excellent control of seepage (permeabilities less than  $10^{-12}$  cm/s). Proper emplacement of the liner requires a smooth, stable surface free of coarse materials that may cause punctures. Special care is required to ensure proper heat sealing of seams and joints. The life of a polymer (Hypalon) lining in this application is expected to exceed 50 years, with a warranted life of 20 years. Also, the extreme extensibility of Hypalon (15%) will greatly minimize the possibility of failure from soils settlement. Finally, although a liner may fail, methods of detection have been provided, and repair procedures will be rapidly implemented.

Natural clays of low permeability may be used to line impoundments. Compacted clay liners are typically several feet thick, with the thickness being determined by the properties of the clay and the desired level of seepage control. Unlike synthetic liners, clay liners will normally allow small continuous amounts of seepage. Also, though clay liners can last up to 40 years, they are susceptible to damage by soil settlement, frost, and heavy traffic.

As a precautionary measure, the proposed short-term storage area will be equipped with a 36-mil Hypalon liner. Experience with the short-term area will aid in identifying the design requirements for the long-term storage area (Sect. 4.1.5.2).

A failed plastic film liner is normally repaired and reused. The failure is located by analyzing water from underdrains or test borings. Stored waste is excavated down to the sand layer overlying the liner and is hauled to a reburial location, which may be adjacent to the same impoundment. The sand layer is temporarily displaced by water sprays used to expose the damaged liner. New plastic film is laid over the tear or puncture and heat sealed, or, if the existing film is sound, the original but defective heat seal is re-formed. The sand is replaced, completing the repair. This type of patching is an industry-accepted maintenance procedure for lined ponds and fills.

#### Acid gas removal

A critical system requirement for the sulfur removal and recovery system is the choice of an acid gas ( $H_2S + CO_2$ ) removal process selective enough for the type of acid gases (sulfur compounds) to be fed to the Claus unit.

Carbonyl sulfide (COS) contaminates the raw product gas. Other commercial processes (Stretford, Sulfinol, MEA, and others) were evaluated in the preliminary plant design stage and ruled out because of their inadequate or unproven capability for COS removal. The Selexol choice is based on its best selectivity against  $CO_2$  and lowest-utilities requirement for the degree of total desulfurization required.

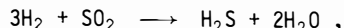
Benfield was selected for the credit generation module because of (1) its low energy consumption compared with the alternate amine solvents and (2) better economics and effectiveness than the Selexol process. The off-gas from this module requires incineration regardless of process choice.

#### Control of sulfur emissions

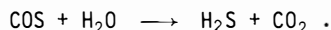
Sulfur emissions occur as small concentrations of sulfur dioxide and hydrogen sulfide in the sulfur recovery cleanup tail-gas, as sulfur dioxide in the coal-fired boiler stack gas, and as sulfur dioxide in the  $CO_2$  vent stream from the acid-gas removal process.

The proposed method of sulfur recovery is the employment of a Claus unit to produce elemental sulfur from the acid-gas stream. Because the tail-gas is directed to the tail-gas-cleanup system, there are no direct atmospheric emissions from the Claus plant.

The untreated tail-gas from the Claus unit [10,916 acfm at 138°C (280°F)] contains unacceptable levels of sulfur compounds (primarily SO<sub>2</sub>, H<sub>2</sub>S, sulfur vapor and COS), which must be removed before discharge to the atmosphere. The preferred method of tail-gas cleanup proposed in the design of the demonstration plant is the Beavon-Stretford process. In the catalytic Beavon converter, hot, moist, fuel-rich combustion gas is used to hydrogenate all SO<sub>2</sub> to H<sub>2</sub>S:



and to hydrolyze most of the COS to H<sub>2</sub>S:



The gas stream is then cooled and passed countercurrently through the Stretford absorber tower. The Stretford solution oxidizes H<sub>2</sub>S to a precipitate of elemental sulfur. Depleted Stretford solution containing sulfur particles must be passed through the Stretford oxidizer module, in which air bubbles form a froth of sulfur particles and also oxidize the Stretford reagent for reuse. The recovered sulfur is washed, melted, and added to the Claus-converter product.

Any HCN escaping conversion in the Claus unit is also captured by the Stretford process, forming sodium thiocyanate.

The proposed Beavon-Stretford system has a removal efficiency of about 99% and is believed by DOE to be BACT for this application. Normal atmospheric emissions in the vent-gas will include 1 ppmv H<sub>2</sub>S and 50 ppmv total sulfur. The process guarantee will be not to exceed 10 ppmv and 200 ppmv respectively.

An alternative to the proposed tail-gas treatment process is the use of the Shell Claus off-gas treating (SCOT) process. This process, using di-isopropanolamine solvent, offers a typical removal efficiency of about 96%, and the tail-gas containing 200 to 500 ppm H<sub>2</sub>S must be incinerated before stack release. Thermal regeneration and steam stripping of the rich SCOT solvent provides a H<sub>2</sub>S-rich gas stream that is recycled to the inlet of the Claus converter. In this application, the desulfurization performance of the SCOT process would not be as good as that of the Stretford.

An alternative to recovery of elemental sulfur would be the production of sulfuric acid. A sulfuric-acid plant would reduce atmospheric emissions of H<sub>2</sub>S by not generating a tail-gas containing H<sub>2</sub>S; however, acid plants produce sulfur-dioxide emissions that contain acid mist. The Wellman-Lord process is available to control these SO<sub>2</sub>/H<sub>2</sub>SO<sub>4</sub> emissions. The MLGW plant, at 100 tons/d of recoverable sulfur or 306 tons/d of H<sub>2</sub>SO<sub>4</sub>, is probably too small to be economically viable as a producer of acid.

Flue gas from the coal-fired boiler is directed to the FGD unit. One proposed method (based on its extensive use record) for the removal of sulfur dioxide is the FMC double-alkali process. This process contacts the gas with a concentrated sodium sulfite solution in a venturi scrubber. The gas and sulfite solution are separated, and the gas is released to the atmosphere. Lime is added to the solution to precipitate calcium sulfite salts, which are filtered, dewatered, and disposed of to landfill.

The second proposed method is the Chiyoda 121 process. This process incorporates a single gas-liquid contacting device within which all the chemical and process steps (SO<sub>2</sub> absorption, sulfite oxidation, and gypsum crystallization) take place, thereby greatly reducing the complexity and inherent problems experienced with other lime-limestone scrubbing systems. The Chiyoda 121 process produces gypsum (CaSO<sub>4</sub>·2H<sub>2</sub>O) as a salable or disposable product. A forced-oxidation step may be added to the double alkali process to convert sulfite (CaSO<sub>3</sub>·1/2H<sub>2</sub>O) to gypsum. The Chiyoda and FMC processes appear to be functionally equivalent and are believed by DOE to be BACT for this application.

Alternative processes exist that do not produce calcium sulfite salts. These processes include the Wellman-Lord and Shell FGD processes, which allow the regenerable absorption of sulfur dioxide for return to the Claus unit. The U.S. Bureau of Mines citrate process regenerates the sorbent by reaction with H<sub>2</sub>S, forming sulfur.

These alternatives are summarized in Table 2.7.



Table 2.7. Major sulfur-containing gas streams and alternative treatment processes

| Stream                                                         | Treatment method                                                                   | Remarks                                                                                                                                                                                          |
|----------------------------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Claus tail gas, 52,746 lb/h<br>(H <sub>2</sub> S, COS)         | 1. Stretford <sup>a</sup>                                                          | Vanadium in liquid blowdown requires treatment                                                                                                                                                   |
|                                                                | 2. SCOT/Super SCOT                                                                 | Higher SO <sub>2</sub> emissions                                                                                                                                                                 |
|                                                                | 3. H <sub>2</sub> SO <sub>4</sub> plant on entire input to Claus                   | Replaces S by-product by H <sub>2</sub> SO <sub>4</sub> by-product; scale of operations probably too small                                                                                       |
| Boiler flue gas<br>(SO <sub>2</sub> , NO <sub>x</sub> )        | 1. Double alkali FGD <sup>a</sup>                                                  | Product sludge may find commercial use                                                                                                                                                           |
|                                                                | 2. Chiyoda 121 <sup>a</sup>                                                        | Saleable gypsum product                                                                                                                                                                          |
|                                                                | 3. Regenerable Na <sub>2</sub> SO <sub>3</sub> scrubbing (Wellman Lord or Citrate) | Concentrated SO <sub>2</sub> enters Claus reactor; probable increased capital cost                                                                                                               |
|                                                                | 4. Regenerable CuO FGD (Shell)                                                     | Concentrated SO <sub>2</sub> enters Claus reactor; requires H <sub>2</sub> source, taken from IFG product; NO <sub>x</sub> reduction capability is easily added, probable increased capital cost |
| CO <sub>2</sub> vent gas from gas treatment (H <sub>2</sub> S) | 1. Incineration with no treatment of flue gas <sup>a</sup>                         | Negligible S content compared to steam boiler effluent; NO <sub>x</sub> level exceeds SO <sub>2</sub>                                                                                            |
| Flare                                                          | 1. None                                                                            | Occasional release (start-up, shutdown)                                                                                                                                                          |

<sup>a</sup>Proposed alternative.

### Control of particulates

A wet suppression system is proposed to control fugitive emissions from the active coal pile. The water forms a thin wet layer on the surface of the pile, which traps dust particles. Wet suppression systems have typical efficiencies of 60%. The application of a polymer crusting agent as a control alternative is impractical because of the repeated disturbances of the active storage pile. However, the employment of a crusting agent is proposed for the reserve coal storage pile, for which control efficiencies are in excess of 90%.

A baghouse dust collection system, with fabric filters, hooding, blowers, and appropriate ductwork, is proposed to control fugitive emissions from the coal and ash handling systems. As indicated below, baghouse systems represent an effective control technique for use in enclosed spaces, with efficiencies approaching 99.9%. Alternatives include the use of cyclones or electrostatic precipitators; however, these candidates suffer from inferior performance with smaller diameter particles and may be unsafe operating on coal dust-air mixtures.

| Technique                   | Size range (μm) | Collection efficiency (%) |
|-----------------------------|-----------------|---------------------------|
| Cyclone                     | <5              | 50 to 80                  |
|                             | 5 to 20         | 80 to 95                  |
|                             | 15 to 40        | 95 to 99                  |
|                             | >40             | 95 to 99                  |
| Electrostatic precipitators | 0.1 to 200      | 98 to 99.6                |
| Baghouses                   | >0.1            | 99+                       |
| Spray tower                 | 5 to 50         | 94 to 99                  |
| Venturi scrubber            | 1 to 50         | 97 to 99                  |

Flue gas generated in the coal-fired boiler contains particulates, mostly in the form of fly ash enriched with trace elements and polynuclear aromatics. The demonstration plant design basis proposes use of either a baghouse or electrostatic precipitator dust collection system. These systems are functionally equivalent in this application, designed to achieve in excess of 99.4% particulate removal. Conventional baghouse material is sensitive to gases with high temperature and significant concentrations of SO<sub>2</sub>, SO<sub>3</sub>, and moisture. Demonstration plant baghouse material must therefore be selected for high corrosion resistance and long life under these conditions. Electrostatic precipitators can experience reduced particulate removal efficiencies as flue gas SO<sub>2</sub> levels drop, which may limit plant flexibility in utilizing low-sulfur coals as an alternative fuel.

Table 2.8 summarizes these alternatives.

Table 2.8. Major particulate emissions and alternative control methods

| Stream                          | Treatment method                  | Remarks                                                                  |
|---------------------------------|-----------------------------------|--------------------------------------------------------------------------|
| Coal pile fugitive dust         | 1. Water spray <sup>a</sup>       | Active pile only                                                         |
|                                 | 2. Polymer crusting               | Reserve pile only                                                        |
| Coal/ash handling fugitive dust | 1. Fabric filtration <sup>a</sup> | System includes hoods, ducts, fans; collected coal dust burned in boiler |
|                                 | 2. Cyclone                        | Lower efficiency alternative                                             |
| Boiler flue gas                 | 1. Fabric filter <sup>a</sup>     | Short bag life with high-sulfur coal; Teflon-coated fiberglass bags      |
|                                 | 2. Electrostatic precipitator     | Up to 99.4% removal; backed up by FGD unit                               |
|                                 | 3. Wet scrubbing                  | Increased fan power consumption                                          |

<sup>a</sup>Proposed alternative.

Boiler flue gas may be treated in Venturi scrubbers for particulate removal or for combined SO<sub>2</sub> and particulate removal. Industry operating experience with combined wet-scrubber removal of dust and SO<sub>2</sub> has indicated that operating problems are common and that SO<sub>2</sub>-removal functions are better performed on dust-free gas streams. Spray-drier baghouse systems are being developed to clean both SO<sub>2</sub> and dust but were not considered sufficiently developed for use in the MLGW plant. Venturi scrubbers for particulate removal only require costly high-head booster fans and high-operating power consumption. Their particulate-removal performance is generally inferior to that of the baghouse system, which is also less expensive to construct.

#### Waste heat rejection

During normal operations the proposed plant will generate approximately  $659 \times 10^6$  Btu/h of process heat that cannot be recovered economically and is therefore rejected as waste heat. The wet mechanical draft cooling tower dissipates  $443 \times 10^6$  Btu/h, and air-fan coolers (dry mechanical draft) dissipate  $216 \times 10^6$  Btu/h. Alternative processes for waste heat removal include once-through cooling, cooling ponds, spray canals, and natural-draft cooling towers. These are summarized in Table 2.9.

Table 2.9. Waste heat rejection alternatives

| Alternative                                    | Remarks                                                                      |
|------------------------------------------------|------------------------------------------------------------------------------|
| 1. Mechanical-draft cooling tower <sup>a</sup> | Concerns are drift, noise, blowdown, steam plume on cool damp days           |
| 2. Once-through river water                    | Thermal discharge impacts water quality and temperature                      |
| 3. Cooling ponds                               | Large acreage required; reduces chlorine discharge                           |
| 4. Spray canals                                | Less acreage than pond alternative; drift losses                             |
| 5. Natural-draft cooling tower                 | Scale of operations probably too small; large visual impact                  |
| 6. Dry fan-assisted cooling                    | Large size, high costs; not justified at this site, where water is plentiful |

<sup>a</sup>Proposed alternative.

Once-through cooling involves a cooling water stream from a natural surface water source, transfer of heat to the stream, and discharge of the stream back to the surface water source. The heat is ultimately transferred to the atmosphere from the water surface. The Mississippi River provides more than adequate flow and surface area for this alternative system. Water quality regulations and restrictions, however, make this system unacceptable.

Cooling ponds operate under the same principles as once-through cooling, except that the cooling stream is recirculated to an isolated body of water. The demonstration plant would require a 37-ha (92-acre) pond for this alternative. This additional acreage is unavailable at the proposed site.

Spray canals reduce the land requirement of cooling ponds by promoting heat transfer through the use of agitators and sprays. The land requirements for this alternative would be about 4 ha (9 acres). However, there are significant questions about the reliability and design requirements of these systems.

Mechanical-draft evaporative cooling towers are the preferred system and use fans to draw air through the tower. Falling water within the tower contacts the air and gives up heat. Mechanical-draft cooling towers are well suited to meeting the demonstration plant cooling requirements. The main environmental concerns for this alternative are blowdown disposal, drift losses, visible plumes, and noise. Land requirements for this alternative are minimal compared with the pond and spray canal alternatives.

Natural-draft evaporative cooling towers use the buoyancy of the heated exhaust air to induce the necessary air draft. The large, hyperbolic chimney characteristic of this technology is necessary to ensure proper operation. Natural-draft cooling towers are competitive with mechanical-draft units in large-scale utility or industrial operations. However, natural-draft cooling towers are not economically justifiable for the relatively small heat load of the demonstration plant. Relative to the mechanical-draft units, natural-draft cooling towers have lower drift emissions but present greater visual impacts.

Dry mechanical-draft cooling towers use fans to draw air across heat exchanger surfaces. Therefore, no water is consumed by evaporation, lost as drift, or discharged as blowdown. Dry heat exchange is much less efficient than evaporative cooling systems so that a much larger tower is required. Both capital and operating costs are prohibitive, except where water supplies for evaporative cooling are scarce. The use of municipal water supplies by the plant will be only about 1% of the MLGW distribution system. Therefore, use of the dry-cooling alternative for the total heat load in the demonstration plant is not being considered (see section on alternative plant makeup water sources, following).

#### Alternative plant makeup water sources

The proposed MLGW facility will use a total of 0.15 m<sup>3</sup>/s (3.3 Mgd) of water. Makeup water will be required at a rate of 0.12 m<sup>3</sup>/s (2.7 Mgd). The remaining 0.03 m<sup>3</sup>/s (0.6 Mgd) of water needed will be obtained by recycling within the plant.

A number of abundant water supply sources are available in the vicinity of the IFGDP, including (1) the Memphis sand aquifer, (2) the Fort Pillow sand aquifer, (3) the shallow alluvium, (4) the Mississippi River, and (5) Lake McKellar. Treated effluent from the Maxson Sewage Treatment Plant is also part of the water supply for the area.

The discussion given below compares these alternative sources of water from both an environmental and economic viewpoint.

Memphis sand (500-ft sand). Since 1886 the Memphis or 500-ft sand aquifer has been the principal water supply source for the Memphis area.<sup>6</sup> Currently, MLGW operates six major well fields, which have a capacity of 8.3 m<sup>3</sup>/s (189 Mgd). Industrial users additionally withdraw about 2.2 m<sup>3</sup>/s (50 Mgd) from the source. Based on current projected growth rates, MLGW intends to increase its water supply to 9.9 m<sup>3</sup>/s (225 Mgd) by the year 2010. This increase will take place irrespective of the IFGDP demand. Thus, supply of 0.12 m<sup>3</sup>/s (2.7 Mgd) to the IFGDP is equal to about 1.2% of MLGW's planned supply into the next century.

Transmissivity of the Memphis sand is between 0.014 m<sup>2</sup>/s and 0.059 m<sup>2</sup>/s (100,000 and 410,000 gal/d/ft). This is a very high value and indicates that the aquifer is an extremely plentiful source of water. In addition, the Memphis sand aquifer is 150 to 250-m (500 to 800-ft) thick, extends for hundreds of square miles, and has a volume of  $7 \times 10^{11}$  m<sup>3</sup> ( $25 \times 10^{12}$  ft<sup>3</sup>). Over the lifetime of the plant, the IFGDP demand is a small fraction (less than 0.01%) of the aquifer volume or of projected availability in the Memphis area.

The IFGDP could obtain water from the Memphis sand either by purchasing city water or by developing a well field near the site. These options are discussed separately.

City water. In 1971, MLGW's Davis Station began to withdraw water at the rate of 0.5 m<sup>3</sup>/s (12 Mgd), about 6 km (4 miles) to the southeast of the IFGDP site. By 1975 this withdrawal rate had caused a water-table drawdown of 3 m (10 ft) within a radius of 1.6 km (1 mile) of the Davis Station. This is to be compared with a total aquifer thickness of between 150 and 260 m (500 and 850 ft). Pumping at the Davis Station is planned to reach 1.23 m<sup>3</sup>/s (28 Mgd) by the year 2010.

Under the alternative of purchasing city water, 0.12 m<sup>3</sup>/s (2.7 Mgd), or less than 10% of the ultimate capacity to be abstracted from the Davis Station, would be distributed to the IFGDP. Because city water is treated to remove iron, manganese, and CO<sub>2</sub>, only demineralization would be required at the IFGDP site for boiler feed water. However, 33% of the supply would need no additional treatment.

Two pipelines would be built to supply water from the existing city water distribution system to the IFGDP. One will extend from the Allen Generating Plant, and the other will link with the existing system at Presidents Island. Installation of this latter pipeline will require dredging in the Tennessee Chute area of Lake McKellar resulting in a small, temporary water quality disturbance.

Costs of purchasing city water through the life of the project are estimated at \$5.07 million, based on constant 1981 prices. These costs are smaller than those for any of the other options, making this choice the preferred alternative.

Separate well field. Separate development of a well field for the plant to tap the Memphis sand aquifer would result in no incremental drawdown at Davis but would cause a slight drawdown near the IFGDP site. Water obtained in this manner would require treatment at the site to remove iron, manganese, and dissolved CO<sub>2</sub> prior to its use in the IFGDP. Other impacts associated with this alternative include

1. the use of offsite land to house the well field, pumping station, and water distribution system, and
2. the need for additional maintenance personnel to operate the pumping station and treatment plant.

Development of a separate wellfield would cost \$5.8 million over the life of the project, a cost higher than that for directly purchasing city water.

Alluvial aquifer. At the site, the alluvial aquifer is 43 to 49-m (140 to 160-ft) thick, with a hydraulic conductivity of 0.1 to 0.35 cm/s.<sup>7</sup> In Tennessee it is principally used for industrial purposes. Near the site, there are seven users who obtain yields of around 0.09 m<sup>3</sup>/s (2 Mgd). In Arkansas the aquifer is used to supply irrigation water, and yields of greater than 0.3 m<sup>3</sup>/s (7 Mgd) are common.<sup>8</sup> Conditions near the site are similar to those found in Arkansas; thus, it is likely that an adequate and reliable supply of alluvial water is available.

Water in the alluvial aquifer has higher levels of iron, manganese, and phenol than does city water and would require treatment before it could be used in the plant. A localized and minor water table drawdown would occur. However, river recharge to the alluvium is rapid, and drawdown is likely to be temporary.

A well field developed in this aquifer would probably be off site and would require that wells, a pump house, and a distribution system be installed. As for the separate wellfield, additional maintenance personnel would be needed to operate the pumping station and treatment plant. Costs for obtaining water from the alluvium would be essentially the same as those for the separate development of a well field in the Memphis sands. Thus, this option's cost is also higher than the cost of purchasing city water would be, and it does not provide substantial environmental benefits.

Fort Pillow sand (1400-ft sand). In the Memphis area, the Fort Pillow sand (1400-ft sand) supplies between 0.18 and 0.3 m<sup>3</sup>/s (4 and 7 Mgd) to industrial users.<sup>6</sup> In the past, it has supplied as much as 0.56 m<sup>3</sup>/s (12.8 Mgd). Transmissivity of the aquifer ranges from 0.012 to 0.02 m<sup>2</sup>/s (90,000 to 140,000 gpd/ft).<sup>6</sup> Although it is not as transmissive or as extensive as the Memphis sand aquifer, the Fort Pillow sand is capable of supplying an adequate volume of water to the IFGDP that is also of better quality than water from the Memphis sand aquifer. However, it would probably still be necessary to treat water at an onsite facility to remove manganese and CO<sub>2</sub> before the water is used by the plant.

Between 1924 and 1973, MLGW operated wellfields in the Fort Pillow sand, and it intends to preserve the aquifer for future use.

Drilling, well development, and pumping costs would be higher in this sand than in the shallower aquifers because of its greater depth and lower transmissivity. Incremental drawdown is also expected to be higher. Otherwise, using the Fort Pillow aquifer has the same overall implications as separately developing a Memphis sand wellfield, and it is a less attractive alternative for the IFGDP.

Mississippi River. The Mississippi River is an abundant source of water at Memphis. The IFGDP demand is only 0.001% of the average flow and 0.005% of the historic low flow of the river.

However, the river contains higher TSS and trace element concentrations than local groundwater; thus, river water would need additional onsite treatment prior to use, probably by sand filtration and, perhaps, reverse osmosis. This could result in the generation of a solid waste that would require disposal.

Construction of an intake for the IFGDP would also result in the following environmental impact:

1. the destruction of a small additional area of wetland/floodplain on the river;
2. temporary disturbances due to localized dredging;
3. entrainment of ichthyoplankton, zooplankton, and phytoplankton larvae, and
4. the creation of an impingement hazard for adult fish.

Capital costs for upgrading the raw water treatment facility to handle river water are estimated to be \$3 to \$5 million above that needed for city water, making this a substantially more expensive alternative.

Lake McKellar. Lake McKellar offers an abundant source of water with an average discharge to the Mississippi River of 8.5 m<sup>3</sup>/s (195 Mgd). The Allen Generating Plant uses the lake to supply cooling water at a rate of 22 m<sup>3</sup>/s (500 Mgd). During low flows in January 1981, the lake elevation was below the Allen plant's intake level. In that the navigation channel extends close to the shore near the IFGDP, it is possible that a lake intake for the IFGDP could also occasionally be above the water level. Thus the reliability of this source is questionable during low flows.

Moreover, an intake would have to be constructed in the lake's turning basin or in the Tennessee Chute. Construction of this intake in the turning basin would result in

1. additional dredging-related impacts on water quality;
2. entrainment of ichthyoplankton, zooplankton, and phytoplankton larvae; and
3. a potential hazard to navigation.

If the intake were located in the chute area of Lake McKellar, similar impacts would occur with the additional impact of a loss of additional wetland/floodplain area affected by intake construction.

In addition, the quality of Lake McKellar water is generally worse than river water, meaning that extensive onsite treatment would be required. This treatment would also probably generate a solid waste that would need disposal. Capital and operating costs would be higher than those for the river option.

Maxson Wastewater Treatment Plant effluent. Treated effluent is discharged at an average rate of 3.5 m<sup>3</sup>/s (80 Mgd) from the Maxson Wastewater Treatment Plant. The minimum recorded flow of the discharge was 1.4 m<sup>3</sup>/s (32.1 Mgd), 8.4% of the IFGDP water demand. Thus, the Maxson plant could conceivably provide an ample supply of water to the IFGDP.

Since it began operating, however, severe organic overloadings have occurred at the Maxson plant and its effluent discharge has frequently exceeded NPDES permit limits for biological oxygen demand (BOD), TSS, and nitrates. By 1983, the plant will have been upgraded and is expected to comply with its permit limits.

Even if the Maxson plant meets permit limits, however, its effluent would require substantial treatment before it is acceptable for use in the IFGDP. It is expected that this treatment would include chlorination, clarification, reverse osmosis treatment, and demineralization. Additional capital costs for upgrading the raw water treatment facility at the IFGDP to handle the Maxson discharge are estimated to be \$7 million. Operating costs for the upgraded facility have not been estimated, but they would be significant because of the manpower, power supply, and raw materials needed.

Traces of pesticides and heavy metals are currently present in the Maxson effluent. If these substances were present in water supplied to the IFGDP, they could be concentrated during cooling tower recirculation and released to the environment via drift and blowdown. In addition, chlorination of the Maxson effluent could produce chlorinated hydrocarbons, which would also be concentrated during recirculation. Release of these substances in the drift could present a human health hazard, and their presence in the blowdown could necessitate further treatment before discharge to the river.

Using surface waters from Lake McKellar or the Mississippi River for plant makeup would have increased environmental impacts over using the proposed source. Water taken from either the alluvial aquifer, the Ft. Pillow sand, a separate Memphis sand well field, or the Maxson facility would require treatment that would generate additional solid wastes.

Table 2.10 summarizes the water supply alternatives evaluation.

Table 2.10. Alternative water sources

| Source                                     | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Memphis sand aquifer                       |                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Purchase of city water <sup>a</sup>        | Abundant and reliable supply of high-quality water needing little onsite treatment. Pipeline construction necessary. Slight incremental drawdown near Davis pumping station. Less expensive than any other alternative                                                                                                                                                                                                           |
| Development of separate wellfield          | Requires additional onsite treatment to that needed for city water. Construction of wells, pumping station, and distribution system required. Slight drawdown will occur near the site. More expensive than purchase of city water                                                                                                                                                                                               |
| Fort Pillow sand aquifer                   | May require additional onsite treatment to that needed for city water. Construction of wells, pumping station, and distribution system required. Due to greater depth and lower transmissivity, costs of well field development and operation are greater than for Memphis sand aquifer. Drawdown will also be greater than in the Memphis sands. More expensive than city water                                                 |
| Alluvial aquifer                           | Requires additional onsite treatment to that needed for city water. Construction of wells, pumping station and distribution system required. Very slight drawdown will occur near the site. More expensive than city water                                                                                                                                                                                                       |
| Mississippi River                          | Requires more extensive additional onsite treatment than groundwaters to remove suspended solids. This treatment may generate a solid waste that would require disposal. Construction of an intake will result in loss of floodplain-wetlands, water quality effects, entrainment of plankton larvae, and will present impingement hazards for adult fish. More expensive than city water                                        |
| Lake McKellar                              | Requires more extensive additional onsite treatment than groundwaters. Treatment may generate a solid waste that would require disposal. Intake may occasionally be above lake level. Construction of an intake will result in loss of floodplain-wetlands, water quality effects, entrainment of plankton larvae, and will present impingement hazards for adult fish. More expensive than city water                           |
| Maxson Wastewater Treatment Plant effluent | Requires very extensive additional onsite treatment to remove dissolved solids and organic contaminants. Pipeline construction necessary to obtain water from Maxson. Contaminants may be concentrated during cooling tower recirculation and released in the drift and blowdown. Release in the drift can present a human health hazard and, in the blowdown, may necessitate further treatment. More expensive than city water |

<sup>a</sup>Proposed alternative.

#### Alternative plant fuel and firing methods

The proposed plant design specifies coal as the fuel for the pulverized fired auxiliary boilers. Even after treatment to reduce the content of sulfur dioxide and particulates in the flue gases, the boilers are the source of about 1140 tons per year of sulfur dioxide and 140 tons per year of particulates. These emissions may be reduced through the use of clean-burning fuels. Natural gas and distillate fuel oils would be environmentally suitable, but, in light of the project goal of reducing reliance on natural gas and oil, such use would be counterproductive. The industrial fuel gas product would be a viable alternative fuel. An expanded credit generation system could make natural gas available for plant startup operations. To maintain the product design output

and to supply all plant fuel needs, the throughput must be increased by 27%. The total coal requirement of the plant would increase by about 8% to 3385 tons/d. Sulfur dioxide emissions caused by the increased production and use of the IFG would be about 100 tons per year. Particulate emissions would be about 3.5 tons per year. Reduction in these pollutants and FGD sludge production would be offset by increased liquid effluent and ash production.

The selection of pulverized firing (PF) (the proposed alternative) is based mainly on the need to utilize efficiently char fines entrained in and recovered from the gasifier product gas. Stokers and fluidized-bed boilers are less able to accept the mixture of high-sulfur coal and fine char as plant fuel. Low-sulfur coal could be burned in a stoker to reduce plant SO<sub>2</sub> emissions and make baghouse particulate collection more reliable. This method would require separate purchase and storage of low-sulfur coal. Fluidized-bed units with limestone sorbent beds would replace the PF-FGD system and avoid wet FGD sludges. These units at their current state of development cannot guarantee the high reliability level (7900 h/year) required for the MLGW demonstration, which is normally recorded by PF-type units.

These alternatives are summarized in Table 2.11.

Table 2.11. Steam generation alternatives

| Alternative                                   | Remarks                                                                                                                                                                                    |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Pulverized-coal-fired boiler <sup>a</sup>  | Able to combust coal plus fines collected in bag filters plus char from gasifier                                                                                                           |
| 2. Fluidized-bed boiler, limestone sorbent    | Eliminates FGD expense; lower efficiency in combusting gasifier char and collected coal dust                                                                                               |
| 3. Stoker-fired boiler                        | Ability to burn gasifier char questionable; Kentucky coal feedstock caking tendency may be excessive, requiring purchase of low-sulfur stoker coal                                         |
| 4. Purchase from Allen Generating Plant       | Pipeline required; high-pressure extraction for pump drives probably not feasible due to turbine design at Allen; would require switch to electric drives for compressors and pumps        |
| 5. Natural gas and distillate fuel oil firing | Contrary to project objectives                                                                                                                                                             |
| 6. IFG firing                                 | Requires increased plant size to make additional gas; results in less SO <sub>2</sub> and particulate release to atmosphere; for start-ups, use natural gas or gas storage on site for IFG |

<sup>a</sup>Proposed alternative.

#### Incineration alternatives

The controlled combustor selected for this plant will burn sufficient product gas to maintain 816°C (1500°F) conditions to ensure the destruction of all odorous compounds.

The alternative to thermal combustion is catalytic incineration at about 482°C (900°F) conditions, providing some potential fuel savings and reduced NO<sub>x</sub> output. The need for FGD reheat with the incinerator output gas negates the possible fuel savings. Noble metal catalysts are easily fouled or poisoned by contaminants in the entering gas streams so that fairly substantial costs are incurred at several-year intervals. Sulfuric acid mist is likely to be formed because of the catalyst action.

Incinerators of the multiple-hearth or fluidized-bed types are suitable for solid/liquid refuse but not for gas-only application.\*

\*T. Shen, M. Chen, and J. Lauder, "Incineration of Toxic Chemical Wastes," *Pollution Engineering*, vol. 10, p. 45, Oct. 1978.

### Coal transportation alternatives

Operation of the plant will require approximately 3150 tons of western Kentucky coal per day. Annual coal use (and, therefore, annual shipments) depends on the number of days per year that the plant operates. If the plant operates 250 d per year, which seems reasonable during the demonstration phase of the project, annual coal use would amount to 787,500 tons. At 330 d per year, as planned for commercial operation after the demonstration phase, annual coal use would be about 1,040,000 tons. Quantities of coal of this magnitude can be efficiently shipped only by rail or barge.

Data provided to MLGW by independent shippers indicate that coal currently can be transported by barge to Memphis from the western Kentucky fields for about \$2.50 to \$3.00 per ton. Comparable estimates for rail shipments range from \$10.00 to \$13.00 per ton.

This difference in transport cost of \$7.00 to \$10.50 per ton implies an annual transport cost differential of \$5.5 to \$8.3 million between the rail and barge options if the plant operates 250 d per year. If it is in production 330 d per year, the cost differential is proportionately larger — \$7.3 to \$10.9 million annually. Assuming that operations start in 1984 and that this cost differential holds over the 20-year life of the plant, this future incremental cost stream has a 1980 value of \$35.2 to \$53.1 million at 250 d per year. If the plant operates 330 d per year, these current value estimates increase to \$46.7 to \$69.7 million. These costs provide a substantial incentive to locate the plant so that it is accessible by barge.

#### 2.3.2.2 Alternative sites

DOE's Request for Proposal RFP-E(49-18)-2043 for a demonstration plant to produce IFG from coal was published in January 1976 and required that a site be specified as part of the proposal. MLGW selected the proposed Allen site for preliminary engineering and design. Subsequent site evaluation studies by MLGW<sup>9</sup> considered in some detail a total of five sites for the MLGW facility, all within Shelby County, Tennessee (construction by MLGW is limited by State law to Shelby County only).

The selection by MLGW of the proposed site involved consideration of projected environmental impacts, as well as costs of land acquisition, plant design modifications, and cost of delay. The DOE has prepared a report entitled "Identification and Evaluation of Alternatives to the Location of a Proposed Federal Action in the Floodplain." This report considers environmental, technical, economic, and scheduling factors. Based on this report, a Preliminary Statement of Findings (PSF) concluding that no practicable alternative exists to siting the MLGW project in the floodplain has been published. The report and the PSF are reproduced in Appendix C.8.

To evaluate better the relative environmental impacts associated with construction and operation at alternative sites, an independent site evaluation was conducted. In this analysis, engineering factors were used only as a screening tool to eliminate sites on which construction was not considered to be feasible; evaluation of the remaining sites was conducted strictly on the basis of environmental factors. The alternative sites were evaluated in the degree of detail necessary to determine whether or not they offered potential for appreciably reduced impacts.

Two of these five sites (Mud Island and the North site) present significant land use problems because their selection would require changes in zoning from residential, agricultural, and light industrial uses to heavy industrial uses. These two sites consequently have been eliminated from consideration here.

The remaining two alternative sites, Rivergate and Pidgeon, are zoned for heavy industry and could be developed so that they are technically suitable for the project. Both the Rivergate and Pidgeon sites, along with the proposed Allen site, are shown in Fig. 3.1. All three sites are within the Memphis city limits. Two of the three sites, Allen and Pidgeon, are owned by the city of Memphis. The Rivergate site is privately owned.

The environment at the proposed Allen site is described in Sect. 3.1, and environmental consequences of construction and operation on the proposed site are analyzed in Sect. 4.1. The Rivergate and Pidgeon sites are described in Sects. 3.2 and 3.3, and the impact analyses for these sites are presented in Sects. 4.2 and 4.3. Environmental impacts at the proposed and alternative sites are summarized and compared below.

#### Overview of the three sites

Allen. The proposed Allen site is located on a peninsula approximately 13 km west-southwest of the center of the city and 1.2 km east of the Mississippi River. The site is on the Mississippi River floodplain and is subjected to annual flooding. Dredged material from Lake McKellar has



been piled along the northern edge of the site. Approximately two-thirds of the site is covered by disturbed bottomland forest, and the remainder is meadow. Access to the site by road or water is good.

**Rivergate.** The Rivergate site (shown in Fig. 2.5) is located 4 km east of the Allen site. Its eastern boundary is formed by a barge canal, and its western boundary, by Lake McKellar. Although the site is on the floodplain of the Mississippi River, it is covered by a dredged fill that raises it above the 100-year flood stage. The site is zoned for industrial development and is part of the Rivergate Industrial Park, but no industry has been built on the site to date. The vegetative cover of the generally flat site ranges from bare, recently disturbed dredge spoil to vegetation characteristic of early to late old field succession, with small trees present. A remnant of highly disturbed floodplain forest borders the site along Lake McKellar and Nonconnah Creek. Access to the site by road, rail, or water would be easily provided by extension of existing services.

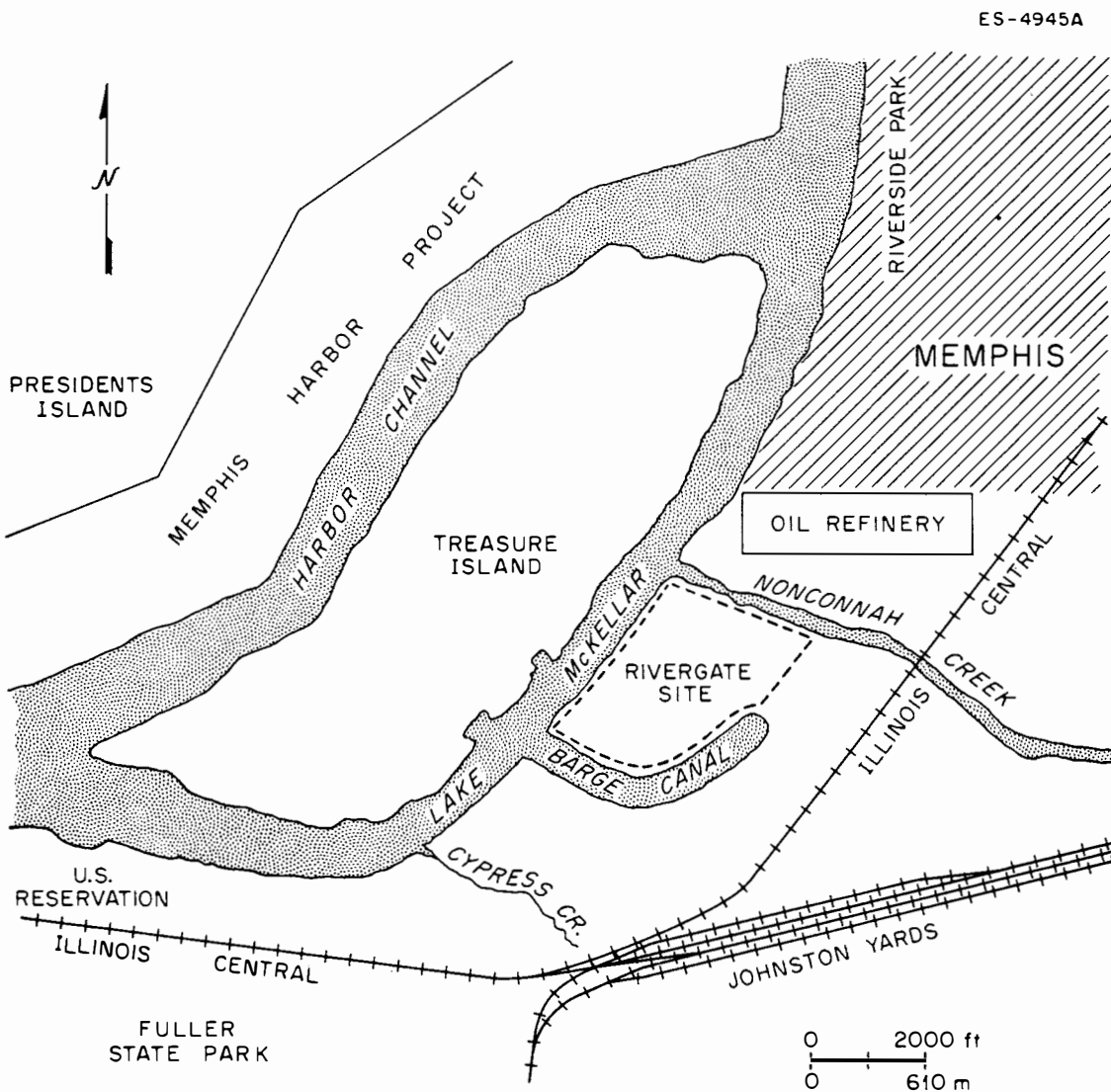


Fig. 2.5. Location of the Rivergate site.

Pidgeon. The Pidgeon site (Fig. 2.6) is located within the flood control levee system on the Mississippi alluvial plain about 2.4 km (1.5 miles) south of the confluence of the Mississippi River and Lake McKellar. The site is nearly flat. Surface runoff flows southeast into Horn Lake Cutoff and flows out of the leveed area at the southeast corner. The site is currently in agricultural use, with soybeans the major crop produced on the land. Prime agricultural soils cover all of the site area. The site is part of the Frank C. Pidgeon Industrial Park. Site access for plant operation requires construction of barge docking facilities and a coal conveyor. These facilities could be located either north of the site in the Allen barge turning basin or west of the site in the Mississippi River. Rail access to the site would require construction of 3.4 km of rail line, which would be installed by the industrial park developers. Barge delivery of coal is much less costly than rail delivery and would result in operating cost savings compared with rail delivery of about \$9 million per year (Sect. 2.3.2.1).

#### Overview of impacts

There are no overriding environmental concerns that preclude the construction and operation of the MLGW facility at the proposed site (Allen) or at either of the alternative sites (Rivergate and Pidgeon). For the most part, impacts of operation will be the same at each of the three sites, whereas differences in environmental impacts will occur as a result of facility construction. The major differences in environmental impacts are summarized below.

#### Allen site

- Plant construction at this site will result in the loss of 54 ha (134 acres) of floodplain, including about 28 ha (70 acres) of low- to medium-quality wetlands.
- Site requires filling to the project-design flood level. Site filling will destroy low-to-moderate-quality terrestrial habitat and will slightly alter flood elevations in Lake McKellar. Dredge/fill operations will have minor impacts on air quality and water quality (TSP).
- Construction of the barge facility will result in minor impacts on aquatic habitats.

#### Rivergate site

- This site as currently filled has inadequate soil-bearing capacity for the MLGW facility. Construction at this site would require the removal and disposal of existing fill and the subsequent refilling of the site to meet design specifications. Environmental impacts related to site preparation would be qualitatively similar to projected impacts at the Allen site but would persist longer here than at the Allen site.
- Use of this site would require construction of a long discharge pipeline right-of-way to the Mississippi River and a long dredge line.
- Use of this site would displace a developed industrial area capable of generating tax revenue.

#### Pidgeon site

- Although protected from direct flooding by an existing levee, the site is susceptible to direct flooding through seepage. Construction and operation of the proposed facility at this site would require filling similar to that required at the Allen site. Therefore, impacts of site preparation at this site will be similar to those at the Allen site.
- Construction at the Pidgeon site would affect land classified as prime agricultural soil. This site is currently under cultivation.
- Locating a coal barge terminal in the Mississippi River to the west of the site would affect approximately 20 ha (50 acres) of high-quality wetlands, an important wildlife habitat.
- Locating a barge terminal at the proposed barge terminal location for the Allen site would produce impacts on floodplain, wetlands, and aquatic ecology identical to those anticipated from construction of the barge terminal at the Allen site. Locating a barge terminal at this location for the Pidgeon site would require an above-ground coal conveyor approximately 2.4 km (1.5 miles) long. This conveyor would be a significant undesirable visual feature as well as a source of fugitive dust emissions during operation.

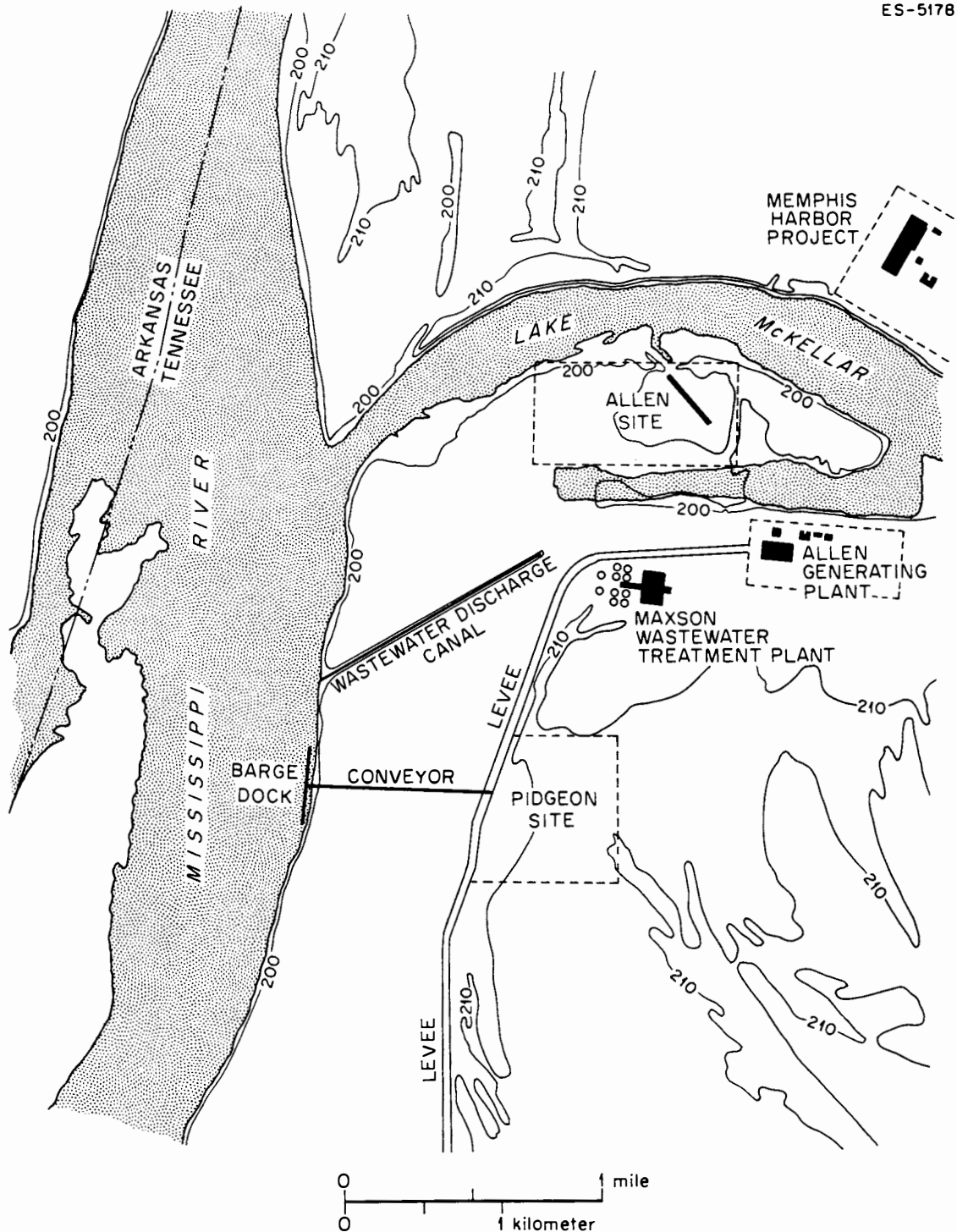


Fig. 2.6. Location of Pidgeon site.

### Comparison of impacts

Table 2.12 summarizes the significant impacts associated with the proposed site and the two alternatives. These impacts are discussed below and are described in greater detail in Sect. 4.

Air quality. The operation of a large coal gasification facility will result in the emission of pollutants, regardless of the location. Variations in terrain, atmospheric dispersive capabilities, ambient air quality, and proximity to population centers will determine the extent of the impacts of the emission of pollutants.

The Allen site is flat, with good dispersive characteristics, as are the Rivergate and Pidgeon sites. All three sites will require substantial earth-moving activities during site preparation, which will increase exhaust emissions during construction. Although all three sites would require extensive site preparation, dredge spoils, which tend to be wet and thus less subject to dusting, will be used. Fill will be kept wet at all sites and will not represent a major concern.

Routine emissions would be similar at all three locations. At any site, fugitive emissions from coal storage can be mitigated and would not be a major concern. Because terrain and local climatology are similar at all three sites, predicted ground-level concentrations of pollutants would be similar at all locations. Specific concentration distributions will be the same; however, their relative locations will vary with site location. For example, the maximum annual average ground-level  $\text{SO}_2$  concentration resulting from operation of the proposed facility at the Allen site is predicted to be  $2 \mu\text{g}/\text{m}^3$  and would occur on Presidents Island about 2 km north of the site. Operation at the Pidgeon and Rivergate sites would also result in a maximum annual average ground-level  $\text{SO}_2$  concentration of  $2 \mu\text{g}/\text{m}^3$ , which would occur about 2 km north of the site. However, for the Pidgeon site, this point of maximum predicted ground-level concentration lies just west of the Allen Generating Plant and south of the proposed Allen site. Add for the Rivergate site, the point of maximum concentration would be in the vicinity of the Memphis Harbor project. The Allen and Pidgeon sites are near Presidents Island, which currently has fair to poor air quality, as does the area near the Rivergate site. The Pidgeon site and the Allen site are very close to the Allen Generating Plant, and the Rivergate site is near the Delta refinery.

Unquantifiable impacts, chiefly from emissions of organic compounds, would be similar at all locations. All three sites are near the Memphis metropolitan area. Under certain wind conditions, the emissions from these sites could affect the Memphis area.

The effects of cooling tower operation would be similar at all sites. All sites are near large bodies of water and are subject to high ambient relative humidities. Deposition of drift from well-maintained towers would not be a problem at any of the sites.

The quantifiable impacts are similar at all locations, and no clearly superior site from the standpoint of air quality is identifiable. All major impacts that have been identified can be successfully mitigated. Unquantifiable impacts, such as synergistic effects with other sources, precipitation modification, and accident conditions, are likely to be similar at all sites.

Hydrology. Construction of the fill, which is necessary to develop the Allen site, will result in slightly raised flood elevations in Lake McKellar. Flooding of the site during fill construction could result in fill erosion and project delays. Raising the elevation of the Rivergate site 1 m by diking or filling would have little impact on surface water hydrology. Should removal of existing fill and subsequent refilling be required to achieve the necessary load-bearing capacity, the site's flooding during fill construction would be a concern. Impacts related to surface water hydrology caused by development of the Pidgeon site depend on how coal is transported. Placement of a barge terminal in the Mississippi River is undesirable for navigation and maintenance reasons. Little hydrologic impact is anticipated from placing the barge terminal in Lake McKellar, although a longer conveyor is required. The process areas of the Pidgeon site are protected by levees. Greater hydrologic impacts would result from development of the Allen site than from use of the Rivergate or Pidgeon sites.

There is some potential hazard to alluvial and bedrock aquifers on all three sites. Alluvial aquifers underlie all the sites at shallow depth. Contamination of the aquifer at the Allen site could pollute several industrial wells. Severe contamination of the alluvial aquifer could affect the bedrock aquifer by leakage; however, this is a remote possibility. The Rivergate site is closer to an area of possible hydrologic connection of the alluvium with the Memphis aquifer, and severe contamination of alluvial groundwater — although not anticipated — could affect Memphis drinking water. The Pidgeon site is farthest from points of use of alluvial groundwater, and potential impacts on the alluvial aquifer would have the least effect on water users in that area.

Water quality. Site preparation activities are likely to be extensive at all three sites. Unless soil testing indicates adequate load-bearing capacity at the Rivergate site, water quality alterations during construction can be considered equivalent at all three sites. Specific perturbations are discussed in Sect. 4.1.3. It is expected that potential impacts on the

Mississippi River from dredging for site buildup would be similar at all sites. Impacts on Lake McKellar from Pidgeon site construction would depend on the location of the barge dock. If located on Lake McKellar, it is likely that disturbances similar to those anticipated at the Allen and Rivergate sites would occur. For all the sites, the installation of the product gas and water supply pipelines will cause short-term perturbations.

The wastewater from operation of all three of the sites will be discharged into the Mississippi River. It is projected that the effluent from the Allen and Rivergate sites will be discharged at approximately the same location, Mile-Point 725.5, and that of the Pidgeon site discharged slightly farther downstream at Mile-Point 724. Effluents from all sites will be rapidly diluted in the river. Outside the mixing zone, the impact to river water quality would be small incremental loadings of those constituents for which ambient concentrations exceed recommended levels. The size of the mixing zone will be determined by the Tennessee Division of Water Quality Control within the Department of Public Health, which is the NPDES permitting agency for the State. Poorer ambient water quality may exist at the Pidgeon site discharge point because of the nearby Tennessee Valley Authority (TVA)-Maxson discharge. Increased barge traffic and periodic maintenance dredging may increase water turbidity and concentrations of some chemicals at all prospective barge dock locations.

Aquatic ecology. Because site buildup requirements at the Rivergate site are uncertain, the impacts to aquatic habitats from dredging in the Mississippi River must be assumed to be equivalent for all three sites. The construction of the barge dock is anticipated to disturb backwater areas such as those occurring in Lake McKellar in the Allen turning basin or at the Rivergate site. Although these areas appear to be medium-quality habitat for fish in the lake, there appear to be other areas of equal or better quality. For all the sites, the installation of the product gas and water supply pipelines will destroy small areas of benthic habitat.

Outside the mixing zone, operational impacts from the wastewater discharge into the Mississippi River are expected to be minor. Increased barge traffic and periodic maintenance dredging may modify localized habitat at all prospective barge dock locations.

Geology and soils. All three sites considered are located on alluvial deposits of the Mississippi River. Detailed subsurface information is available for the Allen and Rivergate sites, and foundation preparation plans have been developed for the Allen site. Development of the Allen site requires extensive filling and fill consolidation by vibroflotation. The Rivergate site has previously been filled to within 1 m of the project design flood elevation; however, available information indicates that in some areas site soils are incapable of bearing the anticipated loads (Appendix C.8). The Pidgeon site is protected by levees; foundation conditions are unknown at the Pidgeon site. Site development plans require filling the site to the project design flood elevation. Comparison of seismic risk to foundations on the three sites is not possible because of lack of subsurface sampling and testing information for the Pidgeon site. There may be local variations in the alluvial deposits that would greatly affect foundation stability and the degree of foundation preparation required.

In terms of agricultural value of site soils, impacts resulting from development of the Pidgeon site would be greater than for development of the Allen or Rivergate sites. Soils on the Allen site are of little or no agricultural value, natural soils on the Rivergate site have already been covered by fill material (gravelly sand), and soils on the Pidgeon site (currently in agricultural use) are classified as prime farmland soils by the Soil Conservation Service.

Land use. All three alternative sites are currently zoned for heavy industrial uses and are near existing industries.

The Allen site has been used for disposal of dredge material, is in the floodplain, and contains about 28 ha of forested wetland. Disposal of these dredge spoils in this area would no longer be practicable. There is no prime farmland on the Allen site (Appendix B.3.2). The Rivergate site, located in the Rivergate Industrial Park, has been filled to above flood stage, has no prime farmland, and is currently vacant. The Pidgeon site is located in the Frank C. Pidgeon Industrial Park and is protected by existing levees. The site is entirely prime farmland (Appendix B.3.2) and is in agricultural use (soybeans) (a more complete discussion of floodplain and wetland impacts is given in Sect. 4.5, Floodplain and Wetlands Assessment and Appendix C.8).

Because both the Rivergate site and the Pidgeon site are in industrial parks and should be attractive for private development, use of these alternative sites could result in the loss of potential income, employment, and tax revenue as compared with the Allen site.

Terrestrial ecology. Impacts on terrestrial biota would be greater at the Allen site and the Pidgeon site than at the Rivergate site. At the proposed site 43 ha (108 acres) of floodplain forest and its associated wildlife would be eliminated (including a small amount off site). About 28 ha (70 acres) of disturbed, low- to medium-quality wetland [primarily a portion of the 43-ha (108-acre) floodplain forest] and 16 ha (40 acres) of disturbed meadow would also be

Table 2.12. Comparison of impacts at the proposed Allen site with impacts at Rivergate and Pidgeon sites

| Potential impacts                             | Allen (proposed)                                                                                                                                                                                                                       | Rivergate                                                                                                                                                                                                 | Pidgeon                                                                                                                                                                                                                     |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Air quality</b>                            |                                                                                                                                                                                                                                        |                                                                                                                                                                                                           |                                                                                                                                                                                                                             |
| Ambient air quality                           | Nonattainment area for TSP in vicinity; good dispersion characteristics                                                                                                                                                                | Near nonattainment area for TSP; good dispersion characteristics                                                                                                                                          | Near area presently listed as nonattainment for TSP; good dispersion characteristics                                                                                                                                        |
| Fugitive emissions                            | Little construction impact; careful coal storage during operation is designed to minimize TSP                                                                                                                                          | Minor; dust suppression required during construction                                                                                                                                                      | Little construction impact; dust suppression required as fill dries                                                                                                                                                         |
| <b>Hydrology</b>                              |                                                                                                                                                                                                                                        |                                                                                                                                                                                                           |                                                                                                                                                                                                                             |
| Surface water                                 | Site lies on Mississippi floodplain and is regularly flooded; development would raise the design flood elevation a maximum of 0.2 m (0.7 ft) in Lake McKellar; flooding during fill emplacement could erode the fill and delay project | Site development would have little impact on hydrology; flooding during construction could be a hazard; the site would likely require refilling to above-design flood elevation.                          | Site development would have no impact on Mississippi River flows; barge terminal may necessarily be located in the floodplain                                                                                               |
| Groundwater                                   | Alluvial aquifer could be contaminated if coal and waste-storage liners failed; minor potential hazard of contamination of Memphis water supply if extreme contamination of alluvial aquifer occurred                                  | Hazard to alluvial aquifer similar to hazard at Allen site; potential hazard to Memphis water supply somewhat greater than for the Allen site                                                             | Alluvial aquifer could be contaminated by coal or solid waste leachates; site is remote from points of water use in alluvial aquifer                                                                                        |
| Water quality                                 | Effluent rapidly diluted by Mississippi River flow; existing water quality not in compliance for several constituents to be discharged                                                                                                 | Effluent rapidly diluted by Mississippi River flow; existing water quality not in compliance for several constituents to be discharged                                                                    | Effluent rapidly diluted by Mississippi River flow; existing water quality not in compliance for several constituents to be discharged; poorer ambient water quality may exist at this site because of TVA-Maxson discharge |
| Aquatic ecology                               | Dredging for construction of barge dock may indirectly affect sunfish spawning area; little or no operational impact                                                                                                                   | Extensive site preparation may adversely affect ecology                                                                                                                                                   | Impact dependent on location of barge dock; little or no operational impact                                                                                                                                                 |
| Geology and soils                             | Site development requires construction of dredged fill on Mississippi floodplain; foundation conditions and seismic risk present a potential geologic hazard requiring mitigative construction                                         | Site is already filled to elevation above flood hazard; seismic risk equivalent to Allen site; foundation conditions undesirable for this project — portions of the existing fill may have to be replaced | Site development may require some filling or dike construction. Foundation conditions are unknown. Prime farmland occupies all of the site                                                                                  |
| Land use                                      | Zoned for heavy industrial; use of site for dredge spoil disposal would be displaced                                                                                                                                                   | Within a prepared industrial park; displacement of private industry could preclude tax revenue otherwise generated                                                                                        | Zoned for heavy industry, though classified as prime farmland and currently in agricultural production. Future agricultural use would be displaced                                                                          |
| Terrestrial ecology                           | 43 ha of disturbed floodplain forest and 16 ha of meadowland would be removed; five State-protected species may utilize site                                                                                                           | 54 ha of weedy, early successional habitat destroyed                                                                                                                                                      | 54 ha of productive farmland in soybeans and possibly 20 ha of floodplain forest, a potential nesting habitat for the Mississippi kite, would be destroyed                                                                  |
| <b>Social, economic, and cultural impacts</b> |                                                                                                                                                                                                                                        |                                                                                                                                                                                                           |                                                                                                                                                                                                                             |
| Labor availability                            | Large labor pool in Memphis area; no shortages expected                                                                                                                                                                                | Large labor pool in Memphis area; no shortages expected                                                                                                                                                   | Large labor pool in Memphis area; no shortages expected                                                                                                                                                                     |
| Transportation and community services         | Good access; only minor traffic impacts expected during construction period; services adequate                                                                                                                                         | Good access; only minor traffic impacts expected during construction period; services adequate                                                                                                            | Good access; only minor traffic impacts expected during construction period; services adequate                                                                                                                              |
| Archaeological and historical resources       | No evidence of any sites                                                                                                                                                                                                               | Little likelihood of significant sites                                                                                                                                                                    | Little likelihood of significant sites                                                                                                                                                                                      |

affected. The Pidgeon site proper consists entirely of soybean fields, which are generally poor wildlife habitat. Therefore, effects on existing native biota would be significantly less than at the Allen site. However, this prime agricultural land is very productive, and, in the absence of intense cultivation, could provide excellent habitats for vegetation and wildlife.

If the Pidgeon site is selected, construction of a coal conveyor would affect either a small amount of forested wetland on the floodplain just west of the site or primarily soybean field and meadow land to the north, depending on where the barge facility is located. If the barge facility is located along the Mississippi River west of the site, it would be necessary to clear about 20 ha (50 acres) of floodplain forest for a barge slip, because the U.S. Army Corps of Engineers will not permit the construction of a barge facility in the Mississippi River Channel. The forest west of the Pidgeon site is mature and appears to be good nesting habitat for the Mississippi kite, a species listed as endangered by the State of Tennessee. A coal conveyor and barge slip in this forest might adversely affect the kite.

At the Rivergate site, a weedy old-field vegetation has become established subsequent to the filling of the site and its immediately surrounding area for industrial use. Because of the recent disturbance resulting from filling, the Rivergate site has little current ecological value and is generally poor wildlife habitat. Thus, construction would have the least ecological impact at this site.

Economic, social, and cultural impacts. Development of the proposed Allen site or either of the two alternative sites would have virtually identical economic, social, and cultural impacts, except for minor differences in traffic access routes and proximity to recreation areas.

The Memphis-Shelby County area is expected to have more than adequate infrastructure to support the relatively small size of the work force. No significant adverse impacts are expected, and positive economic impacts will result from wage and salary payments, local purchase of materials, and increased local business activity.

Negative, but minor, traffic impacts are expected during construction near the Allen site. The Pidgeon site would use the same access roads so that traffic impacts would be similar to those at the Allen site. The Rivergate site would use different access roads near the site, and the localized congestion at shift change should be comparable to that at the alternative sites.

The Rivergate site is located away from Fuller State Park and Chucalissa Indian Village and would thus have no impact on these facilities. The Allen site is 2.4 km (1.5 miles) northwest of Fuller State Park and would be visible from parts of the park that overlook the Mississippi River valley. However, because of the existing industrial nature of the surrounding area, development of the Allen site should not substantially alter the existing visual environment as viewed from Fuller State Park. The Pidgeon site would be more visible from the Chucalissa Indian Village than would the other sites.

Operation of the plant at any of the three sites should result in insignificant noise impacts.

#### 2.3.2.3 Delay of action

A delay in the construction of the demonstration plant could result in a delay in the construction of the full-scale commercial medium-Btu gasification facilities. This delay could, in turn, have an impact on meeting the overall energy goals. On a local and regional level, a delay in the construction of this medium-Btu gasification demonstration plant will result in a delay of the economic advantages associated with this project.

#### 2.3.3 No action

Failure to act on the proposed project will not provide information pertaining to economics, technical risk, environmental performance, or reliability associated with the U-gas process. The accelerated advancement of the state of the art in medium-Btu gasification via the U-gas process will not take place. The goal of using a major domestic energy resource, high-sulfur caking coal, via the U-gas process will be delayed.

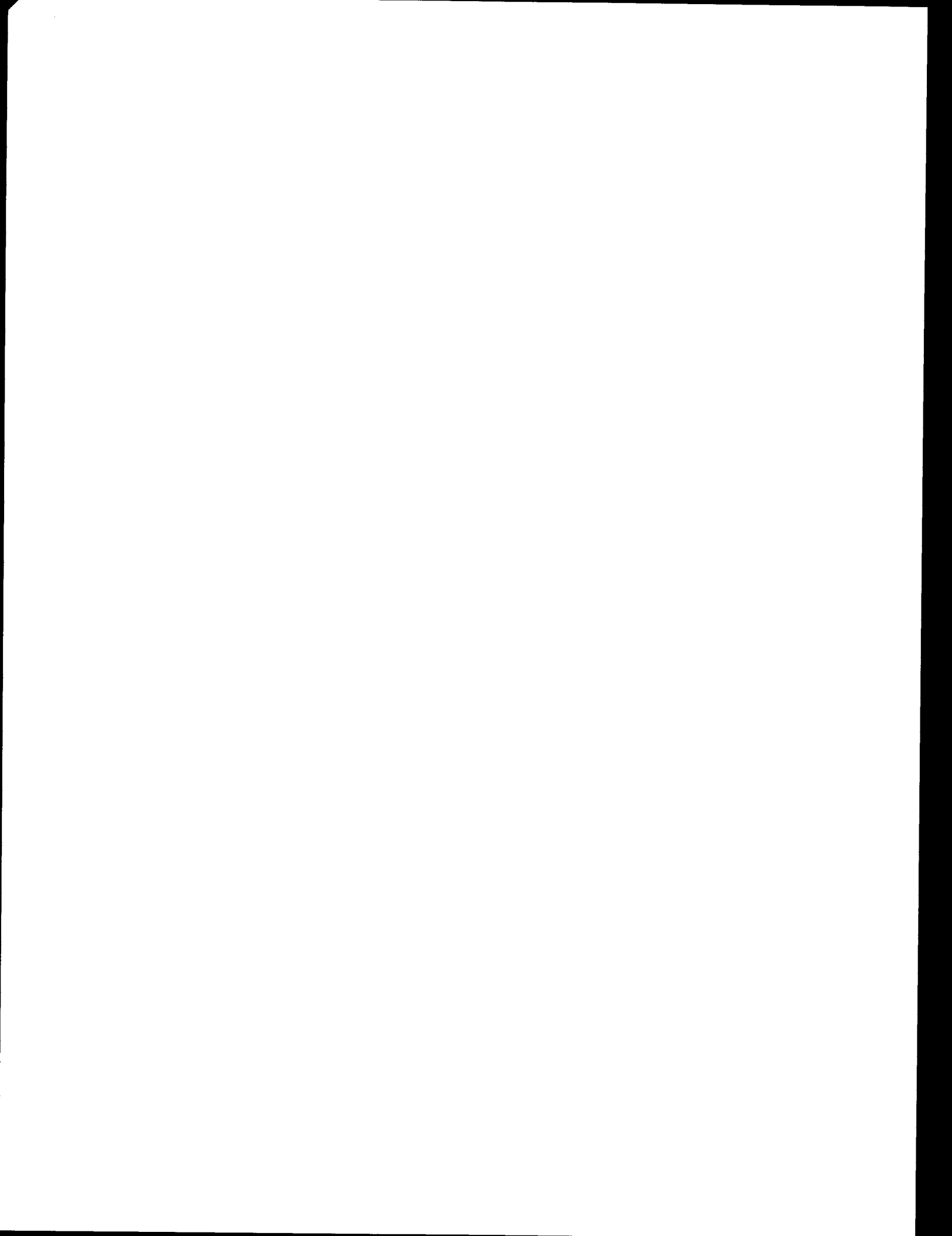
The opportunity for cost-sharing with the city of Memphis, Tennessee, will be lost. Also, the opportunity to build technical confidence in the private sector with a successful demonstration plant will be lost.

The physical and biological environment of Memphis and Shelby County would remain unaffected by this project if the no-action alternative is chosen. However, plans exist for portions of the Allen site, in the absence of the proposed project, to become a future ash disposal area for the TVA Allen Generating Plant (lease agreement between the city of Memphis, MLGW, and TVA, January 1, 1963; amended December 11, 1979). If the no-action option is selected, the region will not receive the economic benefits of increased employment and tax revenue associated with the construction and potential continued operation of the demonstration plant, and MLGW's capacity to provide uninterrupted gas service to its industrial customers could be diminished.

#### REFERENCES FOR SECTION 2

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9. Memphis Light, Gas and Water Division, *Site Evaluation and Selection*, February 1979.





### 3. AFFECTED ENVIRONMENT

This section describes the physical, ecological, and socioeconomic settings at the three sites considered. The proposed Allen site is described in Sect. 3.1, and the Rivergate and Pidgeon alternative sites are described in Sects. 3.2 and 3.3, respectively. The relative locations of these three sites are shown in Fig. 3.1.

#### 3.1 PROPOSED SITE — ALLEN, SHELBY COUNTY, TENNESSEE

##### 3.1.1 Meteorology, air quality, and noise

###### 3.1.1.1 Meteorology

The proposed site lies in the southwest portion of Memphis, Tennessee. The climate is temperate to subtropic, with cool winters and hot, muggy summers. Frontal systems may invade the site from either the northern Great Plains or the Gulf of Mexico, bringing quick changes in temperature, cloud cover, winds, and precipitation.

Normal daily maximum temperatures range from 33.1°C (91.6°F) to 9.7°C (49.4°F), with a maximum reported temperature of 41.1°C (106°F). Normal daily minimum temperatures range from 21.9°C (71.5°F) to -0.2°C (31.6°F). Memphis receives an average of 65% of the possible sunshine per year. The area averages 59 d with temperatures below freezing.

Winds are fairly brisk in the area, averaging 14.8 km/h (9.2 mph). The prevailing wind direction is south-southwest, with a secondary maximum from the north-northeast. The highest reported wind at Memphis was 92 km/h (57 mph) from the west. Dispersion characteristics in the region are fairly good, except in late summer and early autumn, when winds average 11.4 km/h (7.1 mph) and limited vertical mixing occurs. A wind rose depicting the frequency with which the wind blows from a given direction is included in Appendix C.1.1.1.

Precipitation is abundant, averaging 124.7 cm (49.1 in.), and is uniformly distributed throughout the year, with highest amounts occurring in the spring and lowest amounts, in the fall. One hundred six days per year are expected to have precipitation of 0.03 cm (0.01 in.) or more. Total snowfall, including ice pellets, averages 14.0 cm (5.5 in.). Average morning relative humidity is 81%, with 57% being normal in the afternoon. Summer mornings have an average humidity in excess of 90%. Severe thunderstorms are common in western Tennessee, but attendant tornadoes occur infrequently.

###### 3.1.1.2 Air quality

All of Shelby County is classified as nonattainment for ozone, and within the perimeter of expressways, metropolitan Memphis, which is about 9 km from the proposed site, is nonattainment for CO. Air quality levels on Presidents Island, located north of the site on the opposite shore of Lake McKellar, are determined by the U.S. Environmental Protection Agency (EPA) to be currently exceeding national ambient air quality standards (NAAQS) for total suspended particulates (TSP), but the proposed site itself is attaining applicable standards for TSP and CO. The area around and including the site is classified as attaining applicable SO<sub>2</sub> and NO<sub>2</sub> standards. Preliminary dispersion modeling, to identify the proper location for air quality monitoring stations, using existing sources, determined that the Allen Generating Plant is the dominant source of SO<sub>2</sub> and man-made particulate matter in the area.

Air quality monitoring by MLGW at the location of maximum-predicted air quality impact from the proposed facility and the surrounding emitters (approximately 2 km NE of the proposed site) reveals better air quality than the EPA designations would imply. The EPA designations are currently under investigation for possible revision. Table 3.1 is a listing of the measured concentrations and the applicable Federal standards. These measured concentrations reflect the impact of all existing sources. The Federal 1-h ozone standard was exceeded at the monitoring site, but exceeding the standard once is allowed so that the measured concentration does not represent a violation of the standard. Total suspended particulate measurements at the monitoring site showed only one excursion (no violation) of the secondary TSP standard, and this excursion

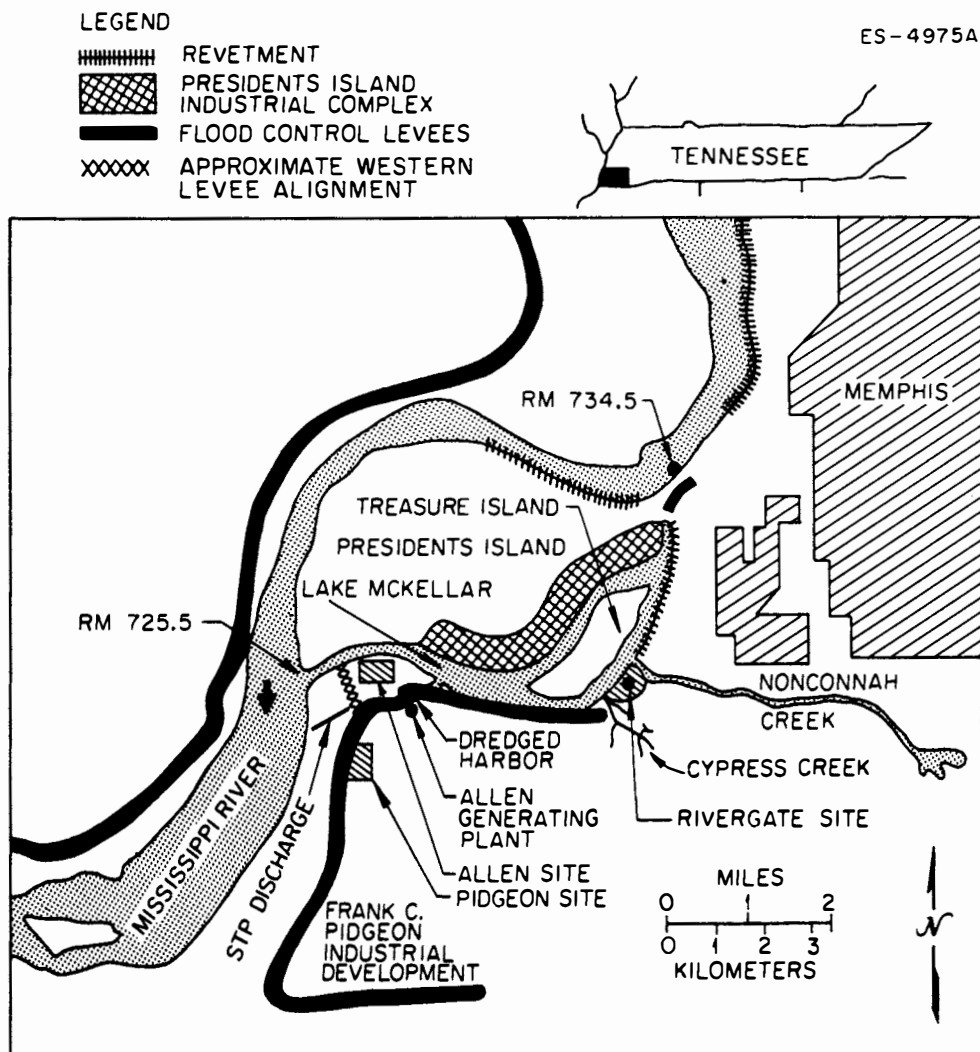


Fig. 3.1. Locations of sites.

was likely caused by fugitive dust from agricultural and natural sources; measurements were all below applicable standards. Particulate sulfate concentrations were measured at the site and represent a sizable fraction of the total atmospheric particulate loading. Polycyclic aromatic hydrocarbons (PAHs) were measured at the monitoring site and were found to be at very low concentrations. These data, measured at the point of predicted maximum impact, are assumed to be representative of the air quality at the site and in the southwest area of Presidents Island.

### 3.1.1.3 Noise

Ambient sound levels were measured at nine locations near the proposed site. These locations include the closest recreation area (Chucalissa Indian Village), the closest permanently inhabited dwelling, other adjacent areas, and the approximate midpoints of the property boundaries.

The measured ambient noise consisted primarily of insect noise and a steady hum from the Tennessee Valley Authority's (TVA's) Allen Generating Plant. The existing noise levels can be classified as suburban-urban during the daytime and as urban at night, based on observed levels not dominated by insect noise.

Appendix C.1.2 lists detailed sound measurements and measurement locations.

Table 3.1. Ambient air quality measured at the IFGDP monitoring site

| Pollutant                             | Measured concentration <sup>a</sup><br>( $\mu\text{g}/\text{m}^3$ ) |                | Federal standard <sup>b</sup><br>( $\mu\text{g}/\text{m}^3$ ) |                  |
|---------------------------------------|---------------------------------------------------------------------|----------------|---------------------------------------------------------------|------------------|
|                                       | Highest                                                             | Second highest | Primary                                                       | Secondary        |
| TSP, 24 h                             | 175.3                                                               | 126.7          | 260 <sup>c</sup>                                              | 150 <sup>c</sup> |
| TSP, annual                           | 58.4 <sup>d</sup>                                                   |                | 75                                                            | 60               |
| SO <sub>2</sub> , 3 h <sup>e</sup>    | 523                                                                 | 505            | 1,300 <sup>c</sup>                                            |                  |
| SO <sub>2</sub> , 24 h <sup>e</sup>   | 214                                                                 | 193            | 365 <sup>c</sup>                                              |                  |
| SO <sub>2</sub> , annual <sup>f</sup> | 34                                                                  |                | 80                                                            |                  |
| NO <sub>2</sub> , annual              | 30.1                                                                |                | 100                                                           |                  |
| O <sub>3</sub> , 1 h (ppm)            | (0.125)                                                             | (0.109)        | (0.120) <sup>c</sup>                                          |                  |
| CO, 1 h                               | 6,800                                                               | 4,500          | 40,000 <sup>c</sup>                                           |                  |
| CO, 8 h                               | 4,800                                                               | 3,113          | 10,000 <sup>c</sup>                                           |                  |

<sup>a</sup>Source: ER.<sup>b</sup>Source: Environmental Protection Agency National Primary and Secondary Ambient Air Quality Standards, *Fed. Regist.* 36(84).<sup>c</sup>Values not to be exceeded more than once per year.<sup>d</sup>Data from February 1978 through August 1979.<sup>e</sup>Data from February 1978 through May 1978.<sup>f</sup>Data from seven TVA SO<sub>2</sub> monitoring in the vicinity of the Allen Generating Plant.

### 3.1.2 Hydrology

#### 3.1.2.1 Surface water

Three major surface water bodies are located within the vicinity of the proposed plant site: the Mississippi River, Lake McKellar, and Nonconnah Creek. Hydrological characteristics of these water bodies are discussed here.

#### Mississippi River

The Mississippi River drains approximately 2,416,000 km<sup>2</sup> (932,700 sq miles) as it passes the mouth of Lake McKellar at River Mile 725.5. The river at this point is walled in between flood control levees on the west side in Arkansas and the levee protecting the Frank C. Pidgeon Industrial Area on the east side of the river, as shown in Fig. 3.1. The average flow passing Memphis is 10,200 m<sup>3</sup>/s (360,000 ft<sup>3</sup>/s).

The Mississippi River is not used directly for domestic or industrial supply purposes within 4.8 km (3 miles) of the plant site because groundwater provides the major source of water for drinking and industrial uses. However, seven point-source elements consisting of five industries and two sewage treatment plants discharge into the Mississippi River near the plant site at a combined flow of  $2.73 \times 10^6$  m<sup>3</sup>/d (722.22 Mgd).

Maximum flow at the West Memphis U.S. Geological Survey gage was 57,200 m<sup>3</sup>/s (2,020,000 ft<sup>3</sup>/s), recorded on February 7, 1937, at 70.8 m (232.2 ft) above mean sea level, and minimum flow was 2208 m<sup>3</sup>/s (78,000 ft<sup>3</sup>/s) on August 25, 1936, at 56.0 m (183.9 ft) above mean sea level. Table 3.2 presents discharges and elevations for selected maximum floods.

Table 3.2. Discharges and elevations for selected maximum floods<sup>a</sup>

|                                              | 10-year flood      | 25-year flood      | 50-year flood      | 100-year flood     | Project design flood       |
|----------------------------------------------|--------------------|--------------------|--------------------|--------------------|----------------------------|
| <b>Mississippi River<sup>a</sup></b>         |                    |                    |                    |                    |                            |
| Flow, m <sup>3</sup> /s (ft <sup>3</sup> /s) | 40,600 (1,435,000) | 46,400 (1,640,000) | 51,200 (1,810,000) | 55,500 (1,960,000) | 68,200 (2,410,000)         |
| Elevation above mean sea level, m (ft)       | 65.99 (216.4)      | 67.06 (220.0)      | 67.85 (222.6)      | 68.55 (224.9)      | 70.96 (232.8) <sup>b</sup> |
| <b>Nonconnah Creek</b>                       |                    |                    |                    |                    |                            |
| Flow, m <sup>3</sup> /s (ft <sup>3</sup> /s) | 82.11 (2,900)      | 101.93 (3,600)     | 118.91 (4,200)     | 137.32 (4,850)     | 201.02 (7,100)             |
| Elevation above mean sea level, m (ft)       | 66.93 (219.6)      | 68.05 (223.25)     | 68.73 (225.5)      | 69.37 (227.6)      | 70.16 (230.2)              |

<sup>a</sup>Unpublished data from the Corps of Engineers.<sup>b</sup>Elevation is for the project design flood.

The project design flood is a flood that would result from a hypothetical series of three major storms affecting the upstream watersheds of the Mississippi and Ohio rivers. The flow line elevation of such a flood is 70.96 m (232.8 ft). Flood control levees in the Memphis area were designed to contain floodwaters resulting from such a flood. The recurrence frequency of a flood of this magnitude has not been assessed but is estimated to be less frequent than once in 500 years (personal communication, Bill Martin, Memphis District, U.S. Army Corps of Engineers, April 1980).

Tennessee Chute gage records for the duration of its existence (1950 to 1978) were used to compute a duration curve for the Mississippi River at the mouth of Lake McKellar, as is shown in Fig. 3.2. The curve shows the high- and low-elevation extremes. Up to an elevation of about 64 m (210 ft) above mean sea level, the river is contained within its banks. Above this elevation, flow across Presidents Island occurs. This would occur, approximately, once every three years. Between 64 and 70 m (210 and 230 ft) above mean sea level, diversion by the Memphis Harbor Embankment takes place (see Appendix B.1.1 for an explanation of the modeling process).

Data taken from the Tennessee Chute during the period 1950 to 1978 indicate that the highest lake and river stages occur from March to May and that the lowest stages occur from August to November.

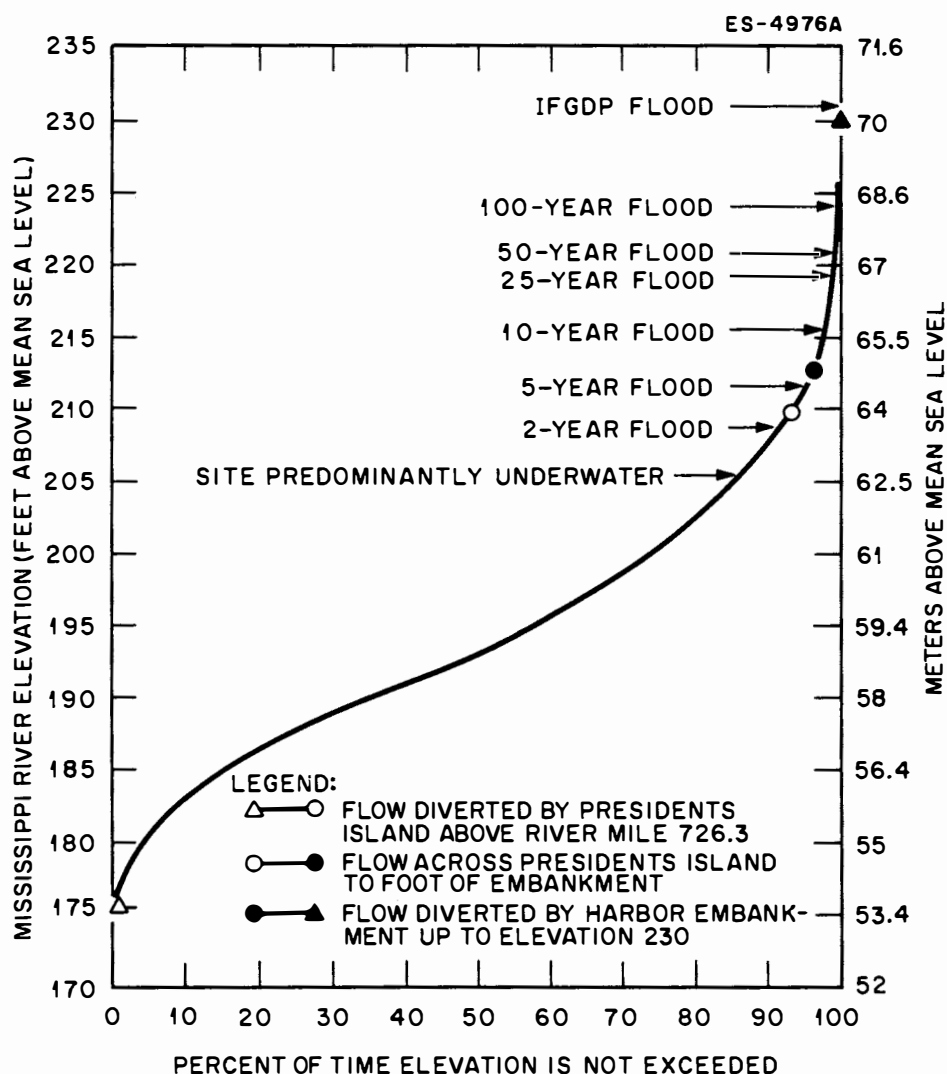


Fig. 3.2. Stage duration curve of the Mississippi River near Lake McKellar as measured on the Tennessee Chute gage, 1950 to 1978. Source: ER, Fig. 3.11, p. 3-35.

### Lake McKellar

Lake McKellar is a man-made, slack-water arm of the Mississippi River. The lake was created when the Tennessee Chute portion of the Mississippi River that flows along the east side of Presidents Island was closed off in 1951. Before closure, approximately equal flows moved through the Tennessee Chute and the Arkansas Chute north of Presidents Island. The Arkansas Chute is currently the main stem of the Mississippi River.

Overall length of Lake McKellar from its confluence with the Mississippi River at River Mile 725.5 to the closure dam is approximately 11.2 km (7 miles). Lake McKellar receives drainage from approximately 517 km<sup>2</sup> (199 sq miles), with Nonconnah Creek contributing the largest drainage area of 473 km<sup>2</sup> (182 sq miles), Cypress Creek adding 34 km<sup>2</sup> (13 sq miles), and miscellaneous small branches and sheet drainage in and around the lake contributing approximately 10 km<sup>2</sup> (4 sq miles). The average yearly discharge from the lake into the Mississippi River is 8.6 m<sup>3</sup>/s (302 ft<sup>3</sup>/s).

The main user of Lake McKellar water is TVA's Allen Generating Plant, which uses approximately 21.9 m<sup>3</sup>/s (773 ft<sup>3</sup>/s) for cooling water purposes. Nine industries discharge into Lake McKellar at a combined flow of 0.13 m<sup>3</sup>/s [ $1.16 \times 10^4$  m<sup>3</sup>/d (3.06 Mgd)]. Seventy-five percent of this effluent is from the Allen Generating Plant ash pond.

Lake McKellar rises and falls in response to the fluctuating stages of the river at the point of confluence with the Mississippi River near the southwest end of Presidents Island (Fig. 3.1). For the period of record from December 1950 to July 1978, annual high-water marks varied between 61.02 and 67.05 m (200.2 and 220 ft) above mean sea level in 1954 and 1976, respectively. Annual low-water marks varied from 54.07 to 56.78 m (177.4 to 186.3 ft) above mean sea level in 1977 and 1972, respectively.

### Nonconnah Creek

Nonconnah Creek is the only large stream in the vicinity of the proposed plant site. Nonconnah Creek drains an area of approximately 473 km<sup>2</sup> (182 sq miles). Major tributaries are John's Creek, Colliersville Creek, and Day's Creek, with numerous smaller tributaries draining less than 26 km<sup>2</sup> (10 sq miles) (Fig. 3.3).

Most of the floodplain area, which averages about 0.8 km (0.5 mile) in width, was used for agricultural purposes before World War II. Since then, many of Nonconnah Creek's meanders have been removed so that it flows in nearly a straight line, and the floodplain has become heavily industrialized and urbanized. Heavy sudden runoff and effluent flows have now changed the creek to primarily a drainage ditch. Flow data from Nonconnah Creek for the period 1969 to 1977 gives an average yearly discharge at the Winchester Street gage of 2.9 m<sup>3</sup>/s (104 ft<sup>3</sup>/s).

Nonconnah Creek experienced frequent flooding from the Mississippi River before the closing of the Tennessee Chute in 1951. Before closure, levees were constructed for flood protection upstream for 4.8 km (3 miles) from the mouth of the creek; following closure, the Mississippi River backwater was lowered by 0.76 m (2.5 ft) at the mouth of Nonconnah Creek. Flood hazards still exist in low-lying areas along the creek, caused by the encroachment into, and modification of, the floodplain by industrialization and urbanization, with the resultant increased volumes of runoff. Table 3.2 presents discharges and elevations for selected return period floods.

#### 3.1.2.2 Groundwater

The Memphis area is underlain by three important aquifers: an alluvial aquifer that occurs in Mississippi River alluvium, the Memphis, or 500-ft, sand, and the Fort Pillow, or 1400-foot, sand.<sup>1</sup> The bedrock aquifers are contained in sediments of Eocene Age, and the Mississippi River alluvium is an accumulation of sediment that has been actively forming during Pleistocene and recent times. Descriptions of the water-bearing formations and stratigraphic relations are presented in Table 3.3. Memphis is one of the largest cities in the United States that depends solely on groundwater for water supply. All water currently used is obtained from the Memphis sand (500-ft sand).

In 1974, water withdrawal from the Memphis sand was approximately  $0.72 \times 10^6$  m<sup>3</sup>/d (190 Mgd). Of this amount,  $0.42 \times 10^6$  m<sup>3</sup>/d (110 Mgd) was pumped by MLGW for the city water supply system. This system used approximately 140 wells in six major fields. The Davis well field is about 6 km (4 miles) south of the site, whereas the Allen field is 8 to 10 km (5 to 6 miles) northeast of the site. In 1976 the production capacity of the six well fields was estimated at about  $0.53 \times 10^6$  m<sup>3</sup>/d (140 Mgd). Industries, independent utility districts, and commercial establishments pump the remainder of the withdrawal from the Memphis sand. Within 5 km (3 miles) of the proposed site there are 11 industrial groundwater users; four of them use the Memphis sand, and seven use the alluvium.

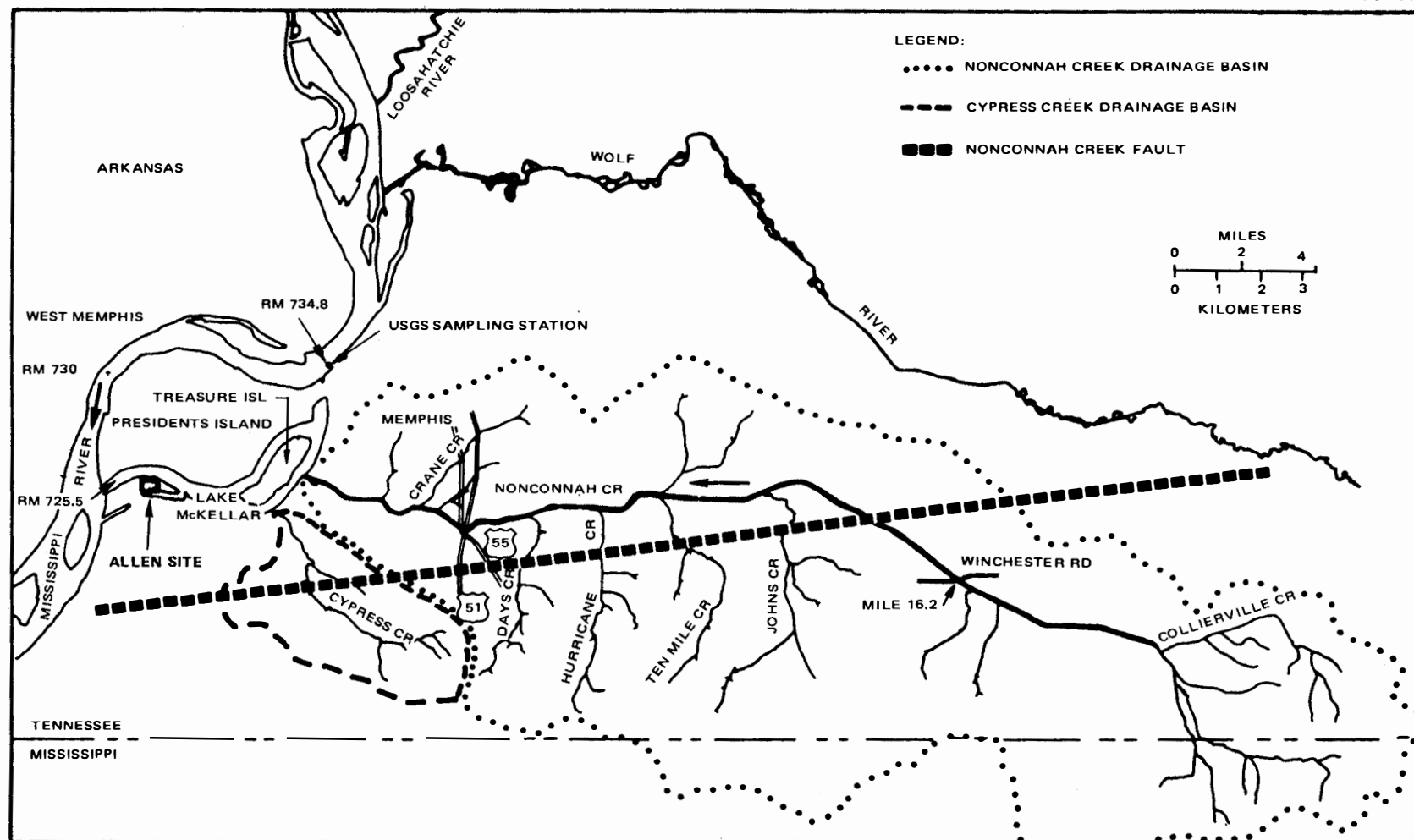


Fig. 3.3. Nonconnah Creek drainage basin map. Source: Modified from ER, Fig. 3.16, p. 3-44.

Table 3.3. Post-midway geologic units underlying the Memphis area and their hydrologic significance

| System                  | Series                   | Group     | Stratigraphic unit                                                   | Thickness (ft) | Lithology and hydrologic significance                                                                                                                                                                                                                                                     |
|-------------------------|--------------------------|-----------|----------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quaternary              | Holocene and Pleistocene |           | Alluvium                                                             | 0-175          | Sand, gravel, silt, and clay; underlies the Mississippi River alluvial plain and the floodplains of other streams in the area; supplies water to a few domestic and industrial wells; could be an important source of water for irrigation and some industrial uses                       |
|                         | Pleistocene              |           | Loess                                                                | 0-65           | Wind-deposited silt; silty clay and minor sand; forms a blanket over the fluvial deposits in upland areas; topographically higher than alluvium; thickest on the bluffs that border the Mississippi River alluvial plains; generally thinner toward the east; not a source of groundwater |
| Quaternary and Tertiary | Pleistocene and Pliocene |           | Fluvial deposits (terrace deposits)                                  | 0-100          | Sand and gravel; minor ferruginous sandstone; underlies the upland areas in a broad, irregular belt east of the Mississippi River alluvial plain; may be locally absent; supplies water to many shallow, small-capacity wells in suburban and county areas                                |
| Tertiary                | Eocene                   | Claiborne | Jackson formation and upper part of Claiborne group ("capping clay") | 0-350          | Gray, bluish-gray, greenish-gray, and tan clay; subordinate beds of fine-grained sand and lignite; supplies water to some small-capacity wells; generally considered to be of low permeability and to confine water in Memphis sand; absent in southeastern part of Memphis area          |
|                         |                          |           | Memphis sand (500-ft sand)                                           | 500-880        | Fine- to coarse-grained sand; subordinate lenses of clay and minor amounts of lignite; thick clay bed locally in lower part; coarse sand lenses locally at base; very good aquifer supplying 95% of water used in Memphis area                                                            |
|                         |                          |           | Flour Island Formation                                               | 160-350        | Gray, greenish-gray, and brown carbonaceous clay; locally contains fine-grained sand lenses and some lignite; serves as lower confining bed for Memphis sand and upper confining bed for Fort Pillow sand                                                                                 |
|                         |                          |           | Fort Pillow sand (1400-ft sand)                                      | 210-280        | Fine- to medium-grained sand; minor amounts of lignite and some clay lenses; second principal aquifer supplying about 3% of water used in Memphis area                                                                                                                                    |
|                         | Paleocene                |           | Old Breastworks formation                                            | 200-250        | Gray, greenish-gray, and brown carbonaceous clay; contains some lignite and is sandy near top; lower confining bed for water in Fort Pillow sand                                                                                                                                          |

Source: U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey, Shelby County, Tennessee*, Washington, D.C., 1970.

As a result of Memphis sand use, there has been a regional decline in water levels. This decline, or cone of depression, is centered near downtown Memphis. It includes most of Shelby County and parts of DeSoto County, Mississippi, and Crittenden County, Arkansas. Within this regional cone there are smaller subsidiary cones that have developed beneath the city's well field and in areas of heavy industrial pumping. It is probable that before the area was developed, water levels in the Memphis sand were in equilibrium with the water table in the shallow aquifers.

#### Alluvial aquifer

The alluvial aquifer at the site is the saturated sand and gravel underlying the Mississippi River floodplain, a deposit 43 to 49 m (140 to 160 ft) thick at the site. In areas adjacent to the river, the alluvial water table fluctuates with river stage; some lag in groundwater response occurs because of infiltration restriction. Because the site is periodically inundated by high river flow, the entire thickness of alluvium is, at times, saturated. Hydraulic conductivity of near-surface alluvium is estimated to be approximately 0.1 cm/s.<sup>2</sup>

Groundwater movements in the zone of influence of the river channel are related to the rise and fall of river stage. As the river stage rises, river water infiltrates the alluvium from the channel. As the river stage recedes and during low to normal flow, groundwater moves in the down-gradient direction into the river. Surface infiltration of precipitation or floodwater through the sandy soils of the site also contributes water to the alluvial aquifer. Movement of groundwater at depth in the alluvium is generally down the gradient of the Mississippi River valley. Topography of the bedrock surface has been mapped by the U.S. Army Corps of Engineers.<sup>2</sup> The bedrock surface is irregularly eroded, with dendritic topography characteristic of the erosion of soft homogeneous sediments. Groundwater movement in alluvium near the bedrock interface may be locally controlled by bedrock topography. Hydraulic conductivity of the alluvium at depth is



assumed to be lower than that near the surface on the site because of the finer sediment texture and greater compaction.<sup>2</sup> The rate of water moving horizontally through the alluvium has been estimated to be 0.009 to 0.08 cm/s. The rate of vertical movement ranges from 0.007 to 0.060 cm/s.<sup>2</sup>

Water levels in a groundwater monitoring well were measured over a six-month period, and comparison with water levels in Lake McKellar shows close correspondence between lake level and groundwater level. Records of these measurements are included in Appendix B.2.2. The predominant water flow direction on the site would be expected to be toward Lake McKellar at a relatively slow rate. The flat topography of the site indicates a relatively flat groundwater gradient and, therefore, slow movement. The rate at which the alluvium will transmit water (hydraulic conductivity) has been determined to be 0.1 to 0.35 cm/s, which is relatively fast for this type material. This rate is probably influenced by the zones of loose sands, which have a higher permeability than the more common firm sands.

#### Bedrock aquifers

Bedrock aquifers in the Memphis area are contained in sediment of Eocene Age. The occurrence of interbedded permeable sandstones and impermeable shales, coupled with regional bedrock dips to the west and southwest, results in artesian conditions in the bedrock aquifers. Under natural conditions, groundwater movement in bedrock is down the regional dip of the formations.

The 500-ft sand is the principal water supply for the city of Memphis, and, as a result, the hydrology of the aquifer has been affected by large volumes of water being pumped from the aquifer for many years. Detailed information on water levels in the 500-ft sand is presented in ref. 3. The effect of pumping on the aquifer has been the formation of a large cone of depression beneath the city of Memphis, the deepest drawdown being located at the Allen and Mallory well fields. Transmissivity of the 500-ft sand is approximately 1520 m<sup>3</sup>/d per foot (400,000 gpd per foot), and the coefficient of storage is approximately  $3 \times 10^{-3}$  (ref. 4). Recharge to the 500-ft aquifer is primarily by infiltration in the outcrop area of the Memphis sand to the east of Memphis.<sup>4</sup> Water movement within the cone of depression is estimated as follows: approximately 12 m (40 ft) per year in the northeast part of the affected area, approximately 21 m (70 ft) per year in the southeast, and approximately 42 m (140 ft) per year at the edge of the area of heavy pumping; even greater movement occurs in and near well fields.<sup>4</sup> The direction of groundwater movement in the 500-ft sand is generally toward central Memphis from all areas. The potentiometric surface of the 500-ft sand is shown in Appendix B.2.1, Fig. B.4; the site is located near the western edge of the cone of depression. The water budget in Table 3.4 indicates approximate water volumes that move into the drawdown region from each direction. Recharge from the west is presumed to enter the aquifer by leakage from the alluvium through (1) areas where the Jackson clay was entirely breached by erosion, (2) permeable areas associated with faults, and (3) areas where the lithology of the Jackson formation is permeable.

**Table 3.4. A water-control budget for the 500-ft sand aquifer**

Computed by using the low-water-level contours for 1960 and checked against the average pumping rate for 1960

| Location                             | Inflow (Mgd) |
|--------------------------------------|--------------|
| Across eastern boundary              | 60           |
| Across northern boundary             | 20           |
| Across southern boundary             | 25           |
| Across western boundary <sup>a</sup> | 29           |
| Depletion of storage                 | 1            |
| Total                                | 135          |
| Average daily pumping rate for 1960  | 135          |

<sup>a</sup>Includes leakage from rocks above aquifer and inflow of water from other sources.

Source: J. H. Criner, P.-C. P. Sun, and D. J. Nyman, *Hydrology of Aquifer Systems in the Memphis Area, Tennessee*, U.S. Geological Survey Water Supply Paper 1779-0, 1964.

The Jackson formation, which separates the 500-ft sand from the alluvial aquifer, was penetrated by two borings on the site. At the southwest corner of the site, the top of the Jackson occurred at 45.7 m (150 ft) below the surface. At the northeast corner of the site, the top and bottom of the formation occurred at 43.9 m (144 ft) and 82.3 m (270 ft), respectively. There appears to be little variation within the formation on the site; the material was clayey silt throughout.

Because of the thickness and consistency of the Jackson formation, it seems unlikely that there is significant leakage through the formation on the site. In addition, the hydraulic conductivity of the Jackson, as determined at the site, is very low:  $10^{-7}$  to  $10^{-9}$  cm/s, which is further evidence for the viability of the Jackson as a seal between the shallow aquifer and the Memphis sand.

The 500-ft sand occurs at 73.5 m (243 ft) beneath the surface at the southwest corner of the site and 81.7 m (270 ft) beneath the surface at the northwest. This difference indicates that the Memphis sand dips toward the north. The hydraulic conductivity onsite is 0.01 to 0.02 cm/s.

The Fort Pillow sand or 1400-ft sand lies at greater depth than does the 500-ft sand, and the intervening Flour Island formation is clay of the Wilcox group, which forms an aquiclude and isolates the 1400-ft sand from other aquifers. The MLGW operated well fields that pumped from the 1400-ft sand during the years 1924 to 1973; however, pumping from those fields has gradually ceased because well screens have become clogged. Pumping from the aquifer was at its maximum of  $0.0008 \times 10^6 \text{ m}^3/\text{d}$  (12.8 Mgd) in 1960 and has declined since then. Industrial pumping from the aquifer continues at approximately one-third to one-half the 1960 rate.<sup>3</sup> Monitoring of observation wells by the U.S. Geological Survey shows that substantial recharge of the cone of depression has occurred since cessation of heavy pumping.<sup>3</sup> Recharge to the 1400-ft aquifer comes from infiltration 100 to 130 km (60 to 80 miles) east of Memphis where the Fort Pillow sand outcrops. Transmissivity of the aquifer ranges from 0.012 to 0.02  $\text{m}^3/\text{s}\cdot\text{m}$  (90,000 to 140,000 gpd per foot), and the storage coefficient ranges from  $1.5 \times 10^{-4}$  to  $4 \times 10^{-4}$  (ref. 4).

### 3.1.3 Water quality

#### 3.1.3.1 Surface water quality

The construction and operation of the MLGW demonstration plant may affect both the Mississippi River and Lake McKellar. Both bodies of water are near Memphis in Shelby County, Tennessee.

#### Mississippi River

The Mississippi River drains an area of 3,222,000  $\text{km}^2$  (1,244,000 sq miles), three-fourths of which is located upstream from Lake McKellar's mouth at River Mile 725.5. The Chickasaw Drainage Basin encompasses all the surface water drainage within Shelby County, including the Loosahatchie and Wolf rivers and Nonconah and Horn Lake creeks.<sup>5</sup> All four of these watercourses are minor tributaries of the Mississippi River (Fig. 3.1).

Throughout the Mississippi's vast watershed, industrial effluents as well as urban and agricultural nonpoint sources cause localized effects. Water quality problems are reduced in severity by the river's enormous dilution capacity, resulting in generally acceptable conditions. However, the reaches of the Mississippi near Memphis have inferior water quality in comparison with upstream and downstream river segments. Several industrial complexes are located on the Loosahatchie River not far upstream from its confluence with the Mississippi. The Wolf River flows through a significant portion of urban Memphis and is subjected to several different adjoining land uses within this urban area. As a result, the Mississippi River above West Memphis, Arkansas, receives high loads of suspended solids and organic and industrial wastes. In addition, the T. E. Maxson Wastewater Treatment Facility in Memphis has consistently failed to meet Federal and State effluent standards. In 1978 Memphis was forced to undertake measures to upgrade the plant and to observe a sewer moratorium on all of the plant's new industrial connections. However, Maxson can accept wastewater from industries if their effluent has been pretreated so that concentrations of wastewater constituents are comparable with domestic waste limits.<sup>5</sup>

The Tennessee Water Quality Control Board has classified the Mississippi River below Mile-Point 740.5 as an "effluent-limited stretch," suitable for the following uses: industrial water supply, fish and aquatic life, irrigation, livestock watering and wildlife, and navigation.<sup>5</sup> The most stringent State water quality criteria applicable to waters classified for these purposes and recommendations formulated by the EPA are summarized in Table 3.5. Also included in this table are criteria and standards from the adjacent states of Mississippi and Arkansas.

Several sources of water quality data are available for the Mississippi River near Memphis. In a baseline monitoring program conducted quarterly during 1978 and 1979, samples of river water were collected upstream and downstream of Lake McKellar's mouth at stations MR1 and MR2, respectively (Fig. 3.4). MR1 was chosen as the control station, and MR2 was located in the projected discharge area. MR2 was approximately 0.75 km upstream of the existing common discharge of the T. E. Maxson Wastewater Treatment Facility operated by the city of Memphis and TVA's Allen Generating Plant. Analyses for selected water quality parameters are summarized in Table 3.6. The water of the Mississippi in the vicinity of the MLGW demonstration plant is characterized as a calcium bicarbonate type, with neutral to slightly alkaline pH values, acceptable levels of dissolved oxygen, and relatively high levels of nutrients. Vertical profile measurements indicated

Table 3.5. Summary of the most stringent water quality criteria or standards applicable to waters in the vicinity of the proposed plant

| Parameter                                 | Criterion/Standard                                                                          | Agency                                |
|-------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------|
| Alkalinity                                | Greater than 20 mg/liter                                                                    | EPA <sup>a</sup>                      |
| Ammonia                                   | Not to exceed 0.02 mg/liter<br>as unionized ammonia                                         | EPA                                   |
| Arsenic                                   | Not to exceed 0.05 mg/liter                                                                 | EPA                                   |
| Barium                                    | Not to exceed 1.0 mg/liter                                                                  | EPA                                   |
| Beryllium                                 | Not to exceed 1.1 mg/liter<br>in hard fresh water                                           | EPA                                   |
| Cadmium                                   | Not to exceed 1.2 µg/liter<br>in hard fresh water                                           | EPA                                   |
| Chloride                                  | Not to exceed 60 mg/liter                                                                   | Ark., <sup>b</sup> Miss. <sup>c</sup> |
| Chromium                                  | Not to exceed 0.05 mg/liter                                                                 | EPA                                   |
| Copper                                    | Not to exceed 1.0 mg/liter                                                                  | EPA                                   |
| Cyanide                                   | Not to exceed 5.0 µg/liter                                                                  | EPA                                   |
| Hydrogen sulfide,<br>undissociated        | Not to exceed 2 µg/liter                                                                    | EPA                                   |
| Iron                                      | Not to exceed 0.3 mg/liter                                                                  | EPA                                   |
| Lead                                      | Not to exceed 0.05 mg/liter                                                                 | EPA                                   |
| Manganese                                 | Not to exceed 0.05 mg/liter                                                                 | EPA                                   |
| Mercury                                   | Not to exceed 0.05 µg/liter                                                                 | EPA                                   |
| Nitrate nitrogen<br>plus nitrite nitrogen | Not to exceed 10 mg/liter                                                                   | EPA                                   |
| Oil and grease                            | Virtually free from all oil and<br>grease, particularly from<br>associated tastes and odors | EPA                                   |
| Oxygen, dissolved                         | Not less than 5.0 mg/liter<br>(exceptions are specified)                                    | Ark., Miss., Tenn. <sup>d</sup>       |
| pH value                                  | 6.5 to 8.5, not to fluctuate<br>over 1.0 pH unit in 24 h                                    | Tenn.                                 |
| Phenol                                    | Not to exceed 1 µg/liter                                                                    | EPA                                   |
| Phosphorus, total                         | Not to exceed 100 µg/liter                                                                  | Ark.                                  |
| Selenium                                  | Not to exceed 0.01 mg/liter                                                                 | EPA                                   |
| Silver                                    | Not to exceed 0.05 mg/liter                                                                 | EPA                                   |
| Solids, total<br>dissolved                | Not to exceed 425 mg/liter                                                                  | Miss.                                 |
| Sulfate                                   | Not to exceed 150 mg/liter                                                                  | Miss.                                 |
| Temperature                               | Not to exceed 30.5°C                                                                        | Tenn.                                 |
| Toxic substances                          | Not to exceed 0.01 of the 96-h<br>median tolerance limit<br>(exceptions are specified)      | Ark.                                  |
| Zinc                                      | Not to exceed 5.0 mg/liter                                                                  | EPA                                   |

<sup>a</sup>The most stringent criteria for which specific concentrations or other quantitative measurements have been formulated are taken from U.S. Environmental Protection Agency, *Quality Criteria for Water*, 440/9-76-023, Washington, D.C., July 1976.

<sup>b</sup>Information from Bureau of National Affairs, Washington, D.C., "Arkansas Regulation Establishing Water Quality Standards for Surface Waters", *Environ. Reporter* 716: 0601-0608, March 26, 1978.

<sup>c</sup>Information from Bureau of National Affairs, Washington, D.C., "Mississippi Water Quality Criteria", *Environ. Reporter* 821: 0501-0506, June 30, 1978.

<sup>d</sup>Information from Bureau of National Affairs, Washington, D.C., "Tennessee Water Quality Criteria", *Environ. Reporter* 916: 0541-0544, April 14, 1978.

that the waters at MR1 and MR2 were well mixed during all seasons. Similarity in the water chemistry at both locations suggested that interchange with Lake McKellar did not alter the river water quality during baseline monitoring.

With the exception of phenol, iron, manganese, and total phosphorus, the chemical constituents in the river water samples generally did not violate the criteria and standards outlined in Table 3.5. Total phosphorus was consistently greater than the maximum concentration (0.1 mg/liter) allowable in streams by the state of Arkansas,<sup>6</sup> probably because of sewage inputs. Both anthropogenic and natural sources are responsible for iron and manganese loads in this portion of the Mississippi. The EPA criteria for these metals included in Table 3.5 are for domestic water supply. Although this portion of the Mississippi River is not classified for use as a domestic water supply, these criteria would be protective of downstream users. Phenol has been detected in industrial effluents in the Memphis area.<sup>5</sup> Mercury and cyanide exceeded the EPA criteria<sup>7</sup> on at least one occasion. No PAHs in excess of the 0.01-ppm detection limit were recorded in water samples collected from the Mississippi. The average total PAH concentration reported in the

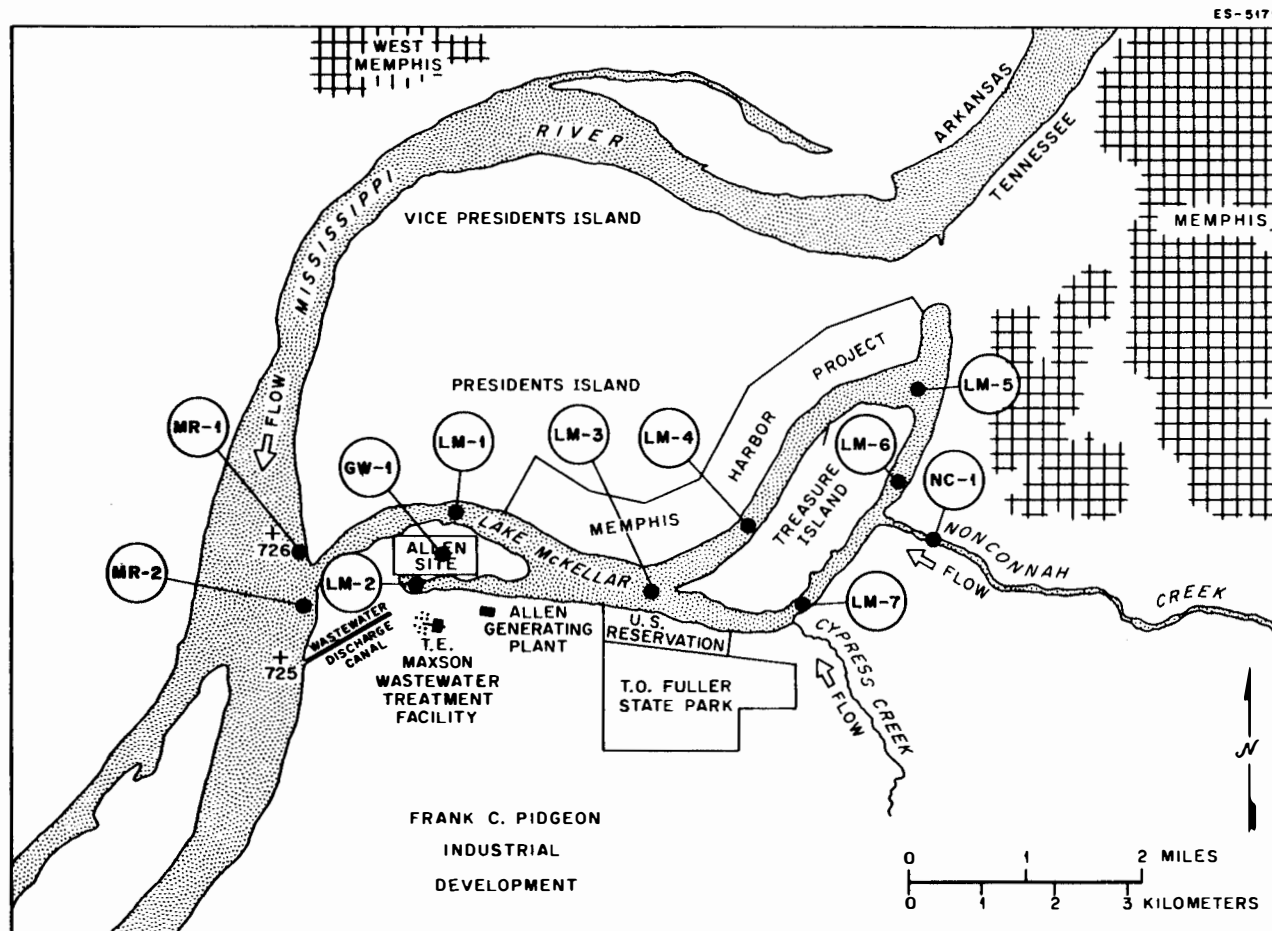


Fig. 3.4. Water quality sampling locations used during the 1978-1979 baseline monitoring program. Source: Redrawn from ER, Fig. 3.17, p. 3-45.

**Table 3.6. Summary of water quality data procured in baseline monitoring studies of selected locations near the proposed plant<sup>a</sup>**

| Parameter <sup>b</sup>                    | Number of quarters<br>parameter determined<br>(out of 4) | Range in quarterly mean parameter levels <sup>c</sup> |                                    |                |
|-------------------------------------------|----------------------------------------------------------|-------------------------------------------------------|------------------------------------|----------------|
|                                           |                                                          | MR1                                                   | Sampling sites <sup>d</sup><br>MR2 | LM1            |
| General and physical                      |                                                          |                                                       |                                    |                |
| pH                                        | 3                                                        | 7.00 to 8.05                                          | 7.15 to 8.1                        | 7.15 to 8.15   |
| Total dissolved solids                    | 4                                                        | 232 to 277                                            | 213 to 274                         | 216 to 279     |
| Total suspended solids                    | 4                                                        | 102 to 387                                            | 93 to 375                          | 27 to 56       |
| Alkalinity, total (as CaCO <sub>3</sub> ) | 4                                                        | 85.0 to 145.5                                         | 85.0 to 151.0                      | 82.0 to 150.0  |
| Temperature, °C                           | 4                                                        | 2.5 to 27.0                                           | 2.5 to 28.0                        | 2.5 to 28.1    |
| Dissolved oxygen                          | 4                                                        | 5.6 to 13.6                                           | 5.6 to 13.8                        | 6.1 to 13.6    |
| Nutrients                                 |                                                          |                                                       |                                    |                |
| Total kjeldahl-nitrogen                   | 4                                                        | 0.39 to 1.26                                          | 0.52 to 1.16                       | 0.49 to 1.19   |
| Nitrite nitrogen                          | 4                                                        | 0.018 to 0.08                                         | 0.019 to 0.065                     | 0.052 to 0.08  |
| Nitrate nitrogen                          | 4                                                        | 0.705 to 2.44                                         | 0.764 to 2.26                      | 0.810 to 1.62  |
| Ammonia nitrogen                          | 3                                                        | 0.19 to 0.33                                          | 0.18 to 0.585                      | 0.44 to 0.62   |
| Total phosphorus                          | 4                                                        | 0.255 to 0.404                                        | 0.265 to 0.530                     | 0.145 to 0.311 |
| Organics                                  |                                                          |                                                       |                                    |                |
| BOD (5 d)                                 | 4                                                        | 1.0 to 8.0                                            | 1.5 to 10.5                        | 2.0 to 5.5     |
| COD                                       | 4                                                        | 22.5 to 34.0                                          | 19.0 to 35.5                       | 16.0 to 37.0   |
| Phenol, µg/liter                          | 4                                                        | 2.5 to 12                                             | 2.5 to 16                          | 2.5 to 13      |
| Oil and grease                            | 4                                                        | 0.6 to 2.6                                            | 0.7 to 3.2                         | 0.8 to 4.1     |
| Major anions                              |                                                          |                                                       |                                    |                |
| Chloride                                  | 4                                                        | 11.0 to 16.0                                          | 10.9 to 17.0                       | 11.4 to 13.9   |
| Cyanide                                   | 4                                                        | 0.006                                                 | 0.006                              | 0.006          |
| Fluoride                                  | 4                                                        | 0.16 to 0.34                                          | 0.014 to 0.360                     | 0.095 to 0.29  |
| Sulfate                                   | 4                                                        | 37.0 to 87.0                                          | 41.5 to 83.8                       | 36.0 to 87.5   |
| Major cations                             |                                                          |                                                       |                                    |                |
| Aluminum                                  | 4                                                        | 2.38 to 9.07                                          | 2.39 to 8.39                       | 0.99 to 3.65   |
| Barium                                    | 4                                                        | 0.28 to 0.55                                          | 0.27 to 0.56                       | 0.17 to 0.50   |
| Calcium                                   | 4                                                        | 35.0 to 50.3                                          | 37.2 to 49.2                       | 31.4 to 50.2   |
| Iron                                      | 4                                                        | 2.95 to 11.8                                          | 0.010 to 9.80                      | 0.92 to 3.25   |
| Magnesium                                 | 4                                                        | 8.86 to 16.2                                          | 8.18 to 18.6                       | 8.08 to 18.8   |
| Other                                     |                                                          |                                                       |                                    |                |
| Arsenic                                   | 4                                                        | <0.01                                                 | 0.01                               | <0.01          |
| Cadmium                                   | 3                                                        | 0.0015                                                | 0.002                              | 0.002          |
| Chromium, total                           | 4                                                        | 0.009 to 0.015                                        | 0.006 to 0.014                     | 0.014          |
| Copper                                    | 4                                                        | 0.01 to 0.014                                         | 0.009 to 0.012                     | 0.004 to 0.007 |
| Lead                                      | 4                                                        | 0.016                                                 | 0.019                              | 0.015          |
| Manganese                                 | 4                                                        | 0.192 to 0.360                                        | 0.189 to 0.359                     | 0.037 to 0.113 |
| Mercury, µg/liter                         | 4                                                        | 0.81                                                  | <0.8                               | 0.9            |
| Nickel                                    | 3                                                        | 0.008                                                 | 0.01                               | 0.007 to 0.012 |
| Selenium                                  | 3                                                        | 0.01                                                  | 0.01                               | 0.01           |
| Zinc                                      | 4                                                        | 0.037 to 0.055                                        | 0.026 to 0.041                     | 0.01 to 0.029  |

<sup>a</sup> Data from ER, pp. 3A-24 to 3A-38.

<sup>b</sup> Expressed as mg/liter unless otherwise specified.

<sup>c</sup> Where only one value is present, there were too many approximate values to establish a range. Single value represents the highest determination in excess of the detection limits.

<sup>d</sup> For location of sampling sites, see Fig. 3.5.

literature for a number of surface waters (mainly German rivers) was 1.2 ppm;<sup>8</sup> the Mississippi appears to be relatively unpolluted by these compounds. This condition is confirmed by analyses performed on MR1 sediment in which the level of only one out of 15 PAH compounds was detected above 5 ppb.

Other analyses of MR1 sediment indicated that it was unpolluted according to a classification system that has been used for Great Lakes harbor sediment<sup>9</sup> (see Appendix C.3.1, Table C.12.). Sediment elutriate contained 22 times more ammonia-nitrogen than the overlying water (Appendix C.3.1). These results are not unusual because ammonia is consistently released from sediments in the elutriate test.<sup>10</sup> The concentration of phenol in the elutriate, like that in the overlying water, exceeds the EPA criterion of 1 µg/liter for protection against the tainting of fish flesh. No PAH compounds were detected in the elutriate.

### Lake McKellar

Lake McKellar, a slack-water arm of the Mississippi River, was formed in 1951 when the Mississippi River Tennessee Chute was closed (Fig. 3.4). There is limited exchange between the lake and the Mississippi. Historically, Lake McKellar has been characterized by poor water quality because sewage and a wide variety of untreated industrial wastes have been discharged into it. Considerable improvements in water quality have occurred during the past ten years as a result of the upgrading of the sanitary sewer systems and the treatment of industrial effluents.

Nonconnah Creek, which enters the eastern part of the lake, drains an area around Memphis that has undergone rapid urbanization. The creek carries high sediment loads resulting from continual construction activities on its floodplain and, occasionally, sewage from overflows and broken mains.<sup>5</sup> High rates of sedimentation have necessitated periodic maintenance dredging of both Lake McKellar's main channel and the side channel adjacent to Allen Generating Plant.

Lake McKellar has been classified as a "water quality-limited stretch," suitable for use as a water supply for industry, fish and aquatic life, recreation, and navigation.<sup>5</sup> The most stringent of the state of Tennessee and the Federal water quality criteria are presented in Table 3.5.

A baseline monitoring program was conducted to characterize the water quality of Lake McKellar and Nonconnah Creek. Of the seven locations sampled within the lake from LM1 to LM7 (Fig. 3.4), LM1 and LM2 represented the areas of greatest potential impact from the construction and operation of the MLGW demonstration plant. LM1 was located across the lake's entrance (the former Tennessee Chute of the Mississippi River) in an area projected to be the corridor access route for the product gas distribution pipeline and to receive decant water from site buildup operations. LM2 was established in the barge turning basin south of the proposed plant site. This backwater arm of Lake McKellar is currently used by watercraft supplying materials to the nearby Allen Generating Plant. The projected barge unloading facility will be constructed in the turning basin. Quarterly in-situ measurements were conducted (1978-1979) at LM1-LM7 and at one location in Nonconnah Creek, NC1. In addition, laboratory analyses were performed on samples collected quarterly from LM1, and from LM6, LM7, and NC1 on one occasion during 1978 to 1979. Depth profiles indicated that, with the exception of LM1, Lake McKellar sampling stations were thermally stratified during July 1978. In the stratified region of the lake, dissolved oxygen was severely depleted (<1.0 mg/liter) in the waters immediately overlying the sediments. In-situ monitoring during the fall of 1978 indicated that turnover had occurred. By January 1979, mixing was even more pronounced, and deep portions of the lake were no longer anoxic.

A summary of the water quality data for LM1 is included in Table 3.6. Like MR1 and MR2, water collected from the mouth of Lake McKellar contained concentrations of iron, manganese, and phenol that were higher than recommended. The EPA criteria for cyanide and mercury were exceeded during at least one quarter's sampling.

Water quality in the barge turning basin (Station LM2, Fig. 3.4) has been characterized by TVA sampling near the Allen Generating Plant's intake (Table 3.7). Water quality was very similar to that at station LM1, except that measured maximum concentrations of alkalinity and total dissolved solids (TDS) were somewhat lower in the turning basin, while maximum concentrations of sulfate, copper, manganese, iron, aluminum, and lead were higher than the main channel concentrations. These elevated concentrations may have been due to drainage from TVA's coal piles or ash ponds. The average concentrations of cadmium, manganese, and mercury exceeded the standards or criteria.

Analyses of sediment from LM1 indicate that Lake McKellar's sediments are more polluted than sediment samples from the Mississippi River. Six of the fifteen PAH compounds tested for were recovered in the LM1 sediment at levels between 3 and 20 times greater than the detection limit of 5 ppb. The Prater/Anderson sediment classification system<sup>9</sup> was also applied to the results of chemical analysis of LM1 sediment. Thirty-six percent of the chemicals existed in concentrations considered representative of moderate to heavy pollution (Appendix C.3.1, Table C.12). Previous sampling of Lake McKellar sediments revealed the presence of some chlorinated hydrocarbon pesticides. Toxaphene was detected at 18 ppb in sediments from the northern part of Lake McKellar.<sup>11</sup>

Elutriate from LM1 sediment showed an elevated level of manganese in comparison with that in the overlying water, and a phenol level averaging 5 µg/liter. As with the analysis of LM1 water, no PAHs occurred in the sediment elutriate above the detection limit of 0.01 ppm.

In short, Lake McKellar is an industrially disturbed site in the process of recovering from the impacts of various waste loads. The installation of a sewer-interceptor system and the upgrading of industrial waste treatment processes have reduced the potential for further water quality degradation. However, sediment-bound contaminants may exceed recommended levels if released under yet undetermined conditions.

Table 3.7. Water quality near the Allen Generating Plant, Lake McKellar, from 1974 to 1976

| Parameter <sup>a</sup>                    | Number of values | Mean                | Minimum | Maximum | Standard or criteria <sup>b</sup> |
|-------------------------------------------|------------------|---------------------|---------|---------|-----------------------------------|
| <b>General and physical</b>               |                  |                     |         |         |                                   |
| Temperature, °C                           | 26               | 17.6                | 7.2     | 28.9    | 30.5                              |
| pH                                        | 27               | NA <sup>c</sup>     | 6.7     | 7.8     | 6.5-8.5                           |
| Alkalinity, total (as CaCO <sub>3</sub> ) | 27               | 86                  | 40      | 130     | >20                               |
| Total dissolved solids                    | 27               | 40                  | 3       | 150     | 425                               |
| Turbidity, JTU.                           | 27               | 73                  | 5       | 300     | None                              |
| <b>Nutrients</b>                          |                  |                     |         |         |                                   |
| Total nitrogen <sup>d</sup>               | 27               | 1.0                 | 0.3     | 1.9     | 10                                |
| Organic nitrogen                          | 27               | 0.35                | 0.11    | 0.81    | None                              |
| Ammonia nitrogen                          | 27               | 0.22                | 0.01    | 2.2     | 0.02 (un-ionized)                 |
| Phosphorus, total                         | 27               | 0.15                | 0.02    | 0.38    | 0.1                               |
| <b>Organics</b>                           |                  |                     |         |         |                                   |
| Chemical oxygen demand                    | 27               | 12                  | 8       | 19      | None                              |
| <b>Major anions</b>                       |                  |                     |         |         |                                   |
| Chloride, total                           | 27               | 12                  | 7       | 18      | 60                                |
| Sulfate, total                            | 27               | 114                 | 11      | 1700    | 150                               |
| <b>Major cations</b>                      |                  |                     |         |         |                                   |
| Calcium, total                            | 27               | 30                  | 6       | 45      | None                              |
| Magnesium, total                          | 27               | 10                  | 5       | 18      | None                              |
| Sodium, total                             | 27               | 15                  | 6       | 29      | None                              |
| Potassium, total                          | 27               | 3.2                 | 1.1     | 6.3     | None                              |
| Aluminum, total                           | 12               | 4.8                 | 0.6     | 15.0    | None                              |
| Iron, total                               | 27               | 4.6                 | 0.7     | 14.0    | 0.3                               |
| <b>Trace elements</b>                     |                  |                     |         |         |                                   |
| Arsenic, total                            | 12               | 0.009 <sup>e</sup>  | <0.005  | 0.026   | 0.05                              |
| Cadmium, total                            | 12               | 0.001 <sup>e</sup>  | <0.001  | 0.004   | 0.0012                            |
| Chromium, total                           | 12               | 0.011 <sup>e</sup>  | <0.005  | 0.021   | 0.05                              |
| Copper, total                             | 12               | 0.10                | 0.03    | 0.22    | 1.0                               |
| Lead, total                               | 12               | 0.02 <sup>e</sup>   | <0.01   | 0.05    | 0.5                               |
| Manganese, total                          | 27               | 0.24                | 0.05    | 0.74    | 0.05                              |
| Mercury, total                            | 12               | 0.0003 <sup>e</sup> | <0.0002 | 0.0016  | 0.00005                           |
| Nickel, total                             | 12               | <0.05               | <0.05   | <0.05   | None                              |
| Selenium, total                           | 12               | 0.002 <sup>e</sup>  | <0.001  | 0.004   | 0.01                              |
| Silver, total                             | 12               | <0.01               | <0.01   | 0.01    | 0.05                              |
| Zinc, total                               | 12               | 0.07                | 0.02    | 0.10    | 5.0                               |

<sup>a</sup>Expressed as milligrams per liter unless otherwise specified.

<sup>b</sup>From Table 3.5.

<sup>c</sup>Listed in the ER (Table 3A-5) as "data not available."

<sup>d</sup>Nitrite nitrogen plus nitrate nitrogen; listed as this in ER table.

<sup>e</sup>Averages computed assuming that values reported as "below detection limits" were equal to detection limit.

Source: ER, Table 3A-5, based on unpublished TVA data.

### 3.1.3.2 Groundwater quality

#### Alluvial aquifer

Water quality of the alluvial aquifer was assessed by review of available literature and by seasonal monitoring of a test well located on the proposed site. Parameters of water quality designated by the EPA were compared with water quality as measured in samples taken on the site. The EPA standards used for comparison were U.S.E.P.A. Drinking Water Standards and Quality Criteria for Water.<sup>12,13</sup>

Water in the alluvium is hard and contains high TDS. Results of groundwater monitoring on the site are presented in Appendix B.2.2. The groundwater failed to meet EPA criteria for secondary drinking water standards because of excessive iron and manganese content in all samples, and barium was in excess of primary drinking water standards on two sample dates (November 1978 and January 1979). Phenol content was consistently in excess of secondary drinking water standards. Groundwater was found to be anaerobic consistently during the period of monitoring, and the buffering capacity of the groundwater (332 ppm as CaCO<sub>3</sub>) was an order of magnitude higher than that of surface water in the Mississippi River and Lake McKellar (26 and 16 ppm as CaCO<sub>3</sub>, respectively). Groundwater pH was found to be slightly acidic in this study.

### Water quality of bedrock aquifers

The Memphis area is underlain by two major bedrock aquifers, the 500-ft and 1400-ft sands. Water quality of these aquifers has been investigated by the U.S. Geological Survey<sup>1,4</sup> and the Tennessee Division of Geology.<sup>14</sup> The water quality in the bedrock aquifers was not monitored in the field investigations.

Water quality characteristics of the two bedrock aquifers are presented in Table 3.8. Water from the 500-ft sand is aerated and filtered to remove iron, CO<sub>2</sub>, and H<sub>2</sub>S; the latter two are locally occurring constituents.<sup>4</sup>

Table 3.8. Water quality of bedrock aquifers, Memphis, Tennessee

| Constituent                      | Typical chemical analysis |                         |                |                         |
|----------------------------------|---------------------------|-------------------------|----------------|-------------------------|
|                                  | 500-foot sand             |                         | 1400-foot sand |                         |
|                                  | ppm                       | Equivalents per million | ppm            | Equivalents per million |
| Aluminum                         | 0.0                       |                         | 0.7            |                         |
| Silica                           | 13.0                      |                         | 12.0           |                         |
| Iron                             | 0.44                      |                         | 0.60           |                         |
| Calcium                          | 10.0                      | 0.499                   | 2.7            | 0.135                   |
| Magnesium                        | 5.5                       | 0.452                   | 1.3            | 0.107                   |
| Sodium                           | 8.2                       | 0.357                   | 35.0           | 1.522                   |
| Potassium                        | 1.3                       | 0.033                   | 2.5            | 0.064                   |
| Bicarbonate                      | 72.0                      | 1.180                   | 101.0          | 1.655                   |
| Sulfate                          | 3.2                       | 0.067                   | 5.1            | 0.106                   |
| Chloride                         | 3.0                       | 0.085                   | 2.0            | 0.056                   |
| Fluoride                         | 0.0                       | 0.0                     | 0.1            | 0.005                   |
| Nitrate                          | 0.4                       | 0.006                   | 0.5            | 0.008                   |
| Dissolved solids                 | 81.0                      |                         | 112.0          |                         |
| Hardness (as CaCO <sub>3</sub> ) |                           |                         |                |                         |
| Total                            | 48.0                      |                         | 12.0           |                         |
| Noncarbonate                     | 0.0                       |                         | 0.0            |                         |

Source: J. H. Criner, P.-C. P. Sun, and D. J. Nyman, *Hydrology of Aquifer Systems in the Memphis Area, Tennessee*, USGS Water Supply Paper 1779-0, 1964.

Dominant dissolved constituents are calcium, bicarbonate, and silica. Water in the 500-ft sand is generally soft but is slightly harder in areas where mixing with harder water that has leaked from the alluvium occurs.<sup>4</sup> Continued pumping from this aquifer is expected to result in increased leakage of alluvial water through the Jackson clay in areas where either faults have produced secondary porosity or the lithology is permeable.

Water in the 1400-ft sand is characteristically a sodium bicarbonate type, with slightly higher dissolved solid content but lower hardness than the 500-ft sand. Water from this aquifer is treated for iron removal by aeration and with water from the 500-ft sand. Water quality parameters for the 1400-ft sand have remained nearly constant in the drawdown area, and there is no indication of leakage from other aquifers from either above or below.<sup>1</sup>

Water samples taken from the Ripley formation [about 792 m (2600 ft) deep] are saline.

### 3.1.4 Aquatic ecology

#### 3.1.4.1 Mississippi River

The proposed MLGW site is near Memphis in Shelby County, Tennessee. The plant will be located on a peninsula extending from Lake McKellar's southern shore close to the lake's confluence with the Mississippi River at River Mile 725.5 (Fig. 3.3).

Biota of the middle reaches of the Mississippi River are not well characterized. A baseline monitoring program initiated in 1978 established sampling transects at two river locations close to the proposed plant site. Both sampling stations were situated in protected areas near the Mississippi's sandy, steep eastern bank. Stations MR1 and MR2 corresponded to those sampled for the determination of surface water quality (Sect. 3.1.3, Fig. 3.4).



Adult and juvenile fish, phytoplankton, zooplankton, and benthic invertebrates were sampled quarterly from spring 1978 to winter 1979. A restricted number of observations were made on periphyton and macrophytes in the shoreline areas.

Ichthyoplankton were collected during 14 weeks in spring 1978. The aquatic biota at MR1 and MR2 do not appear to be unique to this part of the Mississippi River and are representative of populations expected in a large, turbid, swiftly flowing warm water habitat.

During baseline monitoring a total of 272 fish comprising 20 species and weighing 68.6 kg was collected. The fish were warm water types, primarily of rough and forage species. Numerically, gizzard shad was the most abundant species. River carpsucker and relatively few buffalo carp and catfish comprised most of the biomass in the collections. Only a small number of sport fish was encountered. Low densities of ichthyoplankton (9 to 15 larvae per 100 m<sup>3</sup>) included mainly clupeids, suckers, and freshwater drum. Although relatively protected areas with reduced water velocities were sampled, they were not representative of backwater areas such as Lake McKellar, where fish productivity may be greater.

Benthic macroinvertebrates were also sampled during the baseline monitoring program. Estimates of these populations were relatively low (0 to 476 organisms per square meter), possibly because the scouring action of the river left only unstable sandy substrate at MR1 and MR2. Most collections were dominated by immature aquatic earthworms and insect larvae. Small numbers of bivalve mollusks were collected only during October and July 1978.

Seasonal changes in the species composition and density of plankton populations were evident from the baseline monitoring of Mississippi River stations. Approximately 300 zooplankters per cubic meter were collected in summer and fall 1978 at MR2, whereas estimations of greater than 8500 organisms were made from samples collected at MR1 in May 1978. In general, the zooplankton community was dominated by rotifers and copepods. Phytoplankton ranged from 200 to 1600 organisms per milliliter and were composed primarily of diatoms and green and blue-green algae.

No macrophytes were observed during the 1978 and 1979 surveys. The absence of these primary producers and the relatively low number of phytoplankton have been attributed to the Mississippi's high turbidity. Limited observations on the periphytic communities at MR1 and MR2 indicated that a species of diatom was the most abundant component.

#### 3.1.4.2 Lake McKellar

Few studies exist on the aquatic populations inhabiting Lake McKellar; therefore, this discussion will be limited to a consideration of the data obtained from the baseline monitoring program. Sampling transects were established at two sites (LM1 and LM2) within the lake (Fig. 3.4). These stations have been described in Sect. 3.1.3. The baseline monitoring program conducted on Lake McKellar closely resembled the one undertaken in the Mississippi River. As in the river, the fish community was dominated by warm water rough and forage species. However, several sport fish, including largemouth bass, sauger, white bass, yellow bass, channel catfish, sunfish, and crappie, were also caught. Of the total number of 988 fish, more than one-half were gizzard shad. The remaining 445 fish represented 36 additional species. Gizzard shad were also found to be the most numerous fish in the Tennessee Chute in a previous study.<sup>11</sup> Estimates of ichthyoplankton were slightly higher than those recorded for the Mississippi River. Larval densities at LM2 suggested that the turning basin is a nursery area for gizzard shad, sunfish, carp, and freshwater drum. The importance of this area to the lake fishery as a whole is currently undetermined.

Although collections of benthic invertebrates were dominated by immature aquatic earthworms, appreciable numbers of midge larvae were also recorded. There was considerable variation among samples, and densities ranged from 6 to 5000 organisms per square meter.

As with other components of the aquatic biota, the densities of planktonic organisms in Lake McKellar exceeded those in the Mississippi River. Zooplankton ranged from 10,000 to almost 200,000 organisms per cubic meter and consisted primarily of cladocerans and copepods. A previous investigation of Lake McKellar also noted the abundance of zooplankton.<sup>11</sup> The phytoplankton, composed of a mixed assemblage of diatoms, green and blue-green algae, and various other taxa, displayed characteristic seasonal and spatial variation. Maximum densities (average of 3523 organisms per milliliter) occurred in the samples collected in July 1978.

No macrophytes were observed in the vicinity of the transects. High turbidity may limit the distribution of these organisms in Lake McKellar. Limited studies of the periphyton occurring on natural substrates indicated that diatoms are the most common component of this community.

### 3.1.4.3 Endangered species

The baseline monitoring program conducted during 1978 and 1979, as well as a previous study,<sup>11</sup> did not encounter any species included on the list of threatened and endangered species maintained by the U.S. Fish and Wildlife Service (USFWS).<sup>15</sup> The blue sucker (*Cycoreptus elongatus*), considered a threatened species by the state of Tennessee and an endangered species by the Tennessee Heritage Program, is reported in Shelby County. This species, which apparently has declined in population in recent years, seasonally migrates up the Mississippi River to spawn in tributaries of the Mississippi River north of the Lake McKellar area. It has not been observed in Lake McKellar (Dan Eagar, Tennessee Heritage Program, Department of Conservation, personal communication with Susan Turbak, Science Applications, Inc., Apr. 15, 1980).

### 3.1.5 Geology and soils

#### 3.1.5.1 Geology

##### Regional structure

Memphis is located on the portion of the Gulf Coastal Plain known as the Mississippi embayment. The embayment is a broad downwarped trough in the Paleozoic rocks that was filled, in Mesozoic and Cenozoic times, with sediment eroded from central North America. The sediments are interbedded sandstones, shales, and limestones, with minor lignite deposits. Sediments that filled the embayment are poorly consolidated. A stratigraphic column of Eocene sedimentary deposits in the area is included in Table 3.3; more extensive stratigraphic information is in Appendix B.2.

The axis of the Mississippi embayment trends northeast to southwest and dips toward the southwest, forming a broad, open fold. The northern terminus of the embayment is in southern Illinois, and the axis approximately parallels the existing Mississippi valley, lying a few miles west of the current location of the river. Memphis is on the eastern flank of the structure, and bedrock dips to the west and northwest. Several faults are mapped in the embayment; the most significant is the New Madrid fault zone, which trends parallel to the axis of the embayment in eastern Arkansas and Missouri. The Big Creek fault, part of the New Madrid system, apparently controls the course of the Mississippi valley from 120 km (75 miles) north of Memphis to 160 km (100 miles) southwest of Memphis. The White River fault zone trends northwest to southeast from Arkansas into Mississippi and passes approximately 40 km (25 miles) southwest of the site.<sup>16</sup> Recent research has identified a fault zone located approximately midway between Jonesboro, Arkansas, and Memphis. This fault zone is now considered responsible for the seismic activity along the Mississippi River in Missouri, Arkansas, Kentucky, and Tennessee.<sup>17</sup>

##### Local features

The proposed site is located on the floodplain of the Mississippi River and is underlain by approximately 46 m (150 ft) of sand and gravel alluvium. Surface elevations over most of the site area under existing conditions are near 60.5 m (200 ft), except for a dike around the south and east perimeter and mounds of dredge soils on the north perimeter, which reach elevations of about 65 m (215 ft) (Fig. 3.1). Geology and topography of the bedrock surface have been mapped in the northern part of the Mississippi embayment.<sup>2</sup> Bedrock present beneath the site includes the normal sequence for the region (Table 3.3). The term bedrock is used to describe sedimentary units of the Jackson formation, the Claiborne group, and the Wilcox group, because of their broad areal extent as mappable deposits, although they are best described as semiconsolidated sediment.

The Jackson formation is a deposit of clay and silty clay that ranges in thickness in the area from 0 to 108 m (0 to 350 ft). Subsurface investigations on the site penetrated about 41 m (133 ft) of clayey to sandy silt of a greenish-gray color in the Jackson interval. The Jackson formation is an aquiclude, isolating the potable aquifer in the 500-ft sand from near surface and alluvial groundwater. The integrity of the aquiclude is suspect in some areas because of sandy zones in the Jackson,<sup>5</sup> possible eroded windows, and possible local faulting of the formation.<sup>18</sup> No definitive evidence has been found that locates and proves leaks in the Jackson formation; however, permeability has been suggested beneath Nonconah Creek<sup>18</sup> and beneath Mississippi River alluvium in eastern Arkansas.<sup>4</sup>

Subsurface investigations have been carried out to provide information for foundation design. Two of the borings penetrated the full thickness of alluvium and the Jackson formation. These investigations indicate that the Jackson formation extends below the site, and the thickness of the formation at that point suggests that it is both continuous and intact. Figure B.1 in Appendix B.2.1 shows a subsurface profile taken from borings in the northeast and southeast corner. The alluvium ranges from very loose to very dense sand, which grades from fine to coarse with local gravelly zones. An area in the southwest corner of the site is underlain by clayey silt, which extends to a shallow depth. Figure 3.5 shows the locations of borings. Figures 3.6 and 3.7 show two cross-sectional profiles across the site, including graphic logs of borings and results of penetration

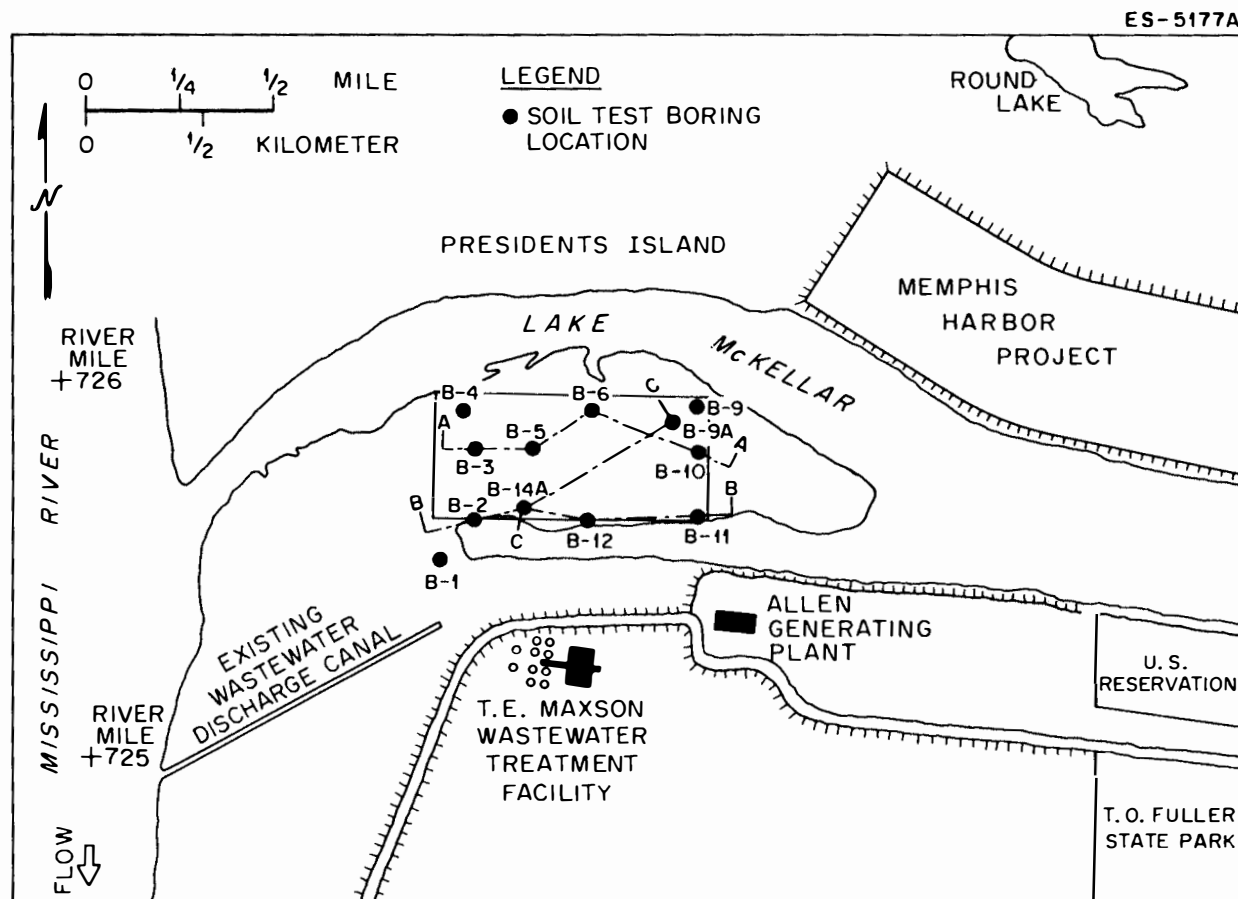


Fig. 3.5. Boring-location plan. Source: Modified from ER, Fig. 3.2, p. 3-12.

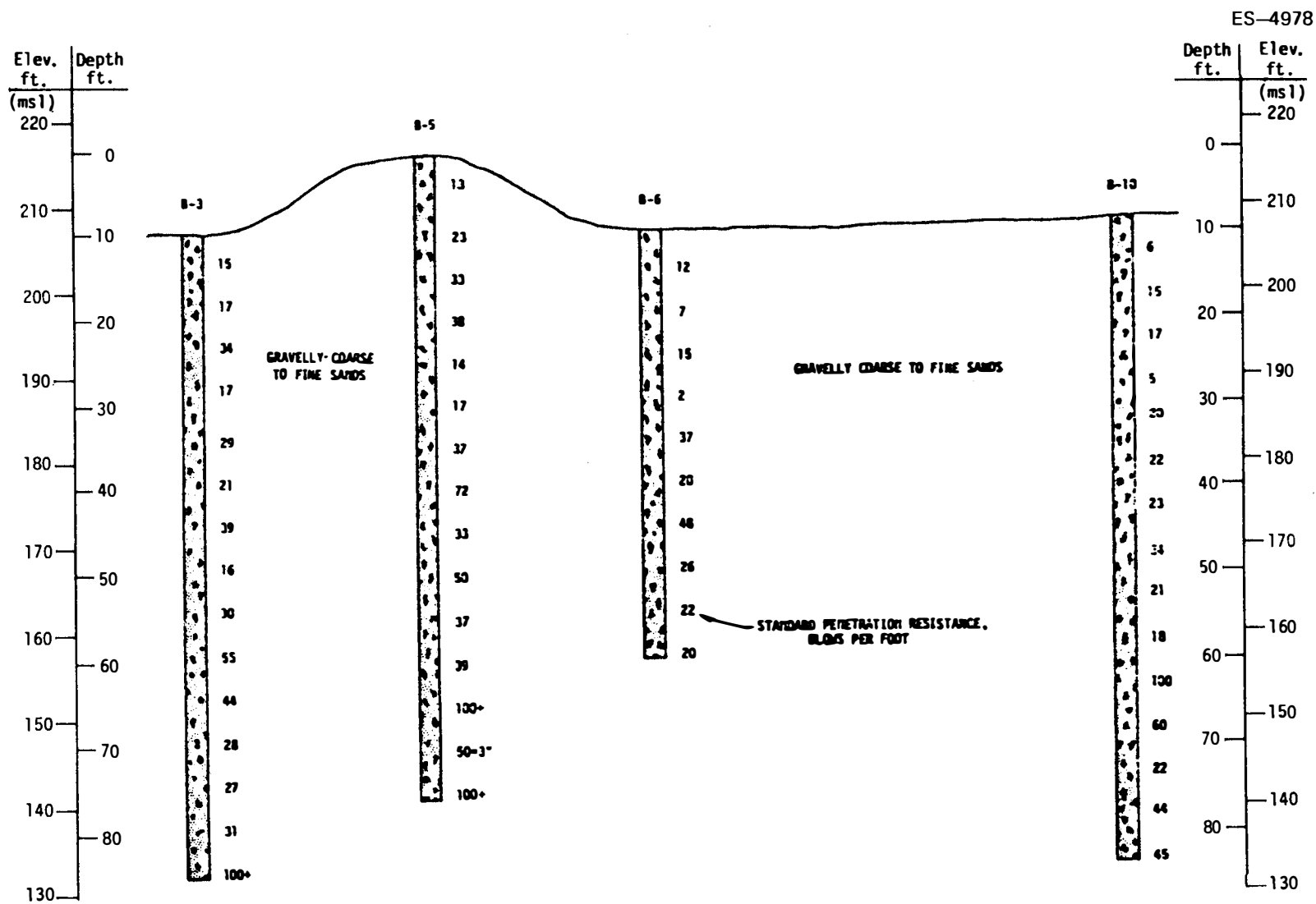


Fig. 3.6. Generalized subsurface profile along Sect. A-A (see Fig. 3.5 for location). Source: ER, Fig. 3.3, p. 3-13.

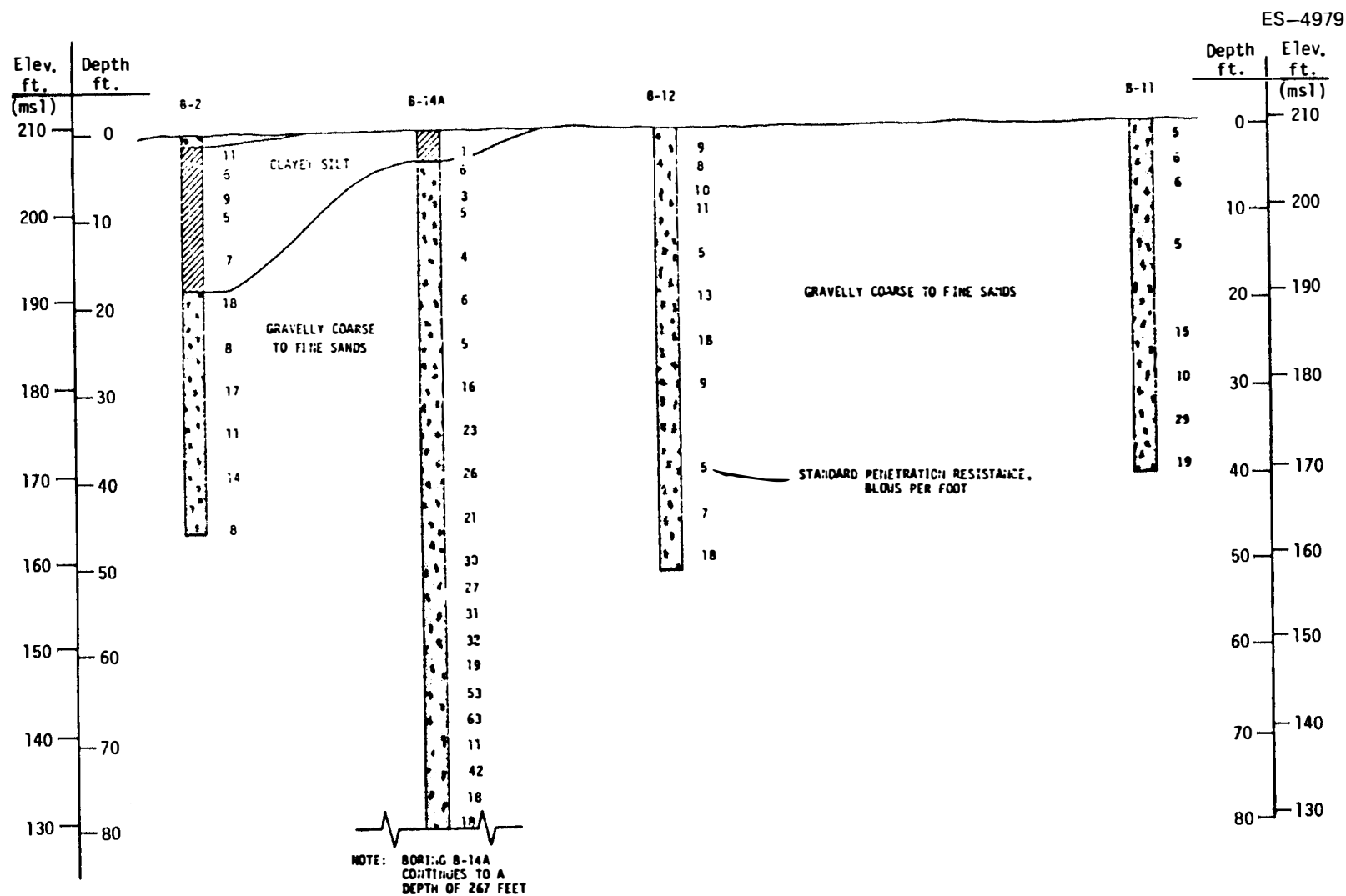


Fig. 3.7. Generalized subsurface profile along Sect. B-B (see Fig. 3.5 for location). Source: ER, Fig. 3.4, p. 3-14.

resistance tests made at regular intervals. In granular soils the penetration resistance test is used as a measure of the relative density of the soils. Penetration resistance values of less than 10 blows per foot indicate loose materials, which may pose a potential foundation problem. Profile A-A (Fig. 3.6) is generally taken across the northern part of the site, and most penetration resistance values are greater than 10 blows per foot. Borings in profile B-B (Fig. 3.7), taken across the southern portion of the site, recorded penetration resistance values of less than 10 blows per foot to depths in excess of 12 m (40 ft) in two of the four borings.

The significance of the loose sandy zones in the subsurface is that some preconsolidation of those areas is necessary to minimize foundation settlement or liquefaction. Development of the site requires emplacement of fill materials to raise the elevation of the process areas above flood elevation. Sand from the Mississippi River is to be dredged and hydraulically placed on the site after clearing of vegetation and removal of surficial soils. Additional information on foundation conditions is included in Appendixes B.2 and C.5, and foundation stabilization plans are included in Sect. 4.1.5.1.

### 3.1.5.2 Seismic history

Memphis is located in seismic risk zone 3 (Fig. 3.8), a zone in which major destructive earthquakes may occur. The United States has been divided into four zones ranging from zone 0, where there is no reasonable expectancy of earthquake damage, to zone 3 where earthquakes resulting in structural damage may occur.

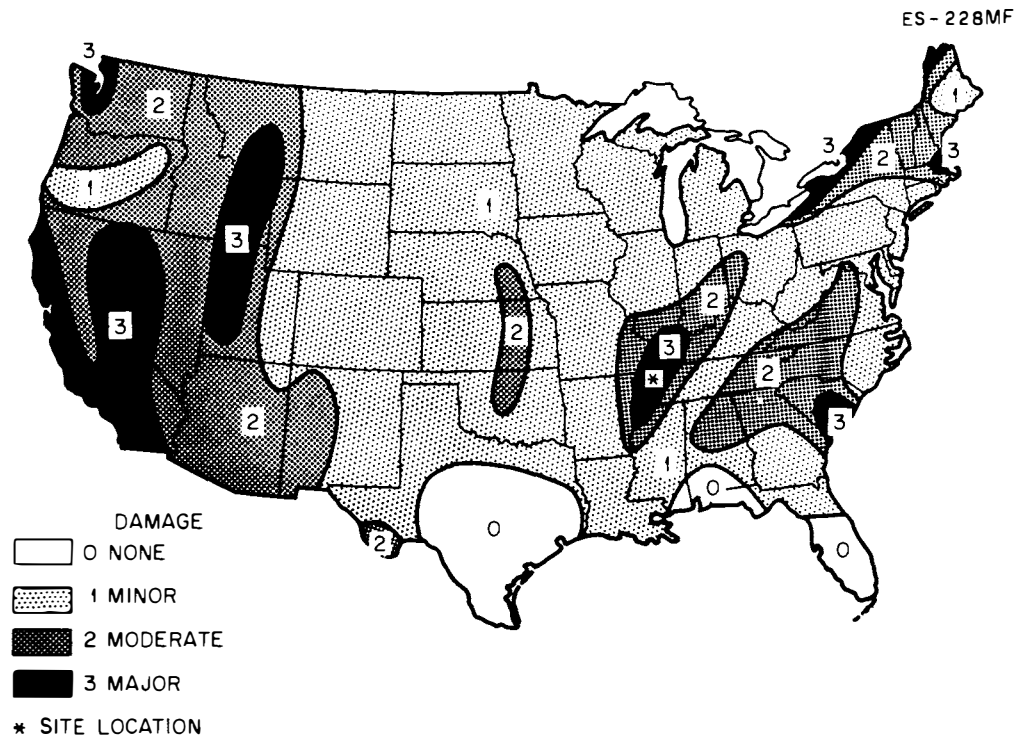


Fig. 3.8. Seismic risk map of the United States. Source: After S. T. Algermissen, "Seismic Risk Studies in the United States," *Proc. 4th World Conf. Earthquake Engineering, Santiago de Chile, January 13-18, 1969*, vol. 1, 1969.

The earliest recorded seismic event in Memphis was experienced by a missionary party in 1699.<sup>19</sup> Other early reports of shocks were recorded by travelers and inhabitants when the area was only sparsely settled. The most severe events experienced in Memphis were the New Madrid (Missouri) earthquakes of 1811 and 1812. Damage from these earthquakes was widespread, and, in addition to destruction of buildings, there was severe disturbance of the Mississippi River and its alluvial deposits.<sup>19</sup> Seismically induced waves cast small rivercraft against the riverbanks or even onto land. Overbank wash of river water was damaging to riverside structures. Caving of the riverbanks was severe near the epicenter, and liquefied sand was ejected from fissures in the land

surface. Effects of the 1811 and 1812 earthquakes in the Memphis area were not recorded because the area was sparsely populated before the 1820s. Although centered in New Madrid the intensity at Memphis was IX or X. Other earthquakes that caused damage at Memphis include an event in 1843 (intensity of VII or VIII) and an 1889 event (intensity of V to VIII). Table 3.9 shows the major recorded events that were felt in the Memphis area.

Table 3.9. Reported seismic events

| Date          | Locality                                      | Area affected<br>(sq miles) | Intensity         |
|---------------|-----------------------------------------------|-----------------------------|-------------------|
| 1843 Jan. 4   | Western Tennessee                             | 400,000                     | VIII <sup>a</sup> |
| 1865 Aug. 17  | Southeastern Missouri                         | 24,000                      | VII               |
| 1878 Nov. 18  | Southeastern Missouri                         | 150,000                     | VI                |
| 1883 Jan. 11  | Cairo, Ill.                                   | 80,000                      | VI                |
| 1891 Sept. 26 | Near Cairo, Ill.                              |                             |                   |
| 1895 Oct. 31  | Charleston, Mo.                               | 1,000,000                   | VIII              |
| 1897 Apr. 30  | Tennessee, Illinois,<br>Indiana, and Kentucky |                             | IV-V              |
| 1905 July 26  | Calumet, Mich.                                | 16,000                      | VII               |
| 1905 Aug. 21  | Mississippi Valley                            | 40,000                      | VI <sup>a</sup>   |
| 1911 Mar. 31  | Rison, Ark.                                   | 18,000                      | V <sup>a</sup>    |
| 1922 Mar. 23  | Western Kentucky                              |                             | V                 |
| 1923 Nov. 26  | 13 km North of Memphis                        |                             | VI <sup>a</sup>   |
| 1923 Dec. 31  | Arkansas                                      | 30,000                      | V <sup>a</sup>    |
| 1927 May 7    | Mississippi Valley                            | 130,000                     | VII               |
| 1934 July 3   | 6 km Northeast of Memphis                     |                             | IV                |
| 1938 Sept. 16 | Northeastern Arkansas                         | 90,000                      | IV-V <sup>a</sup> |
| 1954 Apr. 26  | Memphis, Tenn.                                |                             | V <sup>a</sup>    |
| 1958 Jan. 26  | Memphis, Tenn.                                | (3)                         | V <sup>a</sup>    |
| 1968 Nov. 9   | South-central Illinois                        | 580,000                     | VII               |

<sup>a</sup>Intensity at Memphis.

Earthquake recurrence has been computed for the upper Mississippi valley, which includes the site. The results of these computations show a recurrence interval per 100 years as follows:

| Intensity | Earthquakes per 100 years |
|-----------|---------------------------|
| V         | 24.2                      |
| VI        | 7.65                      |
| VII       | 2.42                      |
| VIII      | 0.76                      |

One of the major concerns about earthquake effects in the Memphis area is possible structural damage caused by sand liquefaction.<sup>20</sup> Liquefaction occurs when seismic shaking causes the reorientation of sediment grains and when loads normally borne by the grains are transferred to the water in the pore spaces between the grains. Kellogg<sup>21</sup> has suggested that liquefaction might occur in the softer, wetter soils of the Memphis area. The fine-grained alluvial sands, such as those found at the site, would be included in these soils. Should liquefaction occur at the site, foundations bearing on loose, liquefiable sands could fail and result in extensive damage to the structures.

### 3.1.5.3 Soils

Soils on the Allen site are silty to sandy, are well drained to excessively drained, and overlie thick alluvial deposits of the Mississippi River. The existing soils are of limited agricultural use because they are subject to both drought and occasional flooding. Borings at the site penetrate approximately 46 m (150 ft) of alluvial sands, gravels, silts, and clays. The parent material for the site soils is the Mississippi alluvium. Crevasse fine sand is the only soil unit mapped on the area by the Soil Conservation Service.<sup>22</sup> This soil is sandy, excessively drained, and droughty and is assigned to capability unit IVs-1. Crevasse fine sand is mapped on approximately 8 ha (20 acres) of the site; soils on the remainder of the site are unclassified. The Crevasse fine sand occurs in 16- to 40-ha (40- to 100-acre) tracts along the Mississippi River. It has low available water capacity, which limits its productivity. Dredged material from Lake McKellar has been piled on the northern edge of the area.

### 3.1.6 Land use

The proposed site is approximately 13 km (8 miles) west-southwest of downtown Memphis, Tennessee, on a peninsula 1.2 km (4000 ft) east of the Mississippi River. The site's boundaries encompass 54 ha (134 acres) of land (Fig. 3.1). The site is within the boundaries of both Shelby County and the city of Memphis, Tennessee.

The site is owned by MLGW but is not currently in productive use. The area surrounding the site is predominantly rural in character but is zoned for heavy industrial use. A 1977 report to the Mississippi-Arkansas-Tennessee Council of Governments projected land use at the site as nonurban.<sup>23</sup> Current industrial activity is limited to the use of parts of the area to receive dredged material from Lake McKellar. Industrial facilities adjacent to the site include TVA's Allen Generating Plant and the T. E. Maxson Wastewater Treatment Facility. Plans exist for portions of the Allen site, in the absence of the proposed project, to become a future ash disposal area for the Allen Generating Plant (Lease Agreement between the city of Memphis, MLGW, and TVA, Jan. 1, 1963; amended Dec. 11, 1979).

The nearest urban development including housing of any significant extent is about 5 km (3 miles) east-southeast of the site, just west of Fuller State Park. The T. O. Fuller State Park and the adjoining Chucalissa Indian Village are well-used recreational areas and are the closest such areas to the site. In 1977-78, there were 178,428 visits to the park and 65,237 visits to the Chucalissa Indian Village (personal communication with T. O. Fuller State Park Office, Memphis State University, Chucalissa Indian Village Headquarters, Oct. 11, 1979).

The region surrounding the site is Shelby County, Tennessee, the 1979 population of which was estimated to be 798,085 (personal communication with Memphis-Shelby County Planning Commission, Oct. 9, 1979). The primary urban area is the city of Memphis, which in 1970 accounted for 37% of the county's area of 1957.8 km<sup>2</sup> (755 sq miles).<sup>24</sup> Other urbanized areas (1970 population of 2500) include the cities of Collierville, Germantown, and Millington.<sup>25</sup> The Memphis Standard Metropolitan Statistical Area (SMSA) also includes the counties of Tipton, Tennessee; Crittenden, Arkansas; and DeSoto, Mississippi. If population change follows projected trends within Shelby County, an increasing area of urbanized land will result.

Several existing and planned industrial sites are in the section of county where the Allen site is located: the Presidents Island Complex, the Pidgeon Industrial Area, and the Rivergate Industrial Complex. Major growth is expected to take place in industrial land use over the next 20 years. By 1995, this land use category is expected to double in area in Shelby County.

Agriculture is the primary land use in Shelby County, where in 1974, 47.2% of the land area was in agricultural use. Most farmland is located in northern and eastern Shelby County rather than in the southwestern part, where the proposed site is located. There is no prime farmland on the site (Appendix B.3.2).

Land use controls affecting the proposed site are primarily zoning regulations under jurisdiction of the Memphis-Shelby County Planning Commission. Authority for such zoning is in the state of Tennessee enabling legislation. Development and use of land in Shelby County are regulated according to a specific district zoning assigned to an area. Currently there are 16 such zoning classifications, one of which is the M-3 heavy industrial use zone that affects the proposed site. The site is currently zoned for its intended purpose.

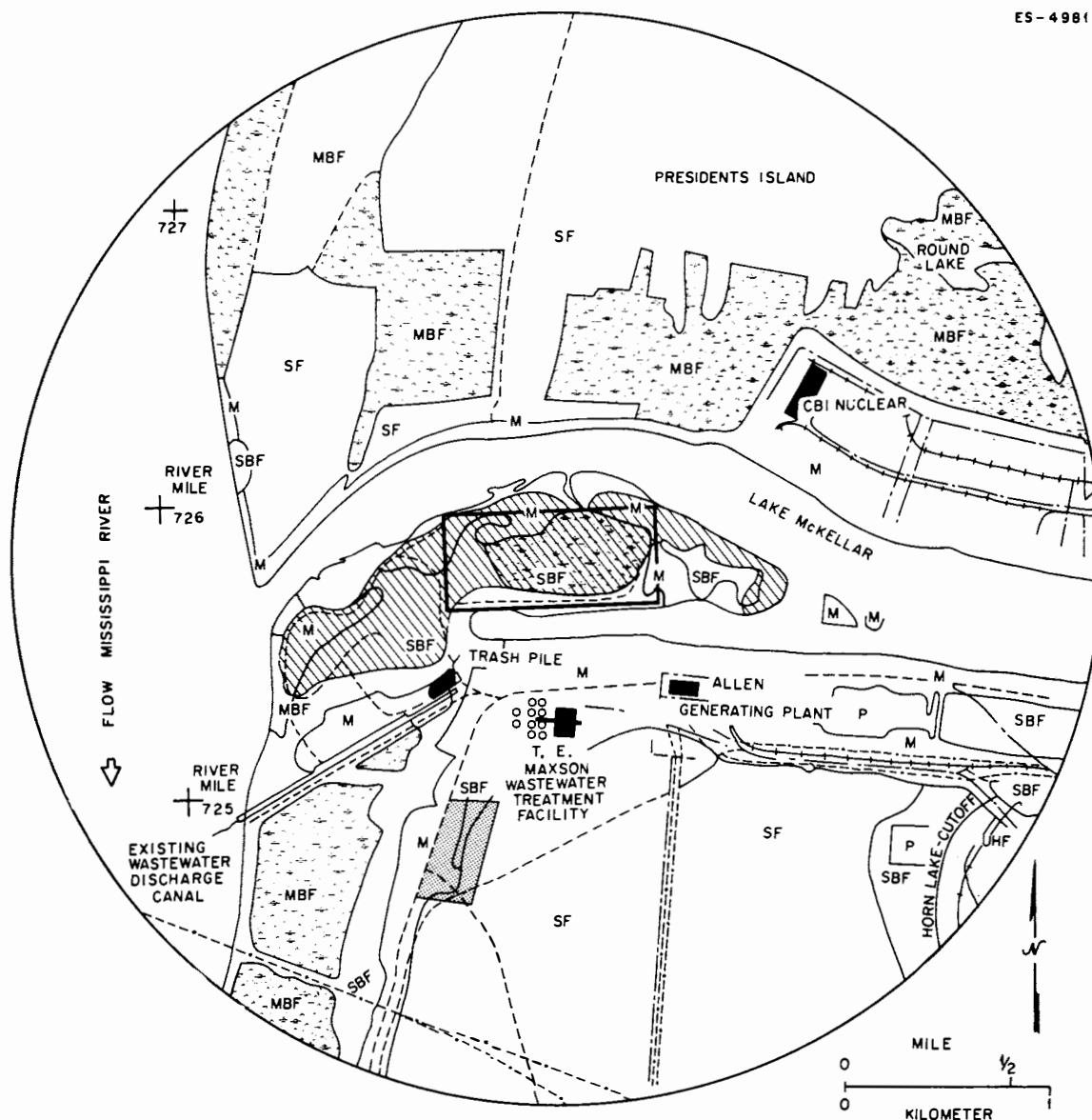
### 3.1.7 Terrestrial ecology

#### 3.1.7.1 Vegetation

The proposed site is located on the Mississippi Alluvial Plain, the region east of the site being part of the Mississippi embayment section of the Western Mesophytic Forest Region.<sup>21</sup> Three kilometers east of the site, the dissected slopes of the Memphis Bluffs bordering the floodplain are vegetated with Mixed Mesophytic Forest and are unlike other parts of the Mississippi embayment section.<sup>21</sup> The vegetation on the floodplain within 3 km of the site consists of soybean fields, successional bottomland forest, mature bottomland forest, and herbaceous meadow. The successional bottomland forest is dominated by black willow, and the mature bottomland forest, by box elder and sugarberry. Vegetation types within 3 km of the site center are shown in Fig. 3.9.

The floodplain has numerous poorly drained, elongated depressions that contain standing water in winter and spring from flooding by the Mississippi River. Wetlands (28 ha) on the site proper are considered to be of low to medium quality for terrestrial wildlife by the USFWS because of low food availability (telephone conversation with D. R. Parsons, U.S. Fish and Wildlife Service, Aug. 20, 1979, and letter EIA-WR-1460). This designation is based on a rating provided by USFWS personnel who visited the site in 1979 (telephone conversation with W. A. Beimbom, Energy Impact Associates, Oct. 17, 1979). However, if disposal of dredged material on the site were discontinued, the site's value to wildlife would rapidly increase.





- |                                                                                         |                              |
|-----------------------------------------------------------------------------------------|------------------------------|
| SF SOYBEAN FIELD                                                                        | ALLEN SITE                   |
| M MEADOW                                                                                | WETLAND                      |
| SBF SUCCESSIONAL BOTTOMLAND FOREST<br>(BLACK WILLOW, LEADING DOMINANT)                  | DREDGE SPOIL                 |
| MBF MATURE BOTTOMLAND FOREST<br>(BOXELDER AND SUGARBERRY, LEADING<br>DOMINANT)          | PIDGEON SITE                 |
| UHF UPLAND HARDWOOD FOREST (MINOR TYPE)<br>(MIXED OAKS, HICKORIES, AND TULIP<br>POPLAR) | BURIED GAS PIPELINE          |
| P POND                                                                                  | ELECTRICAL TRANSMISSION LINE |
|                                                                                         | SURFACED HIGHWAY             |
|                                                                                         | TRAIL                        |
|                                                                                         | RAILROAD                     |

Fig. 3.9. Vegetation types within 3 km of the MLGW site center. Source: Modified from ER, Fig. 3.34, p. 3-169.

Annually in late September, the U.S. Army Corps of Engineers dredges the channel that connects Lake McKellar to the Mississippi River and hydraulically pumps the spoil onto the peninsula west of the proposed site. Sediments settle out, increasing the elevation of the peninsula and burying herbaceous vegetation. Deposition of this dredge spoil affects the overstory of the peninsula as well, keeping the plant community a successional bottomland forest.

Terrestrial ecological field surveys for four seasons were conducted from early May to late December of 1978. The major vegetation types within 3 km of the site center that were identified during this survey are described below.

#### Soybean fields

Soybean fields to the north and south of the site comprise approximately 26.5% of the area within 3 km of the site, but none are present on the site itself. These fields serve as important feeding and resting grounds for migrating waterfowl.

#### Meadow

The site is bounded on the north by an "island sand dune" (e.g., *Sporobolus cryptandrus*- and *Heterotheca latifolia*-dominated) type of meadow and on the east by a seasonally emergent type meadow.<sup>26</sup> A total of 148 taxa, primarily herbaceous species, occur in the divergent meadow types found within 3 km of the site center.

#### Successional bottomland forest

The successional bottomland forest is dominated by black willow and occurs on recently disturbed floodplains that are in standing water part of the year. In addition, cottonwood, box elder, silver maple, and American sycamore are important tree species. Bur cucumber, grape, and poison ivy are dominant shrub and vine species. A total of 69 species was observed in this community. The successional bottomland forest comprises 7.1% of the area within 3 km of the site and approximately 66% of the site itself. Annual deposition of dredge spoil has altered the structure of this plant community by reducing both undergrowth and seedling survival.

#### Mature bottomland forest

Of the 71 woody and herbaceous taxa observed in this forest type, box elder and sugarberry are the most important overstory species. Survey data indicate a changing composition toward a sugarberry-slippery elm forest. Although 12.7% of the 3-km area around the site is covered with mature bottomland forest, none occurs on the site itself.

#### Threatened and endangered species

No plant species on either the U.S. Department of the Interior<sup>27</sup> or State of Tennessee<sup>28</sup> lists were observed within 3 km of the site during the survey and none is expected to occur there (Appendix B.3.1).

#### 3.1.7.2 Wildlife

##### Mammals

Mammals of the proposed site are typical of those on the Mississippi River floodplain. The most common species observed were the eastern cottontail, house mouse, and domestic dog. A waste disposal site 1.2 km southwest of the site provides a particularly suitable habitat for small mammals. Dogs and cats that hunt the area probably exert considerable influence on site wildlife.

Game mammals include the eastern cottontail and the white-tailed deer. Fox, gray squirrels, opossum, and raccoon are present. The raccoon and cottontail are hunted by the local populace. A list of game mammals, furbearers, and nongame mammals that occur within 3 km of the site and their relative abundance is shown in Table 3.10.

In the successional bottomland forest on the site peninsula, dredging operations reduced fall and winter white-footed mouse populations by approximately one-half and apparently displaced shorttail shrew and pine vole populations. In areas where fresh dredge spoil was added, very few mice were trapped, and adjacent areas also experienced a marked reduction in mice abundance. The successional forest not affected by dredging had a dramatic increase in house mouse

Table 3.10. Mammals observed within 3 km of the proposed plant site

| Common name        | Habitat location |            |                |        |                   |        |
|--------------------|------------------|------------|----------------|--------|-------------------|--------|
|                    | Water            | Trash pile | Soybean field  | Meadow | Bottomland forest |        |
|                    |                  |            |                |        | Successional      | Mature |
| Game mammals       |                  |            |                |        |                   |        |
| Eastern cottontail |                  |            | C <sup>a</sup> | A      | A                 | A      |
| Swamp rabbit       |                  |            |                |        | S                 | S      |
| White-tailed deer  |                  |            | C              | C      | C                 | C      |
| Gray squirrel      |                  |            |                |        | U                 |        |
| Fox squirrel       |                  |            |                |        | U                 |        |
| Furbearers         |                  |            |                |        |                   |        |
| Opossum            |                  | C          |                | C      | C                 |        |
| Beaver             | C                |            |                | C      |                   |        |
| Muskrat            | U                |            |                | U      |                   |        |
| Red fox            |                  | U          | U              | U      | U                 | U      |
| Gray fox           |                  | U          | U              | U      | U                 | U      |
| Raccoon            |                  | U          | U              | U      | U                 | U      |
| Bobcat             |                  | S          |                | S      | S                 | S      |
| Nongame mammals    |                  |            |                |        |                   |        |
| Shorttail shrew    |                  |            |                | C      | C                 |        |
| Eastern mole       |                  |            |                | C      | C                 |        |
| Marsh rice rat     |                  |            | U              | U      | U                 |        |
| Cotton mouse       |                  |            |                | C      |                   |        |
| Hispid cotton rat  |                  |            | U              | C      | C                 |        |
| White-footed mouse |                  |            | U              | C      | C                 | C      |
| Pine vole          |                  |            |                | C      | C                 |        |
| Norway rat         |                  | C          | U              |        |                   |        |
| House mouse        |                  | A          | U              | A      | C                 | C      |
| Eastern chipmunk   |                  |            |                |        |                   | U      |
| Coyote             |                  | U          | U              | U      | U                 |        |
| Cat                |                  | C          | C              | C      | C                 | C      |
| Dog                |                  | A          | A              | A      | A                 | A      |

<sup>a</sup>A = abundant: an abundant mammal is very likely to be present in large numbers every time a person visits its habitat at the proper season; C = common: a common mammal is likely to be present in moderate numbers nearly every time a person visits its habitat at the proper season; U = uncommon: an uncommon mammal is likely to be present in low numbers occasionally when a person visits its habitat at the proper season, and S = special concern: a mammal of special concern is rare in all or part of its range and may be listed as threatened or endangered by the U.S. Fish and Wildlife Service and the State of Tennessee.

Source: ER, Vol. II, Table 3-52.

and cotton mouse populations from fall to winter, reflecting population growth and displacement from the flooding of low-lying habitat near the river.

The bobcat is a widespread but uncommon or rare species found within 3 km of the site. The bobcat ranges widely in the site vicinity but is most common near water and in or near mature bottomland forest. Local farmers, TVA security personnel, and Tennessee wildlife officers indicated that bobcat adults and kittens were observed in the area and that several adult bobcats were killed for fur on Presidents Island.

#### Avifauna

A total of 134 bird species was observed within 3 km of the site during a four-season baseline survey, including 45 permanent residents, 36 summer residents, 28 winter residents, 4 winter visitors, and 21 transient species. Representative species were mallard, wood duck, bobwhite, American coot, mourning dove, yellow-billed cuckoo, horned lark, rough-winged swallow, redwing blackbird, common grackle, indigo bunting, and white-throated sparrow. The meadow was used by 101 species and a successional forest by 102, with the ecotone between forest and meadow heavily utilized. Soybean fields were used by only 27 species.

Several species of raptorial birds occur at the site. The most commonly observed species was the American kestrel. Other species included the merlin (a small falcon); an uncommon winter visitor, the marsh hawk;<sup>29</sup> Mississippi kite; red-tailed hawk; sharp-shinned hawk; broadwinged hawk; black vulture; turkey vulture; great horned owl; barn owl; and screech owl. Although not observed during this study, eagles and osprey are known to migrate through the area.<sup>29</sup> In the state of Tennessee, the marsh hawk and the sharp-shinned hawk are listed as threatened, and the Mississippi kite is listed as endangered.<sup>28</sup> A screech owl nest was observed on site in a black willow tree.

Game birds observed include the Canada goose, ten duck species, bobwhite, wild turkey, mourning dove, American woodcock, common snipe, and American coot. The bobwhite and turkey were seen in the meadow and the black willow forest stands on the site.

#### Amphibians and reptiles

Ten amphibian and 13 reptile species were observed within 3 km of the site. The most abundant species were the American toad, the Fowler's toad, and the six-lined racerunner. Five species of frogs, two species of lizards, and seven species of snakes were less numerous.

#### Threatened and endangered faunal species

Animal species listed by the U.S. Department of the Interior as threatened or endangered under provisions of the Endangered Species Act of 1973 are protected, and critical habitat of the species may not be disturbed.<sup>27</sup> The bald eagle may occur frequently as a migrant or winter visitor along the Mississippi River, and the peregrine falcon, as an extremely rare migrant. The site is unlikely to constitute important habitat for either the Indiana bat or the gray bat. The USFWS has reviewed information for the site and believes "... that there are no Federally listed or proposed endangered or threatened plant or animal species in the impact area of the project ... ." (Appendix B.3.1).

The state of Tennessee maintains an official list of endangered and threatened fauna.<sup>28</sup> In addition, the State also maintains a "special management" category, which indicates that the species may be locally abundant in Tennessee but may require special management because of restricted habitat availability. A list of species fitting these categories is in Table 3.11.

Table 3.11. Tennessee endangered, threatened, and special-concern species observed within 3 km of the proposed plant site

| Common name                    | Scientific name                  | Classification <sup>a</sup> |
|--------------------------------|----------------------------------|-----------------------------|
| <b>Mammals</b>                 |                                  |                             |
| Swamp rabbit                   | <i>Sylvilagus aquaticus</i>      | S                           |
| Bobcat                         | <i>Lynx rufus</i>                | B                           |
| <b>Birds</b>                   |                                  |                             |
| Marsh hawk                     | <i>Circus cyaneus</i>            | T                           |
| Mississippi kite               | <i>Ictinia mississippiensis</i>  | E                           |
| Sharp-shinned hawk             | <i>Accipiter striatus</i>        | T                           |
| <b>Amphibians and reptiles</b> |                                  |                             |
| Six-lined racerunner           | <i>Cnemidophorus sexlineatus</i> | S                           |

<sup>a</sup>E = endangered: the species is in danger of becoming extirpated in all or part of its range; T = threatened: the species population is declining and protection is required to prevent species endangerment in all or part of its range; S = special: the species is restricted to a very uncommon habitat and special management is required to maintain both habitat integrity and current populations within the habitat; B = trapping of bobcats for fur is controlled by the Endangered Species Act.

Sources: ER, Vol. II, Table 3-56 (modified); W. A. Beimborn, trip report, "Summer Terrestrial Field Survey," July 17-21, 1978, Letter Number EIA-4499-ER, Energy Impact Associates, 1978; and Tennessee Wildlife Resources Commission, "Endangered or Threatened Species," Proclamation Number 75-15 as amended by Proclamations 77-4, 78-14 and 78-20, Nashville, Tennessee, 1975.

The Mississippi kite is listed as endangered in Tennessee. During the baseline survey this species was observed soaring over mature bottomland forest. The species breeds in large trees [primarily greater than 75 cm (30 in.) in diameter and 30 m in average height]. Such trees occur in mature bottomland forest 2 km southwest of the site and on Presidents Island north of the site, especially along the Mississippi River shore, but not on the proposed site.

Both the marsh hawk, a winter resident, and the sharp-shinned hawk, a winter visitor, are listed as threatened in Tennessee. The sharp-shinned hawk was seen flying over the site on one occasion, and the marsh hawk was occasionally seen hunting over meadows.

The swamp rabbit and the six-lined racerunner are listed in the special management category. Swamp rabbits occur in mature bottomland forest and adjoining edge habitats. The six-lined racerunner occurs on sandy dredge sediments and sandy floodplains on and near the site. It is most abundant locally on the meadow formed by the sandy dredging sediment along Lake McKellar from the Mississippi to the eastern peninsula tip.

The habitat within 3 km of the site that is most sensitive to disturbance is the mature bottomland forest. This forest provides habitat for the bobcat, Mississippi kite, and swamp rabbit. The onsite meadow and successional bottomland forest are less important to endangered and threatened mammals and birds known to occur in the area, although the meadow is good habitat for the six-lined racerunner.

### 3.1.8 Economic, social, and cultural features

This section identifies the socioeconomic characteristics of the study area, including demographics, labor force, economic base, political infrastructure, and transportation. Such information provides a basis for evaluating the potential effects of the facility on the evolving social, economic, and political environment.

Based on a preliminary assessment of available labor and housing within an 80-km (a 50-mile) commuting radius of the site, as well as its accessibility, the area studied to determine the socioeconomic impacts of the proposed facility is the SMSA. The Memphis SMSA includes Shelby County, Tennessee; Tipton County, Tennessee; Crittendon County, Arkansas; and Desoto County, Mississippi. The primary impact area within this region is Shelby County, which includes the city of Memphis, where the MLGW facility is located, and which is the largest county in the SMSA in terms of its population and the size of the civilian labor force.

Shelby County, the city of Memphis, and a number of smaller towns and unincorporated areas comprise the major political jurisdictions within the study area. The Mississippi-Arkansas-Tennessee Council of Governments/Memphis Delta Development District (MATCOG/MDDD), the Memphis-Shelby County Office of Planning and Development, and the Memphis Chamber of Commerce are primary planning groups for the area.

#### 3.1.8.1 Demographics and labor force

The Memphis SMSA had a population of 927,772 in 1980, according to preliminary 1980 U.S. Census figures. Shelby County (population 772,523) is the most populated county within the SMSA (see Table 3.12) and contains the city of Memphis. In 1980 the estimated population of Memphis was 644,838, ranking it among the top 20 largest cities in the United States.<sup>30</sup> Most of the other towns in Shelby County and the rest of the SMSA have populations ranging between less than 1000 and 25,892, as in the case of West Memphis, Arkansas (see Table 3.13).

The population increase in Shelby County has been only partially a consequence of the population increase within the city limits of Memphis. Other towns within Shelby County have grown considerably (e.g., Germantown, Bartlett, and Collierville). This trend is expected to continue. The area is developed economically and is urbanized. In 1960, the median family income in Shelby County, as compiled by the Bureau of Business Research at Memphis State University was \$4903. By 1970 this figure had nearly doubled at \$8671. Estimates for 1975, 1980, and 1985 show the median income increasing steadily from \$11,497 to \$12,428 to \$20,364 respectively.

According to employment figures, information gathered from various trade union officials, and the Human Resources Development Institute in Memphis, an abundance of diversified labor is available in Shelby County. As of November 1980, the Tennessee State Department of Employment Security in Nashville recorded Shelby County as having 331,360 persons employed out of a total civilian labor force of 351,900. Thus, 5.4% (20,540) of the civilian labor force was unemployed. The civilian labor force for the entire Memphis SMSA, according to November 1980 estimates, was 417,045 persons.<sup>31</sup> With union jurisdictions extending beyond the Shelby area, available labor is abundant and diversified within an 80-km (a 50-mile) radius of the plant.

**Table 3.12. Population change from 1970 to 1980 in the MATCOG/MDDD<sup>a</sup> six-county area**

| County                  | 1970    | 1980 <sup>b</sup> | Change | Percent of change |
|-------------------------|---------|-------------------|--------|-------------------|
| Crittenden <sup>c</sup> | 48,106  | 49,156            | 1,050  | 2.18              |
| Desoto <sup>c</sup>     | 35,885  | 53,740            | 17,855 | 49.76             |
| Fayette                 | 22,692  | 25,038            | 2,346  | 10.34             |
| Lauderdale              | 20,271  | 24,112            | 3,841  | 18.95             |
| Shelby <sup>c</sup>     | 722,014 | 772,523           | 50,509 | 7.00              |
| Tipton <sup>c</sup>     | 28,001  | 32,353            | 4,352  | 13.45             |
| Total                   | 876,969 | 956,922           | 79,953 | 9.12              |

<sup>a</sup>The Memphis-Arkansas-Tennessee Council of Governments/Memphis Delta Development District.

<sup>b</sup>Preliminary census figures for December 9, 1980.

<sup>c</sup>Standard Metropolitan Statistical Area.

**Table 3.13. Population changes for counties and towns within the Standard Metropolitan Statistical Area**

| Community                | Population |         | Change |
|--------------------------|------------|---------|--------|
|                          | 1970       | 1980    |        |
| <b>Crittenden County</b> | 48,106     | 49,156  | 1,050  |
| Crawfordsville           | 831        | 690     | -141   |
| Earle                    | 3,586      | 3,493   | -93    |
| Edmondson                | 412        | 347     | -65    |
| Gilmore                  | 461        | 507     | 46     |
| Marion                   | 1,634      | 3,004   | 1,370  |
| Sunset                   |            | 587     |        |
| Turrell                  | 783        | 1,038   | 255    |
| West Memphis             | 25,892     | 28,198  | 2,306  |
| <b>Desoto County</b>     | 35,885     | 53,740  | 17,855 |
| Hernando                 | 2,499      | 2,972   | 473    |
| Horn Lake                |            | 4,318   |        |
| Memphis, Miss.           |            | 50      |        |
| Newport Village          |            | 56      |        |
| Olive Branch             | 1,513      | 2,067   | 752    |
| Southaven (CUP)          | 8,931      | 16,049  | 7,118  |
| <b>Tipton County</b>     | 28,001     | 32,353  | 4,352  |
| Atoka                    | 446        | 692     | 246    |
| Brighten                 | 952        | 974     | 22     |
| Burlison                 | 397        | 380     | -17    |
| Covington                | 5,801      | 6,000   | 199    |
| Garland                  | 292        | 301     | 9      |
| Gilt Edge                | 406        | 142     | -264   |
| Mason                    | 443        | 467     | 24     |
| Munford                  | 1,281      | 1,582   | 301    |
| <b>Shelby County</b>     | 772,014    | 772,523 | 50,509 |
| Arlington                | 1,349      | 1,773   | 412    |
| Bartlett                 | 1,150      | 17,134  | 15,984 |
| Collierville             | 3,625      | 7,819   | 4,194  |
| Germantown               | 3,474      | 19,596  | 16,122 |
| Memphis                  | 623,530    | 644,838 | 21,308 |
| Millington               | 21,177     | 20,010  | -1,167 |
| Lakeland                 |            | 596     |        |

Source: U.S. Census 1980 Preliminary Population Statistics.

### 3.1.8.2 Housing

Shelby County has a housing surplus. In 1977, 4138 permits for single-family residences were issued, resulting in an unsold inventory of 743 completed and 2635 uncompleted homes at year's end. For the first nine months of 1978, 3063 permits for new single-family homes were issued. An inventory of unsold single-family units revealed 772 completed homes and 2738 uncompleted homes in the Shelby County market, which shows a slight decline in activity of new, single-family units. During the third quarter of 1978, 932 new single-family units were sold at an average price of \$58,352. This value is above the \$51,082 figure for the 986 units sold during this same period in 1977. Thus, though transactions decreased by 5%, average sale prices increased by 14%.

Sales information for existing and new single-family units and duplexes indicates that there were 13,848 sales transactions in 1978, at an average sale price of \$39,772. In 1977, 14,700 sales transactions were recorded at an average annual sale price of \$36,565.

During the early 1970s, development in the multifamily market was extremely rapid, resulting in an oversupply of apartment units. Apartment construction has declined since that time, and Memphis has absorbed this surplus. Although the vacancy rate declined from 18% in 1974-75 to 6.1% in 1978, Memphis still exhibits "soft" market conditions for a city of comparable size and growth. The majority of multifamily development experienced in recent years has been in the area of apartment complexes for the elderly.

The 1978 apartment market consisted of 50,039 completed, unsubsidized units. Average monthly rental rates ranged from \$150 to over \$300. The southeastern section of the county has a large concentration of multifamily housing.

The areas of Bartlett, northeast Memphis, and Germantown exhibit the greatest potential for housing growth. These areas are well supported by developed and planned transportation and utility facilities and are also served by existing and planned commercial centers.

### 3.1.8.3 Economic base

The Memphis area has a strong and diversified economic base. The strongest sectors of employment are trade, services, and civilian government, followed by manufacturing. Employment in the trade sector, both retail and wholesale, shows an increasing trend to 1990, as it does in services and government. By 1990 all of these areas are expected to increase significantly, which reflects increasing income and employment levels. Manufacturing does not follow a definite pattern, however, and employment in this sector is projected to decline slightly by 1990. Employment in agriculture will continue to decrease through 1985. Activity in finance, insurance, and real estate sectors is increasing, however. The other sectors of the Memphis economy reflect minor fluctuations of increasing and decreasing activity. Mining alone appears to be constant, with no projected changes in employment, although income levels for this industry are increasing.

The Memphis-Shelby County economy is largely based on the area's providing goods and services to the agricultural sector of a 46-county market area. Growth in the trades and services sector of the economy tends to be contingent on a number of factors: (1) favorable climatic and economic conditions for agriculture, both regionally and nationally, (2) high accessibility to the urban core of Shelby County to facilitate the use of services and the distribution of goods, (3) growth in population and labor force, and (4) continued favorable tax rates, which attracts industry.

### 3.1.8.4 Government services

The level of governmental services provided in Memphis and Shelby County is typical for an urban area of its size.

There are basically three school systems in Shelby County: Memphis City, Shelby County, and various private and parochial schools. With only a few exceptions, the public schools do not appear to be overcrowded. The Memphis City Schools are operating with 66.5% of the total number of available seats filled, and the Shelby County Schools are operating at 79.3% of capacity.

Medical and health facilities are numerous in Shelby County and are considered to be among the finest in the country. Fifteen hospitals in Shelby County provide medical services to both county and regional residents. Four major emergency paramedical services supplement these facilities.

Fire protection within Shelby County is provided by both municipal and volunteer fire departments. The city of Memphis has the largest fire fighting service in the county and currently holds a Class II fire insurance rate. The Memphis Fire Department (MFD) will be responsible for providing

service to the MLGW facility. In 1980, the MFD employed about 1640 uniformed firemen and had 49 strategically located fire stations, which used 114 pieces of firefighting equipment. No special arrangements have been made at this time for protecting the MLGW facility; however, all fire chiefs have been schooled in hazardous materials fires. In addition, each year some firefighters are sent to Texas A&M University for training in fighting fires in petroleum and liquid petroleum gas lines.<sup>31</sup>

There are six large police departments within Shelby County: the City of Memphis Police Department, the Shelby County Sheriff's Department, and the Collierville, Millington, Bartlett, and Germantown police departments. Police protection for the site is to be provided by the Memphis Police Department. In 1978, the Memphis Police Department employed about 1630 persons. The area served by the department encompasses the Memphis area within the boundary of the city limits. The Shelby County Sheriff's Department had about 425 employees in 1978.

#### 3.1.8.5 Finances

Municipal services are generally financed through tax revenues. Tennessee imposes a general property tax at uniform rates on all real estate, tangible personal property, and money on hand or on deposit, in the taxing district where such property is located. There is no State levy. The property tax is supplemented by (1) State taxes on sales, use, income, franchises, privileges, and occupations and (2) municipal taxes and inspection fees.

Shelby County levies a county tax rate of \$4 per \$100 of assessed valuation. Municipalities also levy their own additional assessments. The city of Memphis has a city tax rate of \$3.74 per \$100 of assessed valuation. Assessed value is a percentage of appraised value, depending on a property's classification.

Expenditures for government services totaled \$183,572,000, or \$240 per capita in Shelby County in 1976. Memphis spent \$302,128,000, or \$453 per person, during the same year.

The sales tax rate in Shelby County is 6%. The sales tax in the State of Tennessee is 4.5%, with an additional local sales tax of 1.5%, not to exceed \$7.50 tax on the sale of any single item.

Effective tax rates have been compiled and are available. MLGW will pay no taxes nor will payments be made in-lieu of taxes.

#### 3.1.8.6 Transportation

Highway access into Shelby County is provided by 11 major highways that are linked to the city by a 108-km (67-mile), circumferential expressway system. Interstate 55 is the primary expressway that leads traffic to Mitchell Road, the access road to the proposed site. Air service is provided by the Memphis International Airport and eight other general-aviation airports in the metropolitan area.

Memphis and Shelby County are accessible by various transportation modes. Similarly, the proposed site may be reached by three modes of transportation: road, rail, and water. The site is accessible to water transport via the Mississippi River and Lake McKellar. Rail traffic can reach the site by a spur from the Illinois Central Railroad that runs to the Allen Generating Plant. Access to the general area of the site is provided by a number of roads or highways. All of these avenues of approach eventually connect with Mitchell Road, an east-west trending, two-lane road, which serves as the sole access road to the site itself. Improvements to Mitchell Road are planned for access to the Frank C. Pidgeon Industrial Park. The new Mitchell Road, to be completed in 1984, will follow the perimeter of Fuller State Park instead of running through the park, as does the existing road. In 1979 Mitchell Road had an average daily traffic count of 5370 between Horn Lake Road and Weaver Road. This road is also the primary access to, and passes through, the T. O. Fuller State Park, which had 178,428 visitors in 1977-78. The adjoining Chucalissa Indian Village had 65,237 visitors (based on personal communication with T. O. Fuller State Park Office and Memphis State University Chucalissa Indian Village Headquarters, Oct. 11, 1979). Traffic heading to the plant site along Mitchell Road will pass by the park and will eventually reach the plant site via a new access road, which is to be built in the vicinity of the Allen Generating Plant.

#### 3.1.8.7 Historic, cultural, and archaeological features

The project area does not contain any resources that are listed in, or being considered for listing in, the National Register of Historic Places (see Appendix B.4).



Field surveys show no evidence of prehistoric, architectural, or historic remains.

The project area lies within the 1881 to 1893 channel of the Tennessee Chute (now Lake McKellar), which forms the southern boundary of Presidents Island. Most likely, the 1820 to 1830 channel of the Tennessee Chute flowed through the project area, which would indicate that the project area was recently (post-1893) formed and that any prehistoric or early historic sites that might have existed in the project area would almost certainly have been destroyed by the recent meanders of the Tennessee Chute.

The site contains no unique visual features, but many designated and undesignated areas of visual interest surround the general site area. Undesignated visual features exist and are located on the west bank of the Mississippi River in an area that has become popular for hunting, fishing, and observing nature.

### 3.2 ALTERNATIVE SITE NO. 1 — RIVERGATE, SHELBY COUNTY, TENNESSEE

#### 3.2.1 Meteorology and air quality

Because the Rivergate alternative site is in the same general area as the proposed plant site (Fig. 3.1), its climate and meteorology are similar to those of the proposed site (Sect. 3.1.1.1). The air quality is generally similar, but is somewhat improved because of its location with respect to the Allen Generating Plant. The Allen Generating Plant is the nearest significant emitter of air pollutants to the proposed site, and the Delta Refining Company's oil refinery is the nearest significant emitter to the Rivergate site.

#### 3.2.2 Hydrology

##### 3.2.2.1 Surface water

The site has been filled to approximately 70.1 m (230 ft); the project design flood is 70.96 m (232.8 ft), with the 100-year-flood elevation being 69.4 m (227.6 ft). Filling or diking an additional 0.9 m (2.8 ft) would be required to protect the site from flooding. Surface runoff is discharged directly into Lake McKellar and the barge canal.

##### 3.2.2.2 Groundwater

Alluvial materials beneath the Rivergate site are interbedded sediments from Nonconnah Creek and the Mississippi River. Groundwater movements are not documented, but it is assumed that the water table responds to fluctuations in flow in Nonconnah Creek and Lake McKellar. Water level in Lake McKellar is probably the dominant factor in groundwater elevations. If a zone of infiltration exists beneath Nonconnah Creek, during low-flow seasons there may be some movements of alluvial water toward the permeable zone. Presumably, during high flows in Nonconnah Creek, surface infiltration would satisfy drawdown requirements in the area.

Water quality of the alluvial aquifer is assumed to be similar to that at the Allen site. However, no monitoring data are available.

#### 3.2.3 Water quality

The Nonconnah Creek-Lake McKellar system is described in Sects. 3.1.2, 3.1.3, and 3.1.4. Table 3.14 presents (1) water quality data for the region in which the Rivergate site is located and for surface waters in the Rivergate vicinity and (2) criteria for drinking water and for the protection of aquatic biota. Surface waters in the region are generally hard. Levels of some trace elements (copper, iron, lead, selenium, and zinc) in both Lake McKellar and Nonconnah Creek exceed water quality criteria; however, for those elemental concentrations (copper, lead, selenium, and zinc) reported as total, rather than dissolved, it is not clear whether or not the dissolved fraction exceeded the criteria.

#### 3.2.4 Aquatic ecology

The warm water fishery and other aspects of aquatic ecology of the surface waters in the Rivergate area are described in Sect. 3.1.4. It is not known if resident fish populations are stressed by these trace-element levels.

Table 3.14. Water quality in the vicinity of the Rivergate site  
Concentrations are in mg/liter unless otherwise shown

| Variable                         | Lake McKellar <sup>a</sup>      | Nonconnah Creek <sup>b</sup> | Regional <sup>c</sup> | Drinking water standard | Aquatic biota protection limit |
|----------------------------------|---------------------------------|------------------------------|-----------------------|-------------------------|--------------------------------|
| pH, units                        | 6.8 to 6.9                      | 6.96                         |                       | 6.5 to 8.5 <sup>d</sup> | 6.5 to 9.0 <sup>e</sup>        |
| Temperature, °C                  | 18.2 to 18.6                    | 18.4 to 18.7                 |                       |                         |                                |
| TSS                              | 11.0 to 96.8                    | 26.5 to 293                  | 270 to 1900           |                         |                                |
| D.O.                             | 6.25 to 6.95                    | 6.8 to 7.5                   |                       |                         | 5.0 <sup>e</sup>               |
| Hardness, as CaCO <sub>3</sub>   |                                 |                              | 120 to 180            |                         |                                |
| Alkalinity, as CaCO <sub>3</sub> | 84.5 to 85.5                    | 73.0                         |                       |                         | >20 <sup>e</sup>               |
| Sulfate                          | 39.00 to 43.00                  | 21.00                        |                       | 250 <sup>d</sup>        |                                |
| Chloride                         | 13.00 to 13.50                  | 11.5                         |                       | 250 <sup>d</sup>        |                                |
| Fluoride                         | 0.23 to 0.24                    | 0.30                         |                       | 1.4 to 2.4 <sup>f</sup> |                                |
| TDS                              | 158.0 to 180.5                  | 104.0                        | 120 to 350            | 500 <sup>d</sup>        |                                |
| Arsenic                          | <0.01 <sup>g</sup>              | <0.1 <sup>g</sup>            |                       | 0.05 <sup>f</sup>       | 0.3 <sup>h</sup>               |
| Barium                           | 0.10                            | 0.10                         |                       | 1.0 <sup>f</sup>        | 104 <sup>h</sup>               |
| Cadmium                          | <0.01 <sup>g</sup>              | <0.01 <sup>g</sup>           |                       | 0.010 <sup>f</sup>      | 0.0012 to 0.0120 <sup>e</sup>  |
| Chromium                         | <0.01 <sup>i</sup>              | <0.01 <sup>i</sup>           |                       | 0.05 <sup>e</sup>       | 0.100 <sup>e</sup>             |
| Cobalt                           | <0.01 <sup>g</sup>              | <0.01 <sup>g</sup>           |                       |                         | 6.25 <sup>h</sup>              |
| Copper                           | <0.01 to 0.0100 <sup>g</sup>    | 0.01 <sup>g</sup>            |                       | 1 <sup>d</sup>          | 0.0009 <sup>i</sup>            |
| Iron                             | 1.10 to 1.26                    | 2.39                         |                       | 0.3 <sup>d</sup>        | 1.0 <sup>e</sup>               |
| Lead                             | <0.03 <sup>g</sup>              | 0.05 <sup>g</sup>            |                       | 0.05 <sup>f</sup>       | 0.003 <sup>i</sup>             |
| Manganese                        | <0.01 to 0.010 <sup>g</sup>     | 0.01 <sup>g</sup>            |                       | 0.05 <sup>d</sup>       | 0.35 <sup>h</sup>              |
| Mercury                          | <0.0005 to 0.00077 <sup>g</sup> | 0.0005 <sup>g</sup>          |                       | 0.002 <sup>f</sup>      | 0.00005 <sup>e</sup>           |
| Selenium                         | 0.01 <sup>g</sup>               | 0.025 <sup>g</sup>           |                       | 0.01 <sup>f</sup>       | 0.02 <sup>i</sup>              |
| Zinc                             | 0.02 <sup>g</sup>               | 0.06 <sup>g</sup>            |                       | 5 <sup>d</sup>          | 0.0004 <sup>i</sup>            |

<sup>a</sup>Data for Lake McKellar represent the range of mean values reported for 1978 at stations LM-6, LM-7, MC3, and MC4, from Table 3A-4 and Table 3A-16 in ER.

<sup>b</sup>Data for Nonconnah Creek represent the range of mean values reported for 1978 at station NC-1, from Tables 3A-4, 3A-6, and 3A-16 in ER.

<sup>c</sup>From J. J. Geraghty, D. W. Miller, F. van der Leeden, and F. L. Troise, *Water Atlas of the United States*, 3d ed., Water Information Center, Inc., Port Washington, N. Y., 1973.

<sup>d</sup>From U. S. Environmental Protection Agency, "National Secondary Drinking-water Proposed Regulations," *Fed. Regist.* 42: 62 (1977).

<sup>e</sup>From U. S. Environmental Protection Agency, *Quality Criteria for Water*, EPA-440/9-76-023, Washington, D.C., 1976.

<sup>f</sup>From U. S. Environmental Protection Agency, "National Interim Primary Drinking-water Regulations," *Fed. Regist.* 40: 248 (1975).

<sup>g</sup>Total.

<sup>h</sup>Lowest concentration lethal to fish; from R. M. Cushman, S. G. Hildebrand, R. H. Strand, and R. M. Anderson, *The Toxicity of 35 Trace Elements in Coal to Freshwater Biota: A Data Base with Automated Retrieval Capabilities*, ORNL/TM-5793, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1977.

<sup>i</sup>Hexavalent.

<sup>j</sup>Application factor recommended in footnote e multiplied by the lowest concentration reported as the 96-h LC50, the concentration lethal to 50% of the test organisms in 96 h, in R. M. Cushman, S. G. Hildebrand, R. H. Strand, and R. M. Anderson, *The Toxicity of 35 Trace Elements in Coal to Freshwater Biota: A Data Base with Automated Retrieval Capabilities*, ORNL/TM-5793, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1977.

No Federally designated endangered or threatened aquatic species have been encountered in recent studies in the Lake McKellar area (Sect. 3.1.4). No such species would be expected for the Rivergate area, which lies in the Tennessee section of the lower Mississippi water resource region.<sup>32</sup> The blue sucker (*Cycoreptus elongatus*), considered threatened by the State and endangered by the Tennessee Heritage Program, is reported in Shelby County. This species, which apparently has declined in population in recent years, seasonally migrates up the Mississippi River to spawn in the Loosahatchie River and possibly the Wolf River, both tributaries of the Mississippi River north of the Lake McKellar area. The blue sucker has not been observed and is not thought to occur in the Nonconnah Creek area (Dan Eagar, Tennessee Heritage Program, Department of Conservation, telephone conversation with Robert Cushman, Oak Ridge National Laboratory, Oct. 19, 1979). No aquatic species considered endangered, threatened, or otherwise of concern by State authorities are known to be present in the Lake McKellar vicinity (Paul Somers, Tennessee Heritage Program, Department of Conservation, letter to Kurt Philipp, Roy Weston Company, Oct. 26, 1979).

### 3.2.5 Geology and soils

The Rivergate site is near the eastern edge of the Mississippi River floodplain and is underlain by approximately 30 to 38 m (100 to 125 ft) of alluvium. Bedrock geology is essentially the same as that beneath the Allen site. The Rivergate location is close to both the center of the draw-down area of the 500-ft sand and the area in Nonconnah Creek in which there is a possible hydrologic connection between the alluvium and the aquifer. The site is nearly centered over the deeply eroded channel of ancestral Nonconnah Creek.

Subsurface information for the Rivergate site indicates that the site fill emplacement was uncontrolled and that lenses of silt and clay underlie some portions of the site (see Appendix C.8). Site development would require preconsolidation of compactible zones to limit differential settlement. Portions of the fill that cannot be compacted to improve geotechnical properties may require excavation and replacement with stable fill materials. The site is located in seismic risk zone 3.

Liquefaction of fine sands or silts or loss of bearing capacity could occur in the event of a major earthquake in the region. Soils beneath the fill are gravel, sands, silts, and clays of the combined Mississippi River and Nonconnah Creek alluvium. Soils beneath the fill are saturated, and groundwater seeps containing iron oxides occur along the riverbanks. Sand and gravel forming the fill are erodable, as are evidenced by gullies on the side of the embankment.

### 3.2.6 Land use

The Rivergate site, a tract of approximately 65 ha (160 acres), is located south of downtown Memphis in Shelby County, Tennessee (Fig. 2.5). South of Nonconnah Creek, the site is adjacent to Lake McKellar. The site lies on the floodplains of the Mississippi River and Nonconnah Creek and is covered by a dredged fill, which raises the site above the 100-year-flood stage. A barge canal borders the site on the south and east sides. Site topography is generally flat, although slopes on the sides of the fill are moderately steep. Surface runoff drains directly into Lake McKellar and the barge canal.

The Rivergate Industrial Complex has been developed for the use of approximately 60 small commercial or industrial establishments. The site has been filled to above flood level, and infrastructure is being completed. The Rivergate site is 0.6 km (1 mile) northeast of Fuller State Park and south of Nonconnah Creek, near the Delta Refining Company's oil refinery.

Except for power line rights-of-way, the site is not currently being used for industrial or other purposes. Nearby users include heavy industry (Delta refinery), transportation (Interstate 55 and Illinois Central Railroad facilities), and cultural and recreational facilities (Martin Luther King Park).

The Rivergate site has been developed as an industrial park, but no industries occupy the site. Active industrial, commercial, recreational, and residential areas are found within 1 km of the site. The nearest agricultural area is approximately 4 km to the northwest on Presidents Island.

### 3.2.7 Terrestrial ecology

The site consists of Mississippi River floodplain that has been filled with dredge spoil. The vegetation is early successional, ranging from bare, recently deposited spoil to late old field vegetation with small trees. A remnant of highly disturbed floodplain forest bounds the site along Lake McKellar and Nonconnah Creek. The site is used by field sparrows, voles, and other common old field species.

The only significant area of natural vegetation near the site is the mature floodplain forest on Treasure Island. None of the endangered or threatened species listed in Table 3.11 as occurring in the area are likely to make significant use of the Rivergate site. The six-lined racerunner, a State "special-concern species," may have colonized the site in the few years since it was filled.

### 3.2.8 Economic, social, and cultural features

The Rivergate site is located in Memphis, Tennessee, near the proposed site. Except for a different proximity to the T. O. Fuller State Park and slightly different road access, the economic, social, and cultural settings are the same as those for the proposed site.

### 3.3 ALTERNATIVE SITE NO. 2 — PIDGEON, SHELBY COUNTY, TENNESSEE

#### 3.3.1 Meteorology and air quality

Because the Pidgeon alternative site is in the same general area as the proposed site, its climate and meteorology are similar to those of the proposed site (Sect. 3.1.1). The air quality is generally similar, the two sites being approximately the same distance from major emitting facilities (Figs. 2.5 and 3.1), such as the Allen Generating Plant. The Pidgeon site is not as close to the Presidents Island nonattainment area as is the proposed site, which could result in fewer problems in receiving a Prevention of Significant Deterioration (PSD) Permit to operate the facility.

#### 3.3.2 Hydrology

##### 3.3.2.1 Surface water

The Pidgeon Industrial Park lies within an area protected by flood control levees. The levee system was designed to contain river flows that would be produced by a hypothetical series of three storms affecting the upstream portions of the Mississippi and Ohio river watersheds in rapid succession<sup>23</sup> (personal communication, Bill Martin, Memphis District, Corps of Engineers, to R. H. Ketelle, April 1980). The frequency of occurrence of a flood of this magnitude has not been assessed, but the recurrence interval of such an event is estimated to be less frequent than once in 500 years (personal communication, Bill Martin, Memphis District, Corps of Engineers, to R. H. Ketelle, April 1980). Crest elevation of the levee surrounding the Ensley bottom, where the Pidgeon Industrial Park is located, ranges from 72.6 m (236 ft) to 73.2 m (238 ft). Surface runoff within the leveed area flows southeast into Horn Lake Cutoff from which it flows by gravity during low-water conditions or is pumped over the levee during high river flow conditions. The hazard of site flooding is minimal due to levee protection.

Site development requires construction of a barge terminal either in the Mississippi River or in Lake McKellar, with a conveyor to transport coal to the site. These facilities would lie wholly or partly in the Mississippi River floodway.

##### 3.3.2.2 Groundwater

No site-specific data on groundwater hydrology or water quality are available for the Pidgeon site. The Pidgeon site, located on the alluvial deposits of the Mississippi River, is underlain by interbedded river sands that contain the alluvial aquifer. The thickness of the alluvium is not precisely known; however, contouring of the eroded tertiary surface by Krinitzky and Wire indicates that the alluvium should be of approximately the same thickness as that at the Allen and Rivergate sites. Alluvial deposits partially fill the incised Mississippi valley, covering the eroded surface of the Jackson formation. The sequence of bedrock beneath all three sites is the same, and the aquifers contained in the Memphis sand and Fort Pillow sand (500-ft and 1400-ft sands) are presumed to underlie all three sites. The quality of groundwater encountered in aquifers beneath the Pidgeon site is expected to be similar to water quality in other wells in the Memphis area. Water quality of alluvial and bedrock aquifers in the Memphis area is discussed in Sect. 3.1.3.2 and in Appendix B.2.2.

#### 3.3.3 Water quality

The aquatic environments that could be affected by construction of the MLGW plant at the Pidgeon site include (1) the Mississippi River, where the barge unloading dock and effluent discharge structure might be located (at approximately River Mile 724.5), (2) Lake McKellar, where the gas pipeline would cross, and (3) the barge turning basin near the Allen Generating Plant (a possibility if the MLGW barge unloading dock were located there).

No data regarding water quality are available for the Mississippi River adjacent to the Pidgeon site. However, water quality here should be similar to that at the proposed site (Table 3.6 and Sect. 3.1.3). The river's water quality near the Pidgeon site is slightly altered by the discharge of treated effluent from the Maxson Wastewater Treatment Facility, approximately 1 km upstream. Under most flow conditions the Maxson Wastewater Treatment Facility effluent is probably fully mixed within 1 km downstream of the discharge canal. The facility's design effluent flow [3.5 m<sup>3</sup>/s (80 Mgd)] receives 3000-fold dilution in the Mississippi River's average flow of 10,200 m<sup>3</sup>/s. Low-flow conditions at Memphis are 2600 m<sup>3</sup>/s (the 3-d, 20-year low flow), and these provide 750-fold dilution of the facility's discharge. In addition, this discharge might be expected to stay near the Mississippi's eastern shore. Thus, under low-flow conditions, the Mississippi River adjacent to the Pidgeon site might be within the mixing zone for the discharge. Since the performance of the Maxson Wastewater Treatment Facility is variable (due to slugs of toxic industrial sewage), it seems likely that water quality adjacent to the Pidgeon site is somewhat variable.

Lake McKellar's water quality in the barge turning basin and at the proposed gas pipeline crossing is described in Sect. 3.1.3.

### 3.3.4 Aquatic ecology

Although no sampling of aquatic biota has taken place in the Mississippi River adjacent to the Pidgeon site, conditions there should be similar to those at station MR2, sampled in connection with the proposed site. As noted in Sect. 3.1.4, organisms found in this part of the Mississippi are those adapted to strong currents, much scouring of the river bottom, and relatively poor water quality, especially high turbidity. Based on morphology of the channel, the river's eastern shore near the Pidgeon site probably receives intense scouring (Sect. 3.1.2). Site-specific monitoring would be required to determine if discharge from the Maxson Wastewater Treatment Facility affects aquatic organisms near the Pidgeon site.

Lake McKellar's aquatic communities in the barge turning basin and at the proposed pipeline crossing are described in Sect. 3.1.4.

### 3.3.5 Geology and soils

#### 3.3.5.1 Geology

The Pidgeon site is underlain by alluvial materials similar to those encountered on the Allen site. The existing site topography over most of the site is nearly flat; elevations range from about 64 m (210 ft) to slightly above 66 m (215 ft). The western edge of the site is bounded by a flood control levee, with crest elevations of about 72.6 m (236 ft). Surface drainage from the site is southeast to the Horn Lake Cutoff. The Pidgeon Industrial Park, lying south of the Allen site, is underlain by the same sequence of interbedded sands, silts, and clays, capped by the Jackson formation. The Memphis sand and the Fort Pillow sand (500-ft and 1400-ft sands respectively), which contain potable aquifers, underlie the site. The Pidgeon site, like the Allen and Rivergate sites, lies in seismic risk zone 3, in which slight damage would be incurred to specially designed structures, with more extensive damage to less well-designed buildings. Foundation conditions on the site (relative density and particle-size distribution of alluvium) are unknown because no subsurface investigations have been performed to date.

#### 3.3.5.2 Soils

Soils mapped on the Pidgeon site include Commerce silt loam, Robinsonville fine sandy loam, Tunica silty clay, and levee and borrow pit soils. The coal conveyor easement crosses these soil types plus small areas of Bowdre silty clay and Crevasse silty loam. These floodplain soils have formed on the accumulated silt, sand, and gravel deposits of the Mississippi River along with the finer grained sediment deposited by floodwaters. Soils inside the levee are used primarily for agriculture. A list of the site soils and their classification by capability unit follows:

| <u>Soil type</u>         | <u>Capability unit</u> | <u>Prime agricultural soil</u> |
|--------------------------|------------------------|--------------------------------|
| Bowdre silty clay        | IIw-1                  | Yes                            |
| Commerce silty loam      | I-2                    | Yes                            |
| Crevasse silty loam      | IVs-1                  | No                             |
| Levees and borrow pits   | VIe-3                  | No                             |
| Robinsonville silty loam | I-1                    | Yes                            |
| Tunica silty clay        | IIIw-3                 | Yes                            |

#### 3.3.6 Land use

The Pidgeon site (Fig. 2.6) is prime farmland (Appendix B.3.2) and is currently used for soybean production. The site is zoned for heavy industrial uses and is part of the Frank C. Pidgeon Industrial Park. The site has existing levees and would require fill to the project flood level and access road preparation. Rail access to the site is planned by the Pidgeon Industrial Park from the Illinois Gulf Central Railroad.

Adjoining and nearby land uses are virtually the same as for the proposed site and include the TVA Allen Generating Plant, the municipal sewage treatment plant, Fuller State Park, and the Chucalissa Indian Village.

### 3.3.7 Terrestrial ecology

The Pidgeon site consists entirely of soybean fields. Large soybean fields support very little wildlife and are thus unimportant as wildlife habitat. However, land on this site is very productive, and, in the absence of intense agriculture, could be excellent wildlife habitat. Just west of this site is a mature floodplain forest, which contains large trees and appears to be suitable nesting habitat for the Mississippi kite, although it is not known with certainty that the kite nests in this forest. The kite is listed by the state of Tennessee as endangered. This forest also appears to be suitable habitat for the swamp rabbit, which is listed by Tennessee as in need of special management because of its status as an uncommon and declining species. A large number of other animal species probably use this forest, although a census has not been conducted.

### 3.3.8 Economic, social, and cultural features

The Pidgeon site is located in the Frank C. Pidgeon Industrial Park immediately south of the proposed Allen site. The Pidgeon site would use the same access road (Mitchell Road) as the proposed site, and the economic, social, and cultural settings are the same as for the proposed site. The Pidgeon site is zoned for heavy industrial use. The site would be visible from the Chucalissa Indian Village and the T. O. Fuller State Park.

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#### 4. ENVIRONMENTAL CONSEQUENCES

##### 4.1 PROPOSED SITE

###### 4.1.1 Air quality and noise

###### 4.1.1.1 Construction impacts

Potential air quality impacts associated with plant construction include vehicle and construction equipment exhaust emissions and fugitive dust emissions during earth-moving operations.

Motor vehicles and construction equipment emit oxides of nitrogen and of carbon, hydrocarbons, particulates, and minor amounts of oxides of sulfur. By using estimates for (1) numbers and use of construction vehicles and equipment and (2) emission factors for the various machines,<sup>1</sup> emissions of 54.1 kg/s (214.7 t/year) of oxides of nitrogen, 2.2 kg/s (8.9 t/year) of particulates, 11.0 kg/s (43.7 t/year) of carbon monoxide (CO), and 2.7 kg/s (10.7 t/year) of hydrocarbons are predicted during construction. By use of a simple dispersion equation recommended for area sources<sup>2</sup> and conservative estimates of annual meteorology, ground-level concentrations of these pollutants from construction vehicles at the nearest point on Presidents Island were estimated. Annual concentrations of 13.7  $\mu\text{g}/\text{m}^3$ , 0.6  $\mu\text{g}/\text{m}^3$ , 2.8  $\mu\text{g}/\text{m}^3$ , and 0.7  $\mu\text{g}/\text{m}^3$  of oxides of nitrogen, total suspended particulates (TSP), CO, and hydrocarbons, respectively, are predicted. These concentrations will depend on meteorological conditions, construction schedules, vehicle maintenance, and the fuel used. All of these predicted concentrations, including when added to measured values, are below the ambient air quality standards.

Fugitive dust emissions resulting from earth-moving activities are difficult to estimate. Emissions depend on soil type, soil moisture, earth-moving activities, and wind speeds. Dredged materials are likely to be moist and to reduce dusting potential. If the fill material becomes dry and is disturbed, uncontrolled dust emissions from the proposed project area could result in increased ground-level concentrations of TSP at Presidents Island. By keeping the fill dirt wet, either with water or with some form of dust suppressant, the increased TSP concentrations off site resulting from fugitive dust from the proposed project site will be made negligible.

###### Noise

Table 4.1 lists predicted construction noise levels at each of the nine receiver locations. Other than at locations near the plant boundary, construction noises will be inaudible. There will be some increase in duration of noise at Fuller State Park, caused by increased traffic; however, maximum noise levels should not increase over current ambient noise levels. Construction of such offsite facilities as the access road, natural gas pipeline, product gas distribution, and water and wastewater pipelines will produce intermittent maximum sound levels of 80 dB(A) at 15 m (50 ft). Because most of this construction will take place in nonresidential areas, no significant noise impacts are likely. Appendix C.1.2 includes the detailed noise impact analysis.

###### 4.1.1.2 Operational impacts

Increases in ground-level concentrations of various pollutants resulting from operation of the proposed facility were calculated. These increases, when added to the measured ambient levels, reflect the best estimate of the total impact of the proposed facility and all present emission sources. Maximum annual average increases in concentrations of particulates from coal transportation, handling, and storage are estimated to be 0.6  $\mu\text{g}/\text{m}^3$  by using the techniques and data presented in Appendix C.1. Particles blown from coal handling and storage areas are likely to be fairly large and are expected to settle quickly to the ground, usually within 100 m of the facility, during routine meteorological conditions. Such impacts are typical of large coal-using facilities. Strong winds may carry particles well off site, however. Emissions of dust from the coal handling and storage areas will be reduced by the use of (1) dust suppressants, (2) good coal storage practices, and (3) emission-abatement devices at all coal handling points. Proposed methods are given in Table 2.8.



Table 4.1. Predicted construction noise levels

| Receiver location <sup>a</sup> | Description                   | Source-receiver distance |        | Measured average ambient daytime | Construction period noise level of receiver locations <sup>b</sup> (dBA re: 20 $\mu$ N/m <sup>2</sup> ) |    |    |    |    |
|--------------------------------|-------------------------------|--------------------------|--------|----------------------------------|---------------------------------------------------------------------------------------------------------|----|----|----|----|
|                                |                               | m                        | ft     |                                  | 1                                                                                                       | 2  | 3  | 4  | 5  |
| 1                              | Chucalissa Indian Village     | 3,048                    | 10,000 | 54                               | 23                                                                                                      | 24 | 26 | 26 | 23 |
| 2                              | Top of levee                  | 914                      | 3,000  | 53                               | 53                                                                                                      | 54 | 56 | 56 | 53 |
| 3                              | Farm                          | 1,829                    | 6,000  | 49                               | 40                                                                                                      | 41 | 43 | 43 | 40 |
| 4                              | Memphis Harbor project        | 1,829                    | 6,000  | 56                               | 40                                                                                                      | 41 | 43 | 43 | 40 |
| 5                              | Maxson Sewage Treatment Plant | 945                      | 3,100  | 58                               | 53                                                                                                      | 54 | 56 | 56 | 53 |
| 6                              | Eastern Plant boundary        | 549                      | 1,800  | 59                               | 60                                                                                                      | 61 | 63 | 63 | 60 |
| 7                              | Northern Plant boundary       | 335                      | 1,100  | 57                               | 69                                                                                                      | 70 | 72 | 72 | 69 |
| 8                              | Western Plant boundary        | 549                      | 1,800  | 56                               | 60                                                                                                      | 61 | 63 | 63 | 60 |
| 9                              | Southern Plant boundary       | 335                      | 1,100  | 57                               | 69                                                                                                      | 70 | 72 | 72 | 69 |

Source: ER, Table 4-4.

Increases in offsite ground-level concentrations of particulates resulting from the operation of the proposed facility are presented in Table 4.2. These values do not include fugitive coal dust emissions. However, this is the subject of ongoing review as part of the prevention of significant deterioration (PSD) permitting procedure. The increases in TSP concentrations resulting from the operation of the facility are predicted not to violate air quality standards, nor are the increases predicted to hamper future development in the area. Because the predicted TSP values are below EPA-defined significance level for impacts on nonattainment areas, the plant is unlikely to have a measurable effect upon the area.

Table 4.2. Calculated ground-level concentrations of particulate matter caused by operation of the proposed IFGDP

| Applicable averaging time | Highest concentration      |                                     | Second highest concentration |                                     | Measured ambient level (µg/m³) |                | National ambient air quality standard (µg/m³) |           | PSD class II increments (µg/m³) | Maximum PSD increment consumption % |
|---------------------------|----------------------------|-------------------------------------|------------------------------|-------------------------------------|--------------------------------|----------------|-----------------------------------------------|-----------|---------------------------------|-------------------------------------|
|                           | Particulate matter (µg/m³) | Direction/distance from site (°/km) | Particulate matter (µg/m³)   | Direction/distance from site (°/km) | Highest                        | Second highest | Primary                                       | Secondary |                                 |                                     |
|                           |                            |                                     |                              |                                     |                                |                |                                               |           |                                 |                                     |
| 24-h                      | 3<br>(1) <sup>a</sup>      | 360/2<br>40/5                       | 2<br>(0.9)                   | 360/2<br>360/5                      | 175                            | 127            | 260                                           | 150       | 37                              | <5                                  |
| Annual                    | 0.2<br>(0.1) <sup>a</sup>  | 360/2<br>360/5                      | N/A <sup>b</sup><br>N/A      | N/A<br>N/A                          | 58                             | NA             | 75                                            | 60        | 19                              | <1                                  |

<sup>a</sup>Values in parentheses are for the maximum operating case. The maximum operating case, because of the higher exit temperature and exit velocity for the stack gas scrubber, results in lower ground-level pollutant concentrations than the normal operating case.

<sup>b</sup>N/A, not applicable.

Source: ER, p. 4-70.

The maximum TSP impact of the proposed IFGDP will occur towards Presidents Island, but areas now attaining TSP standards will experience smaller impacts. All those locations, PSD increments for TSP will be consumed as shown in Table 4.2.

Increased offsite concentrations of sulfur resulting from the operation of the proposed facility are presented in Table 4.3. Isopleths of increased sulfur dioxide concentrations around the proposed plant site are presented in Figs. 4.1-4.3. These predicted concentrations will not violate air quality standards. During unusual conditions, such as emergency venting, emissions will be greater, and short-term ground-level concentrations could be higher. These higher concentrations cannot be predicted with accuracy because they will depend on the nature of the release, the meteorological conditions, the ambient air quality at the time of the release, and the duration of the release. Were the upset to occur during worst-case (poorest dispersion) meteorological conditions, increases in 3-h concentrations of sulfur dioxide exceeding 200  $\mu$ g/m<sup>3</sup> could occur off site. These high concentrations, predicted with the assumptions detailed in Appendix C.1.1, would occur for approximately 3 h and would be expected to peak approximately 1.6 km off site, with concentrations decreasing rapidly with downwind distance from that point.

Increases in offsite ground-level concentrations of nitrogen dioxide are estimated from routine plant operations. Because oxides of nitrogen are reactive gases, resultant concentrations are difficult to predict with accuracy. In this study, concentrations of all oxides of nitrogen were

Table 4.3. Calculated ground-level concentrations of sulfur dioxide caused by operation of the proposed IFGDP

| Applicable averaging time | Highest concentration   |                                     | Second highest concentration         |                                      | Measured ambient level (µg/m³) |                | National ambient air quality standard (µg/m³) |                  | PSD class II increments (µg/m³) | Maximum PSD increment consumption % |
|---------------------------|-------------------------|-------------------------------------|--------------------------------------|--------------------------------------|--------------------------------|----------------|-----------------------------------------------|------------------|---------------------------------|-------------------------------------|
|                           | SO <sub>2</sub> (µg/m³) | Direction/distance from site (°/km) | SO <sub>2</sub> (µg/m³)              | Direction/distance from site (°/km)  | Highest                        | Second highest | Primary                                       | Secondary        |                                 |                                     |
|                           |                         |                                     |                                      |                                      |                                |                |                                               |                  |                                 |                                     |
| 3-h                       | 85<br>(32) <sup>b</sup> | 270 (0.9)<br>33 (1.0)               | 64<br>(27) <sup>b</sup>              | 40/1<br>240/1                        | 523                            | 505            | N/A <sup>a</sup>                              | 1300             | 512                             | 13                                  |
| 24-h                      | 24<br>(13) <sup>b</sup> | 360 (2.0)<br>360 (3.0)              | 20<br>(9) <sup>b</sup>               | 360/2<br>360/5                       | 214                            | 193            | 365                                           | N/A <sup>a</sup> | 91                              | 22                                  |
| Annual                    | 2<br>(1) <sup>b</sup>   | 360 (1.7)<br>360 (4.0)              | N/A <sup>a</sup><br>N/A <sup>a</sup> | N/A <sup>a</sup><br>N/A <sup>a</sup> | 34                             | NA             | 80                                            | N/A <sup>a</sup> | 20                              | 10                                  |

<sup>a</sup>N/A, not applicable.

<sup>b</sup>Values in parentheses are for the maximum operating case. The maximum operating case, because of the higher exit temperature and exit velocity for the stack gas scrubber, results in lower ground-level pollutant concentrations than the normal operating case.

Source: MLGW PSD application.

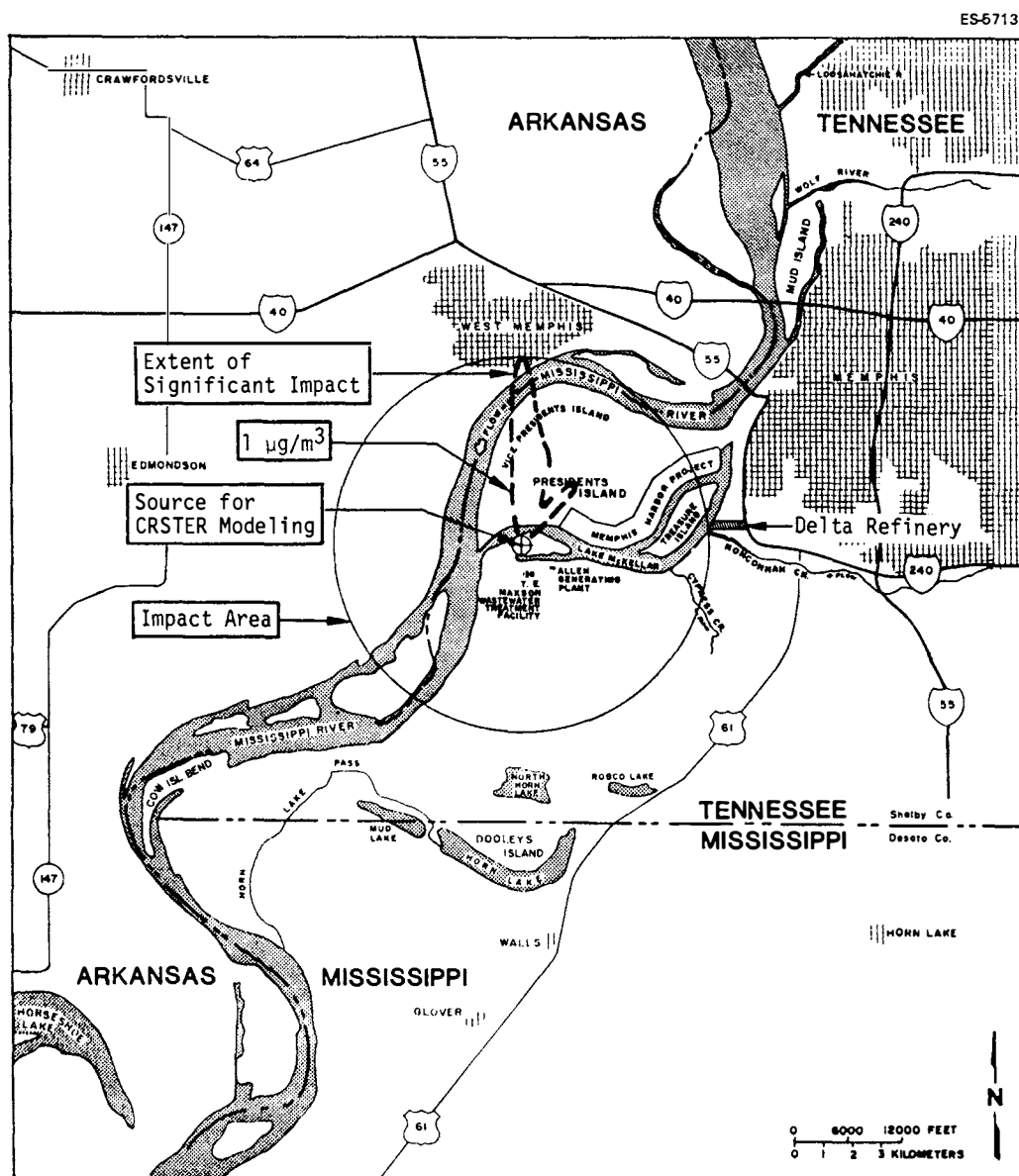


Fig. 4.1. Isopleth of annual extent of significant  $\text{SO}_2$  impact (1  $\mu\text{g}/\text{m}^3$ ) and impact area. Source: MLGW PSD application.

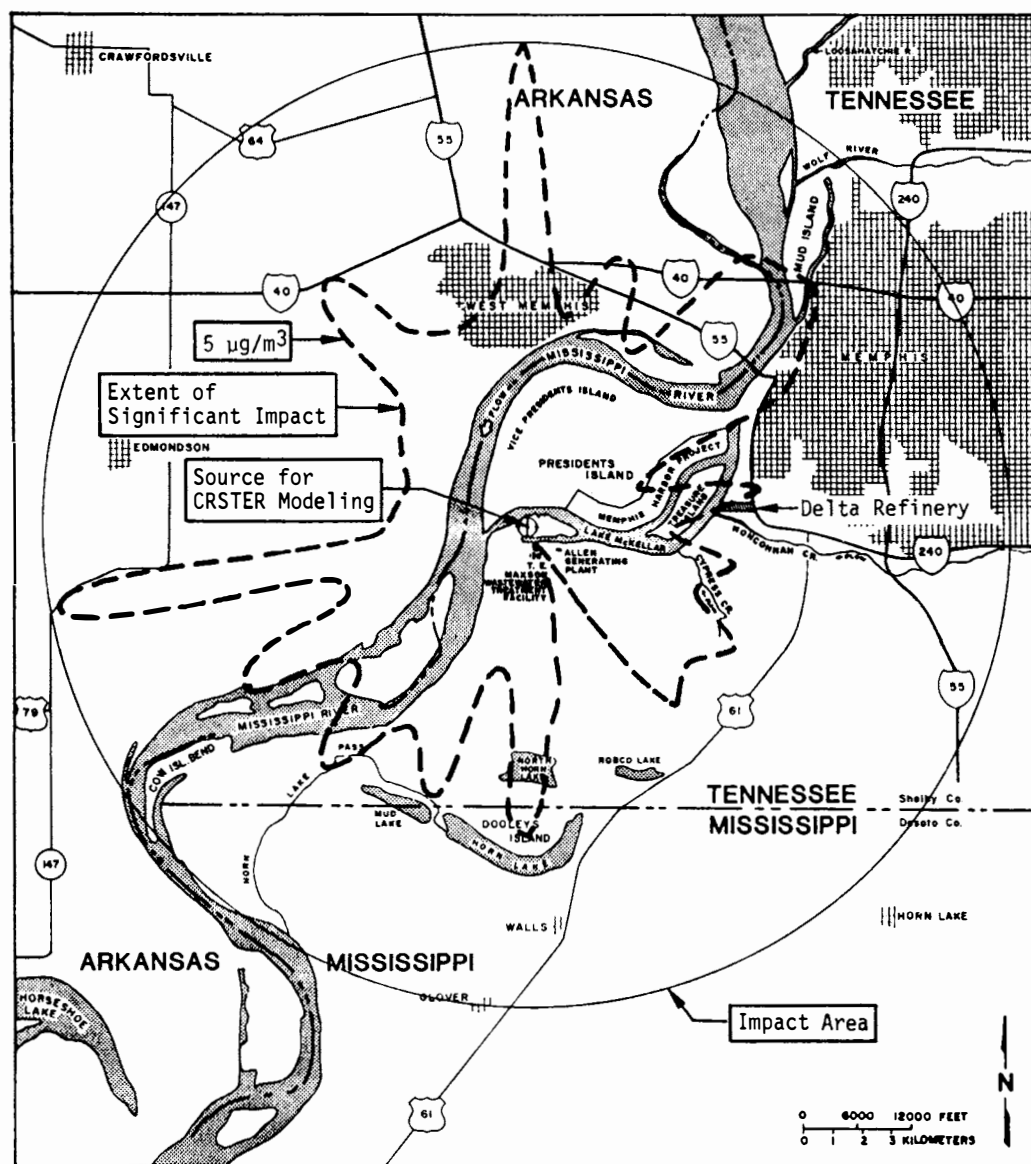


Fig. 4.2. Isopleth of 24-h extent of significant  $\text{SO}_2$  impact ( $5 \mu\text{g}/\text{m}^3$ ) and impact area. Source: MLGW PSD application.

calculated as nitrogen dioxide. This approach should overpredict nitrogen dioxide concentrations and should overemphasize the impact of plant operations. Predicted maximum annual average nitrogen dioxide concentrations are  $2 \mu\text{g}/\text{m}^3$  and represent approximately 2% of the applicable standard. Concentrations of CO, another reactive gas, are estimated by using a similar technique, ignoring CO-removing reactions. Predicted CO levels, applicable standards, and significant concentrations are presented in Table 4.4. Predicted CO concentrations are below the EPA-defined significance level for impact on nonattainment areas. Hydrocarbon emissions resulting from routine plant operation will be minimal (approximately  $0.007 \text{ kg/s}$ ). Unplanned, nonroutine emissions from the proposed facility will occur. These fugitive emissions are not currently quantifiable with great confidence but could release quantities of sulfur dioxide, dust, and hydrocarbons into the atmosphere. Preliminary estimates of  $\text{SO}_2$  concentrations assuming worst-case meteorological conditions are less than the 3 h National Ambient Air Quality Standard (NAAQS) for  $\text{SO}_2$ . Other pollutants cannot be estimated at this time.

The most severe upset conditions would be flare failure. Should this occur, raw product gas rich in  $H_2S$  would be emitted to the atmosphere, possibly resulting in potentially fatal concentrations up to several miles off site. Such a condition would require immediate correction or plant shutdown. Design provisions exist to minimize the probability of flare failure to less than once in 100,000 years (Sect. 2.2.1.18). This potential problem will be addressed in detail in the Safety Analysis Report.

Operation of the cooling towers will produce fog and will deposit droplets of circulating water (drift) onto the surrounding areas. Properly sized, maintained, and operated mechanical-draft cooling towers cause no significantly increased fogging.<sup>4</sup> The elevated plume will be visible, extending downwind of the cooling towers and usually dissipating before passing over the site boundaries. The plume may increase fog on Lake McKellar and the Mississippi River but would only do so during those periods in which naturally occurring fog is likely. Drift deposition, as calculated by the model developed by Roffman and Grimbale, is predicted to be a maximum of 0.6 g/ha per day, occurring 300 m downwind of the towers. Chromate, a corrosion inhibitor added to the circulating water, is estimated to be deposited at a rate of 0.03 g/ha per day. Over the anticipated 20-year life of the plant, the maximum salt deposition is anticipated to be 4.0 kg/ha, and the maximum chromate deposition is predicted to be 0.2 kg/ha.

If the cooling water becomes contaminated with plant effluents (Sect. 2.2.1.5), these effluents could be emitted from the cooling towers. Emission and deposition rates of plant effluents should be small compared with the normal drift deposition rates and the resulting impacts are predicted to be minimal. These plant effluent emission and deposition rates cannot be predicted, but careful monitoring of the cooling water will reduce the total emissions by allowing the quick detection of contamination and the isolation of the faulty heat exchanger so that proper repair measures can be taken (Sect. 2.2.1.11).

Emissions of  $SO_2$  and  $NO_x$  into the atmosphere will result in increased levels of sulfate and nitrate particles downwind of the source. These particles may be transported hundreds of kilometers before being removed. When these particles contact water, the pH of the water will be reduced, and the resulting precipitation will be acidified. Techniques for accurately predicting this phenomenon are not routinely available. However, the  $SO_2$  and  $NO_x$  emissions from the MLGW facility are small, representing an insignificant fraction of the regional total emissions of  $SO_2$  and  $NO_x$ . The impact of the MLGW facility on the precipitation of the region and of the nation is anticipated to be minor and undetectable.

Emissions of  $SO_2$ ,  $NO_x$ , and particles into the atmosphere will result in increased levels of sulfate, nitrate, and other particles downwind of the source. These pollutants may affect the visibility in areas many kilometers downwind. The impact of the operation of the proposed facility on class I PSD areas such as Mammoth Cave, Kentucky, and Mingo, Missouri, is predicted to be minor and undetectable. Further analysis will be conducted by EPA, the Memphis-Shelby County Health Department, and the Federal land managers of the potentially affected class I areas before a PSD permit can be issued.

## Noise

Noise generated during plant operation will have a negligible impact on surrounding areas. Table 4.5 lists predicted operation noise levels at the nine receiver locations and the current ambient sound levels. Figure 4.4 shows the noise receiver locations. Plant associated noises will be essentially inaudible at public-use areas (Chucalissa Indian Village) and at the closest residence. Maximum noise levels anywhere on the plant boundary will be about 70 dBA. All vendor-supplied equipment will meet the Occupational Safety and Health Administration (OSHA) requirements for 90 dBA maximum worker exposure for an 8-h day.

There are no existing State or local noise regulations that would affect the proposed plant. The plant would be essentially within recognized noise guidelines for a heavy industrial area at the plant boundaries<sup>5</sup> and is away from noise-sensitive locations.

Additionally, the plant-generated noise at public-use and residential areas would be less than the levels at which there is no reason to suspect that the general population would be at risk from, or even annoyed by, the noise.<sup>6</sup>

## 4.1.2 Hydrology

### 4.1.2.1 Construction impacts

#### Surface water

As discussed in Sect. 3.1.2, the site is located within the Mississippi River floodplain. Under existing conditions, portions of the site would be inundated by as much as 8 m (25 ft) of water

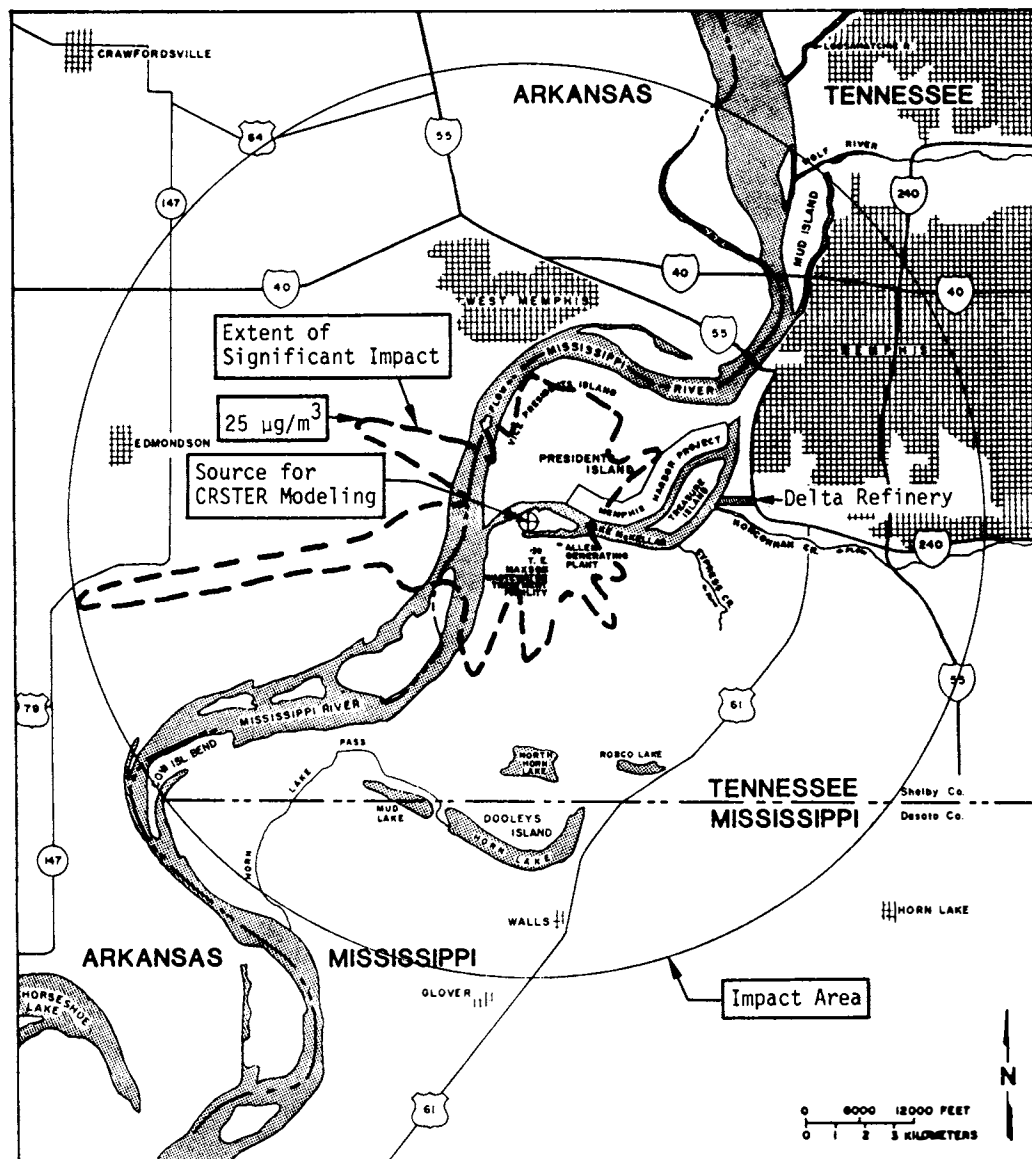


Fig. 4.3. Isopleth of 3-h extent of significant  $\text{SO}_2$  impact ( $25 \mu\text{g}/\text{m}^3$ ) and impact area. Source: MLGW PSD application.

Table 4.4. Calculated ground-level concentrations of carbon monoxide caused by operation of the proposed IFGDP

| Applicable<br>average<br>time | Highest concentration      |                                           | Measured<br>ambient<br>levels<br>(µg/m <sup>3</sup> ) |                   | National ambient<br>air quality<br>standard (µg/m <sup>3</sup> ) |           | PSD class II<br>increments<br>(µg/m <sup>3</sup> ) | Significant<br>level<br>(µg/m <sup>3</sup> ) |
|-------------------------------|----------------------------|-------------------------------------------|-------------------------------------------------------|-------------------|------------------------------------------------------------------|-----------|----------------------------------------------------|----------------------------------------------|
|                               | CO<br>(µg/m <sup>3</sup> ) | Direction/distance<br>from site<br>(°/km) |                                                       |                   | Primary                                                          | Secondary |                                                    |                                              |
|                               |                            |                                           |                                                       |                   |                                                                  |           |                                                    |                                              |
|                               |                            |                                           | Highest                                               | Second<br>highest |                                                                  |           |                                                    |                                              |
| 1-h                           | 60<br>60 <sup>b</sup>      | 290 (0.5)<br>290 (0.5)                    | 6800                                                  | 4500              | 40,000                                                           | 40,000    | N/A <sup>a</sup>                                   | 2000                                         |
| 8-h                           | 35<br>35 <sup>b</sup>      | 240/0.5<br>240/0.5                        | 4800                                                  | 3113              | 10,000                                                           | 10,000    | N/A <sup>a</sup>                                   | 500                                          |

<sup>a</sup> N/A, not applicable.

<sup>b</sup> Values in parentheses are for the maximum operating case. The maximum operating case, because of the higher exit temperature and exit velocity for the stack gas scrubber, results in lower ground-level pollutant concentrations than the normal operating case.

Source: ER, p. 4-69.

Table 4.5. Predicted plant operational noise levels

| Receiver location <sup>a</sup> | Description                   | Distance from source |        | Noise level (dBA re: 20 $\mu$ N/m <sup>2</sup> ) |                  |       |
|--------------------------------|-------------------------------|----------------------|--------|--------------------------------------------------|------------------|-------|
|                                |                               | m                    | ft     | Predicted from plant operation                   | Measured ambient |       |
|                                |                               |                      |        |                                                  | Day              | Night |
| 1                              | Chucalissa Indian Village     | 3,048                | 10,000 | 36                                               | 54               | 56    |
| 2                              | Top of levee                  | 914                  | 3,000  | 56                                               | 53               | 53    |
| 3                              | Farm                          | 1,829                | 6,000  | 46                                               | 49               | 51    |
| 4                              | Memphis Harbor project        | 1,829                | 6,000  | 46                                               | 56               | 43    |
| 5                              | Maxson Sewage Treatment Plant | 945                  | 3,100  | 56                                               | 58               | 60    |
| 6                              | Eastern Plant boundary        | 549                  | 1,800  | 62                                               | 59               | 76    |
| 7                              | Northern Plant boundary       | 335                  | 1,100  | 70                                               | 57               | 63    |
| 8                              | Western Plant boundary        | 549                  | 1,800  | 62                                               | 56               | 59    |
| 9                              | Southern Plant boundary       | 335                  | 1,100  | 70                                               | 67               | 58    |

<sup>a</sup>Receiver locations are shown in Fig. 4.4.

Source: ER, Table 4-20.

by the 100-year flood. The site will be filled to an elevation of 69 to 71 m (227 to 233 ft) in order to provide an area above flood elevation on which to build the facility. Portions of the site will require more than 9 m (30 ft) of fill.<sup>7</sup> Should a major flood occur during the filling operation, the potential impact would be to wash away the fill and destroy the work completed before the flood. Sediment loads to Lake McKellar and the Mississippi River would be greatly increased as the fill material is washed away.

To offset the possibility of such an event occurring, the dredge and fill operation will be scheduled, to the extent practicable, during periods that, historically, have a minimum risk of flooding. Although major flooding can occur at any time, the months from August to November typically have less frequent flooding. The dredge and fill operation will be completed in about 250 d, using the best dredge and fill technology available to minimize the potential for loss of fill by flooding. It is recommended that filling begin during the low-water season. This will permit filling of the site to above the annual flood level before the high-flow season. The source of fill material will be the Mississippi River. The volume of fill required would be equivalent to the volume of a pit measuring 800 x 200 x 29 m.

Water used to transport the dredged river sediment to the site will be discharged to Lake McKellar. A weir will be used to control the discharge. Sediment-size classification of Mississippi River bottom sediment from a potential borrow area (see Appendix C.5) indicates that less than 5% of the sediment is of silt or clay size. Silt- and clay-sized particles remain in suspension longer than do sand-sized particles and contribute to suspended load and turbidity. Discharge from the site-filling operation is expected to increase turbidity in Lake McKellar. Potential impacts on the aquatic ecosystem are discussed in Sects. 4.1.3 and 4.1.4. In compliance with Sect. 404 of the Clean Water Act, a permit for the dredge and fill operations will be obtained before the project begins.

Once the site is filled to design elevation, it will become a man-made peninsula, bound by the Mississippi River during flooding situations, and will obstruct flood flows and alter existing flow patterns. Encroachment on the floodplain by the fill required for the site reduces the flood-carrying capacity, increases the flood heights, and increases flood hazards in areas beyond the encroachment itself.

To determine the severity of the increased flood hazard, the U.S. Army Corps of Engineers, Memphis District, was asked to model the effect of the fill on the flooding characteristics of the Mississippi River for the area adjacent to the site. Mathematical models were used to predict the effects but gave conflicting results. Therefore, the physical model of the Mississippi River, the Mississippi Basin Model, located in Clinton, Mississippi, was used to predict flood heights with the fill in place. This model, built to scale and calibrated to historical events, represents the best methodology available for predicting flood elevations on the Mississippi River. The only areas affected by the proposed site development will be along the east-west portion of the Ensley Levee, the north bank of Lake McKellar adjacent to Presidents Island, and the east bank of the Mississippi River. The flow line along this portion of the levee would be raised as much as 0.2 m (0.7 ft) for the project design flood. With this rise in flow line, 0.9 m (3 ft) of levee freeboard would still be available, except for one short reach where it would be slightly less (Appendix C.2.1). The project design flood was used to design

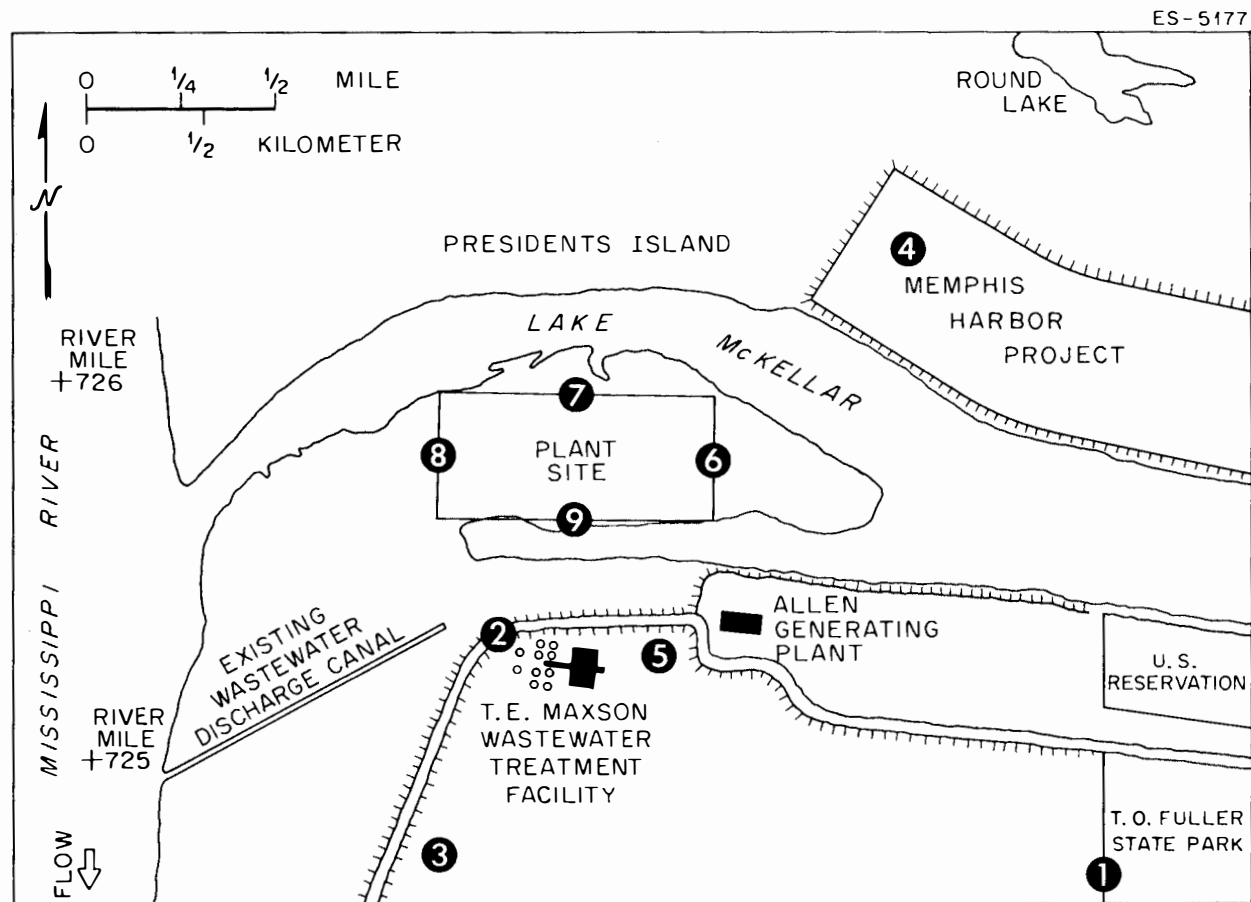


Fig. 4.4. Sound level measurement locations. Source: Modified from ER, Fig. 3-33, p. 3-160.

the Ensley Levee. Although the hydrological impact would be minor, it is unavoidable because of the location of the MLGW site.

#### Groundwater

The construction impacts on groundwater are (1) the effect of groundwater flooding on site preparation and construction, (2) groundwater use during construction, and (3) seepage of runoff.

Currently, groundwater levels below the site are shallow and rise and fall with changing water levels in Lake McKellar. During construction, prior to application of the fill, a rise in water level in Lake McKellar could cause groundwater flooding of the site and result in construction delays.

The shallow water table will lengthen the time required to dewater the dredge material to be placed on site, by preventing loss of water through vertical percolation. In addition, during periods of high water level in the lake (above current elevation), groundwater levels would be expected to rise into the dredge material and further impede the dewatering process. Because of the interaction between the onsite groundwater and Lake McKellar, dewatering would not seem practical unless a grout curtain or other impermeable barrier were installed between the construction area and Lake McKellar.

Maximum groundwater use during construction will be 53.2 m<sup>3</sup>/d (14,000 gpd). This will be supplied by the city of Memphis from existing well fields and will have no impact on the aquifer or on other users. This water use represents 0.01% of the current water supply capacity.

During the construction period, runoff water will be stored in the unlined settling pond. There will be some seepage from this pond. In addition, there will be infiltration from storage areas for construction materials and equipment. Seepage will enter the alluvial aquifer and eventually will discharge into Lake McKellar. Results of elutriate testing of Mississippi River sediment obtained from a potential borrow area indicate that infiltration of water used for transport of the dredge material should cause no adverse impact on groundwater quality under normal conditions.

#### 4.1.2.2 Operational impacts

##### Surface water

Operational impacts on surface water hydrology consist of slight increases in flood elevations along the southern edge and near the mouth of Lake McKellar. Construction activities are planned to raise the general elevation of process and support areas to 71 m (233 ft) above mean sea level; the elevation of the project design flood is 70.96 m (232.8 ft). This will effectively raise the site above the maximum flood elevation. Formation of this fill will affect the discharge of floodwaters from Lake McKellar and will raise the elevation of floodwaters for the project design flood a maximum of 0.22 m (0.7 ft) along the Ensley Levee on the south bank of Lake McKellar. Flood levels will be raised a lesser amount along the north bank of Lake McKellar, adjacent to Presidents Island and along the east bank of the Mississippi River (see Appendix C.2.1). This impact is unavoidable and will persist as long as the postconstruction floodplain configuration remains unaltered. Flooding of the site should not be a factor after the fill is constructed. The elevation of the 100-year flood is 69.2 m (224.9 ft), and the elevation of the project design flood is 70.96 m (232.8 ft). Process areas are to be constructed at an elevation of 71 m (233 ft).

##### Groundwater

Under normal operating conditions, no adverse impacts on groundwater are anticipated. Areas of the facility which have the potential for endangering groundwater quality include coal storage areas, wastewater handling areas, and the solid waste landfills. Though this aquifer is not used for drinking water, the design of these areas includes the use of liner materials to isolate, to the best possible extent, liquid wastes from the soil-groundwater environment. The critical factor in liner stability is that the liner be installed in such a manner as to minimize deforming stresses. In the case of the coal storage areas, there will be cyclic loading conditions on the liner due to use and replenishment of the coal supply. The liner will consist of a synthetic membrane overlain and underlain by permeable sand, with a leachate interception drain beneath it (Fig. 2.4, Sect. 2.2.18). The soil and fill material beneath the coal storage area will be thoroughly compacted to minimize settlement, which would weaken the liner and contribute to its deterioration. Coal pile leachate is discussed in Appendix C.3.2. Leaching tests on gasifier wastes (using the EPA extraction procedure) indicate that the waste will not be classified as a hazardous waste according to criteria included in the regulations of the Resource Conservation and Recovery Act (RCRA). In addition to gasifier ash, sludges from the wastewater treatment and



from gas desulfurization, bottom ash, fly ash, spent catalysts, and chromate sludge will be landfilled. The leachability of wastewater sludges is currently untested. These wastewater sludges will be tested during the Institute of Gas Technology (IGT) pilot plant run to be held in the spring of 1981. Should these tests indicate that the wastewater sludges are hazardous, they will be trucked off site within 90 d to an EPA-approved disposal facility such as "Chemical Waste Management of Alabama" located near Livingston, Alabama, approximately 270 miles from Memphis. Leachates derived from desulfurization sludges are high in dissolved solids that have high sulfite content. In the event that a leak should occur in a liner beneath coal or waste storage areas, the underliner drain would serve as a warning that leachates were infiltrating the alluvium. The underliner drain would not intercept all infiltrating fluids from a large leak, and the leachate would rapidly seep into the fill material and enter the alluvial aquifer. Depending on the composition of the leachate, water quality of the alluvial aquifer beneath the site could deteriorate. Existing water quality is marginal in the alluvium, with iron, manganese, and phenols exceeding drinking water standards consistently (Appendix B.2, Table B.1). Upon entering the saturated zone, leachate migration would be controlled by groundwater flow in the alluvium. The intimate connection of the river water and alluvial groundwater is apparent since groundwater levels respond rapidly to fluctuations in river level (Appendix B.2, Table B.2). Repeated fluctuations of river and groundwater levels is expected to cause oscillatory groundwater movement with a lateral component of migration. The result is expected to be seepage of leachate into Lake McKellar during receding and normal flow stages. Mitigation of this impact, should it occur, could require dewatering of the contaminated area and treatment of effluent water.

Leachates that collect in sumps adjacent to coal and waste storage areas will be monitored. The parameters to be measured, the frequency of testing, and the threshold concentrations above which leachates will be directed to wastewater treatment are shown in Sect. 2.2.1.8. Leachates that do not exceed any of these parameters will be discharged with the normal plant liquid discharge streams.

Groundwater use during the operation of the facility will be approximately  $0.01 \times 10^6 \text{ m}^3/\text{d}$  ( $2.71 \times 10^6 \text{ gpd}$ ) supplied by the MLGW city water system. The current capacity of the system is  $0.7 \times 10^6 \text{ m}^3/\text{d}$  ( $189 \times 10^6 \text{ gpd}$ ); current use is  $0.45 \times 10^6 \text{ m}^3/\text{d}$  ( $118 \times 10^6 \text{ gpd}$ ). This water is supplied by the 500-foot sand and the 1400-foot sand. The 500-foot sand has shown a regional decline in water levels. System capacity is adequate to supply water demand for the foreseeable future (Sect. 2.3.2.1).

#### 4.1.3 Water quality

##### 4.1.3.1 Construction impacts

##### Mississippi River

The construction activities that will affect surface water quality of the Mississippi River consist of dredging operations to provide fill for site buildup and construction of the wastewater discharge pipeline. Over a period of 250 calendar days, dredging operations will remove an estimated total of  $4.6 \times 10^6 \text{ m}^3$  of fill material from the Mississippi River in the vicinity of Mile-Point 725. Two alternate dredge sites have been identified. The primary site is located southwest of River Mile 725, adjacent to an unnamed island in the middle of the Mississippi River. The secondary site is along the east side of the river, at approximately River Mile 725.5. Both sites are regularly dredged by the U.S. Army Corps of Engineers and appear to have abundant quantities of high quality, low-silt sand suitable for fill material (Appendix C.5, Table C.15). No more than  $0.15 \text{ km}^2$  will be disturbed during dredging operations. Potential water quality problems resulting from dredging (increased turbidity, release of water-soluble chemicals, and increased oxygen demand resulting from the disturbed materials) are unlikely because of the sandy nature of the dredged material. Resuspension of disturbed sediments depends on particle size, and heavier particles, such as sand, settle rapidly. Dredging-induced turbidity will probably be noticeable only in the immediate vicinity of the dredge plant, especially since, with hydraulic dredging, turbidity is usually not high.<sup>8</sup>

Water quality may be affected if dredging mobilizes elements or compounds adsorbed onto sediment particles. Adsorbed materials are mostly associated with fine particles, such as silt and clay. An oxygen demand may be exerted if organic material or reduced chemicals (such as manganous ion, ferrous ion, and sulfide) from disturbed anaerobic sediments react with dissolved oxygen.<sup>9</sup> Elutriate testing of sediments at station MR-1 (Table C.10) indicated that only ammonia nitrogen and biological oxygen demand (BOD) had elevated concentrations in the elutriate. Although specific information on sediment elutriates of the alternate locations is not available, sediments at station MR-1 are probably representative of areas that may be dredged. When the dredge site is finally chosen, the U.S. Army Corps of Engineers will determine the need for elutriate testing for issuance of the Sect. 404 permit.

A study of dredged materials collected from a wide variety of geographical locations indicated that the concentrations of chemicals in the elutriate were rarely sufficiently high to cause

adverse effects on water quality and/or aquatic organisms. Ammonia and manganese were the only chemicals consistently detected in sediment elutriates.<sup>10</sup> In dredging for MLGW site fill, localized increases in some dissolved chemical species (especially ammonia) may occur, but significant degradation of the Mississippi's water quality is not anticipated.

The construction of the wastewater discharge pipeline will disturb no more than 64 m<sup>2</sup> (404-Sect. 10, Permit Application). Although the length of time this operation will take is uncertain, it is expected to be short, and perturbations to the water column are expected to be qualitatively similar to those described above. Because the affected area is very small and the Mississippi's dilution capacity in this area is large, pipeline construction will not significantly affect the surface water quality.

#### Lake McKellar

The construction activities that may affect the surface water quality of Lake McKellar include runoff from the site during construction, shoreline disturbance during site grading, construction of the water supply and product gas distribution pipelines, and construction of dock facilities in the barge turning basin. Impacts resulting from construction activities will be temporary.

A total of  $4.6 \times 10^6$  m<sup>3</sup> of dredge fill will be distributed over the surface of the proposed plant site to raise it to 71 m (233 ft) above mean sea level. These efforts are scheduled to take about 9 months. The area being filled will be diked, with the excess fluids discharged to Lake McKellar through a weir. As slurry from the dredging operation is deposited on the site, sand will settle rapidly. The diked area (either the entire plant site or a portion of it) will serve as a sedimentation pond. Particulate materials in the decant water may affect the receiving waters by increasing both the turbidity and the quantities of sediment-bound contaminants (heavy metals, oil and grease, and chlorinated hydrocarbons). Turbidity and potential contaminants are generally associated with fine-grain solids such as silts.<sup>11</sup> The discharge of particulates is not anticipated to significantly degrade Lake McKellar's water quality because (1) the silt content of dredged material is expected to be low (see Table C.15) and (2) the temporary retention of dredge fluids within the diked area will allow some of the finer particles (silt and clay) to settle. In addition, Corps of Engineers permit requirements will specify the allowable turbidity.

Alterations in water quality associated with the soluble phase of decant water are uncertain because elutriate testing of the dredged fill material has not been performed. If MR-1 elutriate test results are considered representative of the dredge site, then the decant water may contain concentrations of ammonia nitrogen as high as 1.5 mg/liter (Appendix C.3.1, Table C.10). With the maximum pH of 8.2 for Lake McKellar (Table 3.6), 7% of the total concentration of ammonia could be present as un-ionized ammonia.<sup>12</sup> Thus, the decant water could contain up to 0.11 mg/liter of un-ionized ammonia, a level roughly five times the standard, 0.02 mg/liter (Table 3.5), recommended to avoid toxicity to fish. As decant water enters Lake McKellar, it will be diluted, and water quality standards will be met with fivefold to sixfold dilution. Degradation of water quality would occur within only a limited mixing zone.

Site grading is scheduled to last for five months. Riprap will be placed along the outside slopes of the plant site to reduce erosion caused by wave action along the shore. A slight degradation in water quality may result from increased turbidity and increased levels of soluble and adsorbed chemicals in localized shoreline areas.

Less than 3800 m<sup>3</sup> of sediment will be dredged from the Tennessee Chute portion of Lake McKellar during installation of the water supply and the product gas distribution pipelines. Construction of the entire product gas pipeline system is scheduled to take from month 34 to month 45, though the portion under Lake McKellar is expected to involve considerably less time. Data from the elutriate test performed on sediment collected at sampling station LMI indicated that manganese, ammonia nitrogen, and orthophosphate levels in the elutriate were elevated in comparison with ambient concentrations (Appendix C.3.1, Table C.10). Although manganese levels in lake water collected at LMI have exceeded the criteria for domestic water supplies (Sect. 3.1.3), additional degradation caused by higher concentrations of metal or higher concentrations of nonionic ammonia is expected to be localized because this area comprises only 0.04% of the total bottom area of Lake McKellar. In light of the annual dredging of the lake by the U.S. Army Corps of Engineers, localized short-term alterations in water quality are not considered significant.

Other impacts from pipeline installation include oxygen depletion and increased turbidity from the disturbed materials. Unlike other locations in Lake McKellar, LMI was not anoxic during the summer (Sect. 3.1.3). Although sediments from LMI contain significant quantities of iron, the chemical oxygen demand is not high when compared with values reported in the literature.<sup>10</sup> It is difficult to predict how extensively oxygen may be depleted as a result of dredging. If anaerobic conditions occur, they may permit the mobilization of nutrients and certain pollutants such as sulfides and heavy metals. Localized, water quality may suffer as the result of pipeline installation.

Over a period of 12 months (month 12 to month 24), approximately 32,000 m<sup>3</sup> of sediment will be removed from the turning basin to permit the construction of the barge docking facilities. The water quality of this comparatively undisturbed backwater area is discussed in Sect. 3.1.3. Because sediment and elutriate data are nonexistent, dredging-induced water quality perturbations cannot be assessed adequately. The turning basin has not been dredged by the Tennessee Valley Authority (TVA). The basin is isolated from the main channel of Lake McKellar and, unlike the lake, does not receive high loads of suspended materials from runoff and inflowing waters (Tom Verna, U.S. Army Corps of Engineers, Memphis District, personal communication with Susan Turbak, Science Applications, Inc., Nov. 2, 1979). Thermal stratification and oxygen depletion of the lower water column have been observed in the summer (Sect. 3.1.3). As with the Mississippi River and the main channel of Lake McKellar, dredging-induced impacts are likely to include increased turbidity, higher concentrations of certain water-soluble chemicals, and oxygen depletion in the water overlying the disturbed sediments for short periods of time.

Dredging-induced impacts will be reduced by the use of a cutterhead hydraulic dredge. To the extent practicable, the impacts will also be mitigated by performing operations during low water level seasons (autumn or early winter) when mixing is at a maximum and when water overlying the sediments is well oxygenated. Appropriate techniques as specified by the responsible regulatory agency will be implemented to reduce the turbidity associated with dredging procedures and operations. These suggestions will be given special consideration in the barge turning basin because the amount of material to be removed is large for the size of the basin, and the basin's isolation may make the impacts more long lived.

Dredging impacts to Lake McKellar will be mitigated in accordance with requirements of the Sect. 404 permit issued by the U.S. Army Corps of Engineers, Memphis District Office.

The use of settling and weirs will decrease the load of suspended materials and, therefore, sediment-bound contaminants entering Lake McKellar during site buildup. The placement of riprap along the shoreline areas will help to control siltation during site grading.

#### 4.1.3.2 Operational impacts

##### Mississippi River

Impacts to the water quality of the Mississippi River during MLGW demonstration plant operation may result from the disposal and discharge of wastes. Assorted solid wastes stored on the MLGW plant site could affect the river indirectly by contaminating the shallow groundwater beneath the site that undergoes exchange with the river. This possibility is addressed in Sect. 4.1.2.2.

The most direct and significant impact on the Mississippi's water quality will come from liquid waste discharges. Current plans call for the transport of all sanitary wastewater (0.63 liter/s) to the nearby T. E. Maxson Wastewater Treatment Facility via the municipal sanitary sewer system. Other liquid wastes will include process wastewater, cooling-tower blowdown, coal pile runoff, ash pile runoff, storm water, and spent service water. With the exception of ash pile runoff, all wastewaters will be appropriately treated before combined discharge into Mile-Point 725.5 of the Mississippi River from the effluent holding basin (Sect. 2.2.1). The plant discharge will vary between 56 liters/s (normal flow) and 212 liters/s (design flow), depending on the magnitude of storm runoff. The expected chemical concentration of the effluent is presented in Sect. 2.2.1.2, and the chemical loading to the Mississippi River is estimated for normal flow conditions in Table 4.6. As illustrated in this table, the projected amounts of chemicals discharged into the Mississippi River each day are trivial in comparison to the river's mass flow calculated for worst-case conditions (maximum ambient concentrations and low-flow conditions).

The discharge of the proposed plant's effluent into the Mississippi River will require a National Pollutant Discharge Elimination System (NPDES) permit. In Tennessee, the NPDES permitting authority has been delegated to the State Division of Water Quality Control within the Department of Public Health.<sup>13</sup> The portion of the river projected to receive the discharge is classified as an effluent-limited segment (from Mile-Point 714.0 to 741.0). General regulations for the state of Tennessee specify that effluent limitations for new sources on segments designated as such shall require "the greatest degree of effluent reduction achievable through application of best available control technology (BACT) which shall be new source performance standards (NSPS), if available."<sup>14</sup> New-source performance standards have not been developed for coal conversion facilities. In the absence of Federal guidelines, the state of Tennessee will develop effluent limitations, based on the best available technology determination for this project. Additional or revised effluent limitations may be required for issuance of the NPDES permit based on the evaluation of State officials or the regional EPA administrator.

To assess the assimilation capacity of the Mississippi River at the point of MLGW demonstration plant discharge, a buoyant plume model was applied for two worst-case conditions [at an effluent flow (900 gpm) slightly above normal plant operation combined with (Q<sub>3-20</sub>) flows and extreme

Table 4.6. Chemical loading of MLGW effluents to the Mississippi River under low-flow conditions

| Chemical constituent              | Effluent load <sup>a</sup><br>(kg/d) | Mississippi River load <sup>b</sup><br>(t/d) | Percentage increase in<br>Mississippi River load <sup>c</sup> |
|-----------------------------------|--------------------------------------|----------------------------------------------|---------------------------------------------------------------|
| Ammonia, as N                     | 1 to 9                               | 189                                          | 0.001 to 0.005                                                |
| Antimony                          | 0.08                                 | 20                                           | Negligible <sup>d</sup>                                       |
| Arsenic                           | 0.08                                 | 2                                            | 0.004                                                         |
| Beryllium                         | 0.02                                 | 0.5                                          | 0.003                                                         |
| Biochemical oxygen<br>demand, 5 d | 37 to 115                            | 2,700                                        | 0.002 to 0.005                                                |
| Cadmium                           | 0.18                                 | 2                                            | 0.01                                                          |
| Chemical oxygen demand            | 92 to 238                            | 8,550                                        | 0.001 to 0.003                                                |
| Chromium                          | 0.23                                 | 3.6                                          | 0.006                                                         |
| Cyanide                           | <0.16                                | 2                                            | 0.01                                                          |
| Lead                              | 1.6                                  | 7                                            | 0.03                                                          |
| Magnesium                         | 0.08                                 | 4,210                                        | Negligible                                                    |
| Mercury                           | 0.01                                 | 0.23                                         | 0.005                                                         |
| Nickel                            | 0.08                                 | 5                                            | 0.002                                                         |
| Oil and grease                    | 17 to 56                             | 900                                          | 0.002 to 0.007                                                |
| Phenol                            | <0.04                                | 5.6                                          | 0.001                                                         |
| Selenium                          | 0.4                                  | 2                                            | 0.02                                                          |
| Total dissolved solids            | 4,500 to 9,300                       | 63,700                                       | 0.007 to 0.02                                                 |
| Total organic carbon              | 17 to 75                             | 1,900                                        | 0.001 to 0.004                                                |
| Total suspended solids            | 75 to 115                            | 93,600                                       | Negligible                                                    |
| Zinc                              | 0.8                                  | 20                                           | 0.004                                                         |

<sup>a</sup>Calculated from projected concentrations of chemical constituents in the effluent and the effluent flow rate (43 liters/s) under normal operating conditions.

<sup>b</sup>Calculated from maximum ambient concentrations (ER, Appendix 3A, Tables 3A-16 to 3A-19) and 3-d, 20-year low flow (2,205 m<sup>3</sup>/s, or 92,000 cfs).

<sup>c</sup>Calculated by (effluent load, kg/d)/(river load, t/d X 1000 kg/t) X 100.

<sup>d</sup>Negligible considered to mean percentages <0.001.

winter and summer river temperatures] and two average conditions [at an effluent flow (900 gpm) slightly above normal plant operations combined with average river flows and temperatures]. Results of such modeling indicated that, even under the most conservative conditions, chemical constituents in the plant effluent are rapidly diluted.

The behavior of ammonia nitrogen, cadmium, chromium, cyanide, hydrogen sulfide, lead, mercury, phenol, and selenium are of particular interest because their proposed maximum concentrations in the MLGW demonstration plant effluent exceed water quality criteria under worst-case conditions (Table 4.7). However, preliminary data developed as part of the NPDES permitting procedure suggest that these concentrations will be within criteria. In addition, effluent concentrations of cadmium, lead, and selenium exceed recommended effluent limitations for treated industrial wastewaters (although, if it can be demonstrated that treatment by practical conventional unit treatment processes cannot meet the effluent limitations, other reasonable concentration limits can be established).<sup>15</sup> Assuming worst-case conditions, water quality criteria for temperature, ammonia nitrogen, hydrogen sulfide, and lead are met within 65 m of the discharge point (Table 4.7). Difficulties are encountered in the interpretation of modeling results for the dispersion of cadmium, cyanide, mercury, phenol, and selenium because ambient levels of these chemicals exceed the criteria (Sect. 3.1.3). Average ambient concentrations for summer, coupled with summer low flow, produced the longest predicted plumes for mercury and cyanide. Under these conditions, cyanide levels in the plume are reduced to 6.9 µg/liter (15% higher than the ambient 6.0 µg/liter) within 65 m of the discharge point. In a similar distance, plume mercury would decrease to 5% higher than the average summer ambient value of 6.0 µg/liter. It is anticipated that phenol, selenium, and cadmium will be diluted to levels comparable with ambient levels within a short distance of the discharge point.

In the model, mixing zones are expected to be relatively narrow in width and restricted in length. Larger mixing zones may be permitted in a body of water the size of the Mississippi River; however, the proximity of discharges from other operations must be considered.<sup>16</sup> It is not anticipated that the mixing zone of the projected MLGW effluent would extend into the mixing zone of the combined discharge from the Allen Generating Plant and the Maxson Wastewater Treatment Facility. Both the thermal and the chemical components of the MLGW discharge would be readily diluted to ambient levels. The only impact on water quality likely to result from the discharge

Table 4.7. Comparison of MLGW Demonstration Plant effluent with water quality criteria<sup>a</sup>

| Chemical constituent                  | Water quality criterion concentration, $C_r$                                                           | Effluent limitations from industrial wastewater treatment <sup>b</sup> | Maximum concentration in IFGDP effluent, $C_e$ | Maximum ambient concentration, $C_a$ | Maximum dilution required to meet criterion <sup>c</sup>                                      | Distance downstream from outfall criterion net (m)                 |
|---------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Ammonia nitrogen                      | 0.02 as un-ionized ammonia (assumed to be approximately equal to 1 mg/liter of total ammonia-nitrogen) | Not listed                                                             | 0.5 to 3.0                                     | 0.84                                 | 10                                                                                            | <23                                                                |
| Cadmium                               | 0.0012                                                                                                 | 0.01                                                                   | 0.05                                           | <0.01                                | $C_a$ may exceed criteria; chemical detection limits too insensitive                          | Criterion may not be met because of high $C_a$                     |
| Chromium                              | 0.05                                                                                                   | 3.0                                                                    | 0.06                                           | 0.016                                | 1.3                                                                                           | Immediately at outfall                                             |
| Cyanide                               | 0.005                                                                                                  | 0.05                                                                   | <0.05                                          | 0.009                                | $C_a$ exceeds criteria frequently                                                             | Criterion may not be met because of high $C_a$ ; reduced to 0.0061 |
| Hydrogen sulfide                      | 0.002 as undissociated hydrogen sulfide                                                                | Not listed                                                             | <0.1                                           | No data; assume 0                    | 50                                                                                            | <65                                                                |
| Lead                                  | 0.05                                                                                                   | 0.1                                                                    | 0.5                                            | 0.022                                | 17                                                                                            | <23                                                                |
| Mercury                               | 0.05 $\mu\text{g/liter}$                                                                               | 50 $\mu\text{g/liter}$                                                 | 2 $\mu\text{g/liter}$                          | 1 $\mu\text{g/liter}$                | $C_a$ exceeds criteria; chemical detection limits too insensitive to calculate how frequently | Criterion may not be met because of high $C_a$                     |
| Phenol                                | 0.001                                                                                                  | 1.0                                                                    | <0.01                                          | 0.025                                | $C_a$ exceeds criteria consistently                                                           | Criterion may not be met because of high $C_a$                     |
| Selenium                              | 0.01                                                                                                   | 0.01                                                                   | 0.10                                           | 0.01                                 | $C_a$ exceeds criteria occasionally                                                           | Criterion may not be met because of high $C_a$                     |
| Physical property:<br>Temperature, °C | Summer: 30.5<br><br>Winter: $\Delta 3 = 3.3$                                                           | Not listed                                                             | 26.7<br><br>18.3                               | 28.9<br><br>0.3                      | Criterion met without dilution<br><br>6                                                       | Criterion met prior to discharge<br><br>5                          |

<sup>a</sup>Data taken from ER, Sect. 3A and 4A; chemical constituents expressed as mg/liter unless otherwise specified.

<sup>b</sup>Data from Bureau of National Affairs, "Tennessee Effluent Limitations and Standards", *Environ. Reporter* 916: 1001-1002 (1978).

<sup>c</sup>Calculated by the following equation:  $(C_e - C_a) / (C_r - C_a)$ .

would be small incremental loadings of those constituents for which ambient concentrations already exceed water quality criteria for water uses for which the affected reach of the river is classified. These uses do not include domestic uses.

Modeling of the effluent plume has provided insight into the dispersion rates of chemicals entering the Mississippi River; however, only this aspect of the behavior of water-borne chemicals has been addressed. Chemical data used in modeling predictions and loading calculations generally consist of total concentrations rather than of the dissolved, undissociated, or biologically active components. Chemicals entering a receiving water may be volatilized, sequestered in the sediments in relatively immobile states, or otherwise transformed, and therefore much of this load may not be available for biological uptake. Thus, the modeling results are extreme worst-case estimates of the effects of the discharge on the river. Monitoring programs are discussed in Sect. 4.4.3.

#### Lake McKellar

The storage areas for solid wastes generated from the operation of the MLGW demonstration plant will be contained so that runoff or leachates from these areas may not enter Lake McKellar. Potential water quality perturbations to the lake will be associated with the activities in the barge turning basin. Barge traffic and maintenance dredging will increase the turbidity of the basin's waters, an area which is poorly flushed. Other water quality alterations may result from dredging (Sect. 4.1.3.1). Coal spillage may constitute a localized water quality impact. Oxidizing conditions will promote the formation of acid from the sulfide minerals in coal, and trace elements may be released into the water column. Polycyclic aromatic hydrocarbons (PAH) may

also enter the aquatic environment via coal spillages if conditions are appropriate for their release. However, positive steps will be taken to prevent accidental coal spillages. These include providing a spill lip on the barge unloading dock to ensure that any spills will be returned to the barge; carrying out the dumping operations within a three-sided structure; and bulldozing residual coal from each barge to the unloading hopper.

In summary, the most likely impact to water quality from increased barge traffic in the turning basin is significant increases in turbidity, with resulting impacts to aquatic biota (Sect. 4.1.4.2). In addition, maintenance dredging will cause short-term degradation of water quality.

#### 4.1.4 Aquatic ecology

##### 4.1.4.1 Construction impacts

###### Mississippi River

Construction activities that will affect aquatic organisms and their habitat include dredging operations to provide fill for site buildup and construction of the wastewater discharge pipeline. Both dredging and installation of a dredge slurry pipeline along the river bottom will destroy benthic organisms and habitat within the affected locations. The water column and adjacent areas may also be affected by dredging-induced water quality perturbations (Sect. 4.1.3.1). It is anticipated that no unique or sensitive areas will be disturbed.

The magnitude of construction-related impacts is difficult to assess because site-specific analyses of dredge areas have not been performed. Although the baseline monitoring program has sampled, the aquatic populations in the vicinity of an alternative site for supplying fill (near station MR2; see Fig. 3.4), these data may not be representative of the site that is ultimately chosen. The fill, however, will consist primarily of unstable sand substrate that provides poor habitat for benthic organisms. Data collected at station MR2 indicated that the density of benthic organisms in this area was lower than that in Lake McKellar and was highly variable, ranging from 0 to 476 organisms per square meter. Benthic organisms in this area consisted primarily of immature aquatic earthworms and insect larvae (Sect. 3.1.4).

Although benthic populations in the proposed dredge area are expected to be low, recolonization rates are uncertain. It is likely that fish will avoid the dredged area because of activity, noise, and possible water quality perturbations. Dredge sites have not been specified, so it is difficult to assess the effects dredging will have on localized spawning. Because relatively few warmwater sport fish are found in the reaches of the Mississippi being considered as a source of dredge fill (Sect. 3.1.4), dredging operations will not appreciably affect these organisms. The impact of benthic defaunation on the river's food web is expected to be localized. Although the most abundant fish, the gizzard shad, is a plankton feeder<sup>17</sup> and does not therefore depend on the benthos as a food source, other fish species subsist on this valuable resource.

Potential impairments of river water quality are discussed in Sect. 4.1.3.1. They are not expected to affect the river's aquatic biota significantly because they will be localized and short term.

The construction of the wastewater discharge pipeline will disturb no more than 64 m<sup>2</sup> (404, Sect. 10, Permit Application). Perturbations are expected to be qualitatively similar to those described above. Because the affected area is quite small and is not anticipated to include any unique or sensitive regions, pipeline construction will not significantly affect the aquatic biota.

###### Lake McKellar

The construction activities that will affect aquatic organisms and their habitat include dredging of the Tennessee Chute portion of the lake to facilitate installation of the water supply and product gas pipelines, dredging and filling of the barge turning basin during dock construction, and the site buildup and grading. All construction activities will be temporary.

Pipeline installation operations are expected to destroy benthic organisms in the Tennessee Chute portion of the lake, the majority of which are expected to be immature aquatic earthworms, midge larvae, and fingernail clams. The affected area, however, comprises a very small portion (about 0.04%) of the total bottom area of Lake McKellar. Based on these data, the impact of localized defaunation on the lake's food web is not expected to be significant. Because of annual dredging, heavy barge traffic, changes in the Mississippi's stage, and high loadings of suspended solids, Lake McKellar undergoes continual disturbance. Benthic populations in the lake will probably recover rapidly from such perturbations.

Although inferior water quality may result in areas adjacent to dredged sites (Sect. 4.1.3.1), adverse effects are expected to be localized and of short duration. Specifically, criteria for

oxygen, manganese, and un-ionized ammonia may not be met during and immediately after dredging. Criteria for aquatic life have been developed to protect organisms from chronic exposure. Their application to relatively short-term water quality perturbations such as dredging has been questioned.<sup>10</sup>

Sediment dewatering, using settling and the weir is not anticipated to adversely affect the shoreline of Lake McKellar. In addition, the filling operation will be under the requirements specified by the Corps of Engineers. The majority of potential pollutants may be bound to sediment particles and therefore possibly unavailable to aquatic organisms, with the exception of detritus feeders. Limited data prevent an analysis of the potential for bioaccumulation; however, the likelihood of this phenomenon is reduced by the temporary nature of the perturbation.

Unknown quantities of soluble chemicals, such as ammonia and possibly manganese, will enter Lake McKellar during sediment dewatering. Manganese is not considered to be a problem for the freshwater biota,<sup>18</sup> but the portion of ammonia present in the un-ionized state (Sect. 4.1.3.1) may be toxic if elevated levels persist under certain conditions (higher pH and temperature) for an extended period of time.<sup>19</sup> However, the concentrations will fall to nontoxic levels within a short distance of the dredging fluid discharge, thus restricting the impact to a small area (see Sect. 4.1.3.1). Impacts are not expected to be significant.

Shoreline sites sampled in the baseline monitoring program are moderately productive spawning areas, primarily for forage fishes. Dike construction, placement of rip-rap, and slight increases in siltation will modify some portions of available spawning habitat and may slightly reduce the productivity of habitat surrounding the facility. On the other hand, placement of riprap will produce a type of habitat that is relatively uncommon in the area, that is, large rock. Such habitat may serve as spawning habitat for channel catfish, sauger and perhaps white bass; it will provide substrate for a variety of invertebrates not found in the predominant silty and sandy areas; and it will provide cover for small fish of all species, cover which is presently scarce at normal water levels.

Construction impacts in the barge turning basin may affect fish populations in and near the area. The area immediately east of the site is flooded during high water, producing excellent habitat for fish spawning. During construction this area will be unaffected. However, medium-quality aquatic habitat in the turning basin will be affected. During the baseline survey the highest density of fish larvae was measured in the turning basin at Station LM2-A. This area will be destroyed by dredge and fill operations conducted to provide uniform bank for dock construction. The turning basin may serve as a nursery area for fish larvae and juveniles, specifically gizzard shad, sunfish, carp, and freshwater drum (Sect. 3.1.4). Zooplankton are more dense in this area than at station LMI or in the Mississippi River. In summary, the turning basin appears to be a biologically productive area. Construction activities will alter a portion of the aquatic habitat and reduce the quality of habitat in the remainder of the turning basin through dredging-induced sedimentation and water quality degradation. Populations of aquatic biota using this area will be displaced to other suitable nursery areas in Lake McKellar. The overall impact will be a small but significant loss of medium-quality aquatic habitat in the limited area of the basin itself. The most valuable habitat area east of the site will not be affected, and the riprap could attract other species for spawning. Degradation of the basin is likely to continue during plant operation due to coal spillages, barge traffic, and maintenance dredging.

#### Endangered species

No unique areas, such as habitat of endangered or threatened species, will likely be affected during construction activities. The baseline monitoring program, the Memphis Harbor Study, and the U.S. Fish and Wildlife Service (USFWS) (Appendix B.3.1) did not identify any aquatic organisms included on the lists of threatened and endangered species maintained by the USFWS and the state of Tennessee (Sect. 3.1.4).

#### 4.1.4.2 Operational impacts

##### Mississippi River

The major impact of MLGW demonstration plant operations on the aquatic populations of the Mississippi River will be restricted to effects of the plant wastewater discharge. The chemical characteristics of the effluent and its predicted dispersion in the receiving water have been described (Sect. 4.1.3.2). With respect to the interaction between the aquatic biota and point-source chemical inputs from the MLGW demonstration plant, two factors must be considered: (1) the effects of chemical inputs on the biota (toxic and stimulatory effects at the organism, population, or community level) and (2) how biota affect the concentrations of chemicals (via uptake, accumulation, transformation, and elimination).<sup>20</sup>

The potential toxicity and bioaccumulation of chemicals present in effluents from coal conversion facilities are functions of many environmental variables, including concentration, chemical form, and food web dynamics.<sup>21</sup> Effluent chemistry is not well defined; moreover, effluent bioassay data, useful in predicting the potential toxicity of complex chemical mixtures, are lacking. Because of their suggested toxicity and carcinogenicity, some trace elements and organic compounds are expected to be hazardous constituents in waste streams from coal conversion operations.

Of these two general groups of chemicals, more attention has been focused on trace elements. Levels of toxicity of different trace elements to the aquatic biota have been summarized by Braunstein,<sup>22</sup> based on data compiled by Cushman et al.<sup>23</sup> Selected portions of these data are presented in Table 4.8 to illustrate rough measures of relative toxicities tested under a wide variety of conditions. Data were generated by averaging elemental concentrations that were lethal for all or a fraction of the bioassay organisms in tests conducted for at least 24 h.<sup>22</sup>

Table 4.8. Potential toxicity and bioaccumulation of selected trace metals in the MLGW Demonstration Plant effluent

| Chemical constituent | Maximum concentration in IFGDP effluent (mg/liter) | Mean concentration toxic to aquatic organisms (ppm) <sup>a</sup> |             |         |          |               |             | General bioaccumulation potential <sup>b</sup>                                                                         |
|----------------------|----------------------------------------------------|------------------------------------------------------------------|-------------|---------|----------|---------------|-------------|------------------------------------------------------------------------------------------------------------------------|
|                      |                                                    | Fish                                                             | Crustaceans | Insects | Molluscs | Phytoplankton | Macrophytes |                                                                                                                        |
| Trace metal          |                                                    |                                                                  |             |         |          |               |             |                                                                                                                        |
| Cadmium              | 0.050                                              | 8.2(29)                                                          | 0.035(2)    |         |          | 0.27(3)       | 7.4(1)      | Readily accumulated by marine and freshwater organisms, particularly shellfish                                         |
| Chromium             | 0.060                                              | 100.2(90)                                                        | 6.8(13)     | 76.3(5) | 17.1(2)  | 1.8(11)       | 5.4(2)      | Accumulated by fish and invertebrates; may be rapidly eliminated                                                       |
| Lead                 | 0.50                                               | 40.8(53)                                                         | 1.8(5)      | 37.3(3) |          | 2.5(1)        | 363.0(1)    | Accumulated by fish and invertebrates, particularly shellfish                                                          |
| Mercury              | 0.002                                              | 0.80(21)                                                         | 0.009(2)    | 2.0(3)  |          | 1.3(13)       | 3.4(1)      | Methyl mercury readily accumulated by aquatic organisms and concentrated in tissues                                    |
| Selenium             | 0.10                                               | 23.9(7)                                                          |             |         |          | 2.5(1)        |             | Not as well studied as other elements; some evidence for accumulation in aquatic organisms, particularly invertebrates |

<sup>a</sup>Data taken from H. M. Braunstein, Ed., *Environmental and Health Aspects of Disposal of Solid Wastes from Coal Conversion: An Information Assessment*, ORNL-5361, Oak Ridge National Laboratory, Oak Ridge, Tenn., September 1978, Table 3.4, p. 3-7. (Note: data contained in this table was compiled from R. M. Cushman, S. G. Hildebrand, R. H. Strand and R. Anderson, *The Toxicity of 35 Trace Elements in Coal to Freshwater Biota: A Data Base with Automated Retrieval Capabilities*, ORNL/TM-5793, Oak Ridge National Laboratory, Oak Ridge, Tenn., June 1977, 41 pp.), numbers in parentheses indicate number of determinations.

<sup>b</sup>References include D. J. Wilkes, "Animals: Bioenvironmental Effects," Ch. 9 in H. M. Braunstein, E. D. Copenhaver, and H. A. Pfuderer, Ed., *Environmental, Health, and Control Aspects of Coal Conversion: An Information Overview*, Vol. 2, Oak Ridge National Laboratory, Oak Ridge, Tenn., April 1977; G. R. Phillips and R. C. Russo, *Metal Bioaccumulation in Fishes and Aquatic Invertebrates: A Literature Review*, EPA-600/3-78-103, U.S. Environmental Protection Agency, Duluth, Minn., December 1978, 115 pp.

In the projected MLGW demonstration plant effluent, the maximum levels of cadmium, chromium, lead, mercury, and selenium exceed water quality criteria (Sect. 4.1.3.2) under worst-case conditions. Comparisons between maximum concentrations of these trace metals in the effluent with average toxicity data should be made cautiously because of the sensitivity of bioassay responses to small changes in test conditions. However, almost without exception, the average toxicity levels are at least an order of magnitude higher than the maximum effluent concentrations. These rough comparisons suggest that the proposed plant's effluent, under worst-case conditions (i.e., maximum projected levels of potentially hazardous chemicals), should not be acutely toxic to aquatic organisms. When rapidly diluted in the receiving waters, potential toxicity appears more unlikely.

Sublethal effects may be produced from chronic exposure to concentrations of trace metals that are much lower than the average values presented in Table 4.8. In particular, benthic organisms may elicit sublethal responses because they inhabit environments that are sinks for trace metals.



Many of these organisms also effectively accumulate trace metals from their environments. However, the buoyant discharge plume from the IFGDP may minimize exposure of benthic organisms to trace metal concentrations noticeably above ambient levels.

Generalized summaries of the bioaccumulation potentials of the five trace elements (Table 4.8) indicate that all five trace metals are accumulated by aquatic organisms. Maximum concentrations of these metals anticipated in the IFGDP effluent (Table 4.9) indicate that, at the point of discharge, chromium would present high potential for bioaccumulation, while cadmium, lead, mercury, and selenium would be medium in this regard.<sup>21</sup> These concentrations will decline to ambient river levels within several hundred feet of the discharge, at which point all of these elements would present low to medium potential for bioaccumulation (Table 4.9). The effect of the IFGDP effluent is therefore of minor and localized importance:

Table 4.9. Bioaccumulation potential<sup>a</sup> of selected trace metals in IFGDP effluent

| Chemical constituent | Concentration in IFGDP effluent (mg/liter) | Maximum ambient concentration in river (mg/liter) | Threshold bioaccumulation concentration | Bioaccumulation Potential <sup>b</sup> |       |
|----------------------|--------------------------------------------|---------------------------------------------------|-----------------------------------------|----------------------------------------|-------|
|                      |                                            |                                                   |                                         | Effluent                               | River |
| Cadmium              | 0.05                                       | <0.01                                             | 0.002                                   | 25                                     | <5    |
| Chromium             | 0.06                                       | 0.016                                             | 0.0004                                  | 150                                    | 40    |
| Lead                 | 0.5                                        | 0.022                                             | 0.006                                   | 83.3                                   | 3.7   |
| Mercury              | 0.002                                      | 0.001                                             | 0.00007                                 | 28.6                                   | 14.3  |
| Selenium             | 0.1                                        | 0.01                                              | 0.002                                   | 50                                     | 5     |

<sup>a</sup>From S. G. Hildebrand, R. M. Cushman and J. A. Carter, "The Potential Toxicity and Bioaccumulation in Aquatic Systems of Trace Elements Present in Aqueous Coal Conversion Effluents," in D. D. Hamphill, Ed., Trace Elements in Environmental Health-X, 1976, A Symposium, University of Missouri, Columbia, Table III, p. 311.

<sup>b</sup>High bioaccumulation potential is >100; medium bioaccumulation potential is 11-100; low bioaccumulation potential is 1-10.

Much less is known about the potential biological impact of complex organic compounds such as PAH. Although both adsorbed and soluble fractions may be present in the aquatic environment, most PAH compounds will probably be adsorbed on the surfaces of particles and, therefore, may be more available to sediment- and suspension-feeding animals.<sup>24</sup> The toxicity of some aromatic compounds to marine and freshwater organisms has been tested.<sup>25</sup> The results have not always been consistent, so it is difficult to extrapolate extant data to the levels of these chemicals in the MLGW demonstration plant effluent. Polycyclic aromatic hydrocarbon compounds are accumulated by the aquatic biota and may be metabolized readily by fish and invertebrates, with the exception of shellfish.<sup>25</sup>

It is not anticipated that the effluent will interfere with the behavior of organisms present in the Mississippi River near the point of discharge. During the winter, the temperature of the effluent will be higher than that of the receiving water, and the mixing zone may attract some fish to the discharge point. Of the potential impacts produced from the chemical and thermal characteristics of the projected MLGW discharge, chronic exposure of aquatic organisms to concentrations of chemical constituents exceeding ambient levels is expected to be the most important. The relatively small size of the mixing zone will limit the number of organisms exposed to these conditions. Monitoring procedures are suggested in Sect. 4.4.4.

#### Lake McKellar

Plant operation will necessitate increased barge traffic (for coal transport) in, and periodic dredging of, the barge turning basin. Disturbance and possible alterations of water quality (as a result of both coal spillage and dredging) will reduce the quality of this habitat. The magnitude of these impacts on the biological productivity of Lake McKellar, especially of the fish populations, will depend on the amount of barge traffic and coal spillage and the frequency of maintenance dredging.

## Endangered species

It is not anticipated that any unique areas, such as habitat of endangered or threatened species, will be affected during operational activities. The baseline monitoring program and a USFWS review (Appendix B.3.1) have not identified any aquatic organisms included on the list of threatened and endangered species maintained by USFWS (Sect. 3.1.4).

## 4.1.5 Geology and soils

### 4.1.5.1 Construction impacts

Potential construction impacts related to geology are (1) alteration of site topography during construction and (2) potential foundation settlement or liquefaction due to the presence of poorly consolidated sand beneath the site. Before construction activities begin, the site will receive approximately  $4.6 \times 10^6 \text{ m}^3$  ( $6.0 \times 10^6 \text{ yd}^3$ ) of fill, which will be hydraulically dredged material. Filling is necessary to raise the process areas above flood level. Methods for dewatering the dredge fill include settling, passing the water over a weir, and any requirements established by the U.S. Army Corps of Engineers or other regulatory body. Decant water will be discharged into the Tennessee Chute portion of Lake McKellar. Emplacement of the fill will raise the current topography at the site coal pile from the current elevation of 62 m (203 ft) to 71 m (233 ft) above mean sea level. The short-term ash storage area and long-term coal storage area will be graded to 68.6 m (225 ft) and will be surrounded by a levee at 71 m (233 ft). Filling and grading are unavoidable if the site is to be used for industrial development. The impact on topography cannot be avoided or mitigated.

The presence, nature, and extent of poorly consolidated alluvial deposits beneath the site are discussed in Sect. 3.1.5 and in Appendix C.5. The potential problems of settlement and liquefaction are recognized, and the following mitigating measures will be used to stabilize the foundation. Prior to site filling, additional soil boring and sampling will be completed to locate near-surface clayey materials and to delineate the extent of low-density sand. If uncompactable clayey soils are found at shallow depths, they will be investigated in place by standard penetration testing and in the laboratory by consolidation testing to determine their settlement potential. If they will consolidate during the site filling program so that residual settlement after construction will not affect foundation design, these clayey soils will be left in place. If settlement is calculated to be significant, then the clayey soils will be removed.

The soft sands will also be studied both in place and in the laboratory for their potential to liquefy under seismic conditions. If analysis indicates that this potential exists, it can be corrected by normal densification techniques or alternatively supporting foundations on piles. A reliable method will be chosen and field testing will be performed to ensure that soil liquefaction is not a problem for structural foundations. Foundations for structures on the site are being designed in accordance with recommendations for seismic risk zone 3.

Potential construction impacts on soil are (1) loss of soil by covering it with dredged material and (2) erosion.

As stated previously (Sect. 3.1.5), only 8 ha (20 acres) of the site are covered by natural soils (Crevasse fine sand); the remainder of the site is covered by dredged material. The site will be covered by dredged material that will be placed to bring the site up to the design elevation of 71 m (233 ft). Covering existing dredged material will halt any soil development that had begun. In addition, the naturally occurring soil will be lost.

The loss of Crevasse fine sand from use can be prevented by stockpiling before applying fill. The soil could then be used as topsoil on open areas after construction. Erosion of dredged fill material can be minimized by establishing vegetation as soon as the fill is dry enough to maintain plantings.

The characteristics of the dredged material, both that which is now on site and that which is to be applied as fill, make it impossible to determine the quantity of soil that will be eroded from the site during construction. However, because the actual construction will take place after the site is brought up to grade elevation, there will be only minimal erosion of the present onsite materials. Most material lost to erosion will be the dredged material to be used as fill.

The occurrence of a major flood prior to completion of the dike could result in erosion of whatever quantity of fill had already been applied. This erosion could require replacement of lost fill. Minor soil loss by erosion is unavoidable; losses will be minimized by using vegetative cover, riprap, or paving to protect the site.

#### 4.1.5.2 Operational impacts

Under normal conditions, no adverse impacts related to geology and soils are anticipated. Location of the site in seismic risk zone 3, where ground acceleration of 0.2 g (20% of the gravitational force) may result from earthquakes with an approximate 50-year frequency, requires plant design to withstand such forces. Foundation preparation is expected to limit settlement to acceptable amounts, and densification of the sand to about 80% maximum density will reduce the possibility of liquefaction. The preliminary foundation design currently available calls for placement of all structures on spread footings with a minimum depth of 0.92 m (3.0 ft). Foundations are being designed to load the underlying soils to a maximum of 1/3 of the soil's ultimate bearing capacity (safety factor = 3) with a 1/3 increase for wind or earthquake loading. Safety factors for the concrete in the foundations of 1.8 to 2.1 against overturning and 1.5 against foundation uplift will be used in design. Final foundation plans will be completed after additional testing is performed.

The ultimate result of site failure caused by a seismic event other than structural damage would be the possible release of contaminants from coal storage, waste disposal, and process areas. The potential sinks for these contaminants are Lake McKellar and the alluvial aquifer. Resulting impacts cannot be quantified but could be significant.

Waste and coal storage areas will be constructed with a synthetic liner that has a leachate drainage system above it and an underdrain network beneath it (Fig. 4.5). Soils beneath these areas will be densified prior to construction to prevent differential settlement, which could cause formation of low-lying pockets or could overstress the synthetic membrane, causing leaks. Under normal operating conditions, leachates from the coal and waste would seep laterally through a bed of sand over the synthetic liner and would discharge to a sump area to be pumped into the wastewater treatment system. In the event of liner failure, leachates would be intercepted by the system of underdrain pipes.

It is improbable that all of the infiltrating fluids would enter the underdrain; however, this system provides an early warning of leaks should they occur. Results of leachate testing on the coal and ash indicate that of the areas for solids to be stored on site, the coal storage areas have a greater potential for producing hazardous leachates than do the ash disposal areas. The potential leachability of sludges produced in the wastewater treatment area has not been quantified; these solids will be stored in the lined and monitored short-term ash storage landfill.

Operational impacts on soils are (1) a temporary hiatus in the development of soil and (2) the deposition of particulates in the soil.

Drift from the facility cooling tower will result in the deposition of salts on exposed soil. The maximum deposition of 0.01 lb/acre per day will occur 91 m (300 ft) downwind of the cooling tower. This deposition will be a small quantity, which, over the life of the project, will have minimal impact on soils. Under prevailing wind conditions, cooling tower drift will fall on the plant site, much of which will be occupied by waste storage areas or buildings.

The maximum particulate deposition from the facility stacks will be  $2.3 \times 10^{-5}$  lb/acre per day about 1.5 km (1 mile) downwind of the site. Impacts of this deposition are similar to those of cooling tower deposition; however, the geographic limit of impact is greater.

#### 4.1.6 Land use

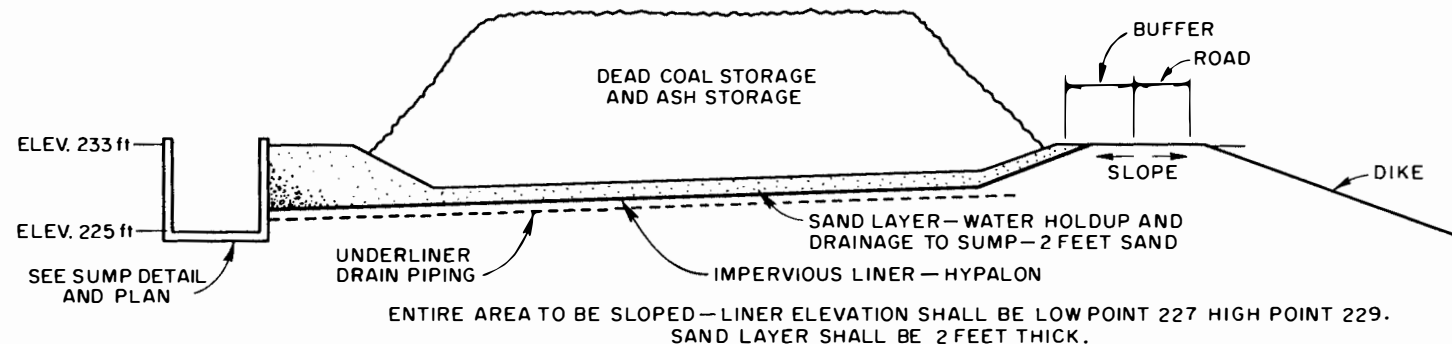
##### 4.1.6.1 Construction impacts

The effects of project construction on existing and projected site land uses and on regional land use and development are discussed here. The project consists of the elevated plant site and access road, the barge unloading area, and offsite utilities. Utilities include product gas, natural gas, water supply, sanitary sewer, wastewater pipelines, and power and telephone lines.

Construction activities at the plant site, at the road buildup, at the barge unloading area, and along the pipeline are not expected to result in adverse impacts on either existing or projected site land uses. The only land use in these areas has been for disposing dredge spoils from the annual dredging in Lake McKellar, although site development will preclude this use. No prime farmland exists on the site (Sect. 3.1.6). The projected use for the site, as determined by its zoning classification, is for heavy industry (M-3). Construction of the plant on this site will be in accordance with this classification.

Construction of the product gas and water supply pipelines from the plant site to Presidents Island is also not expected to result in adverse impacts on existing or projected land use for two reasons:

1. One portion of the pipeline will be installed beneath Lake McKellar and will not affect land use.



**PUMPS:** EACH SUMP SHALL BE PROVIDED WITH TWO 150-gpm PUMPS.

**PIPELINES:** PUMP DISCHARGE SHALL BE SEPARATE FOR EACH SERVICE.

**WINTERIZING:** PIPELINES SHALL BE BURIED TO PREVENT FREEZING; SUMPS AND PUMPS SHALL BE WINTERIZED.

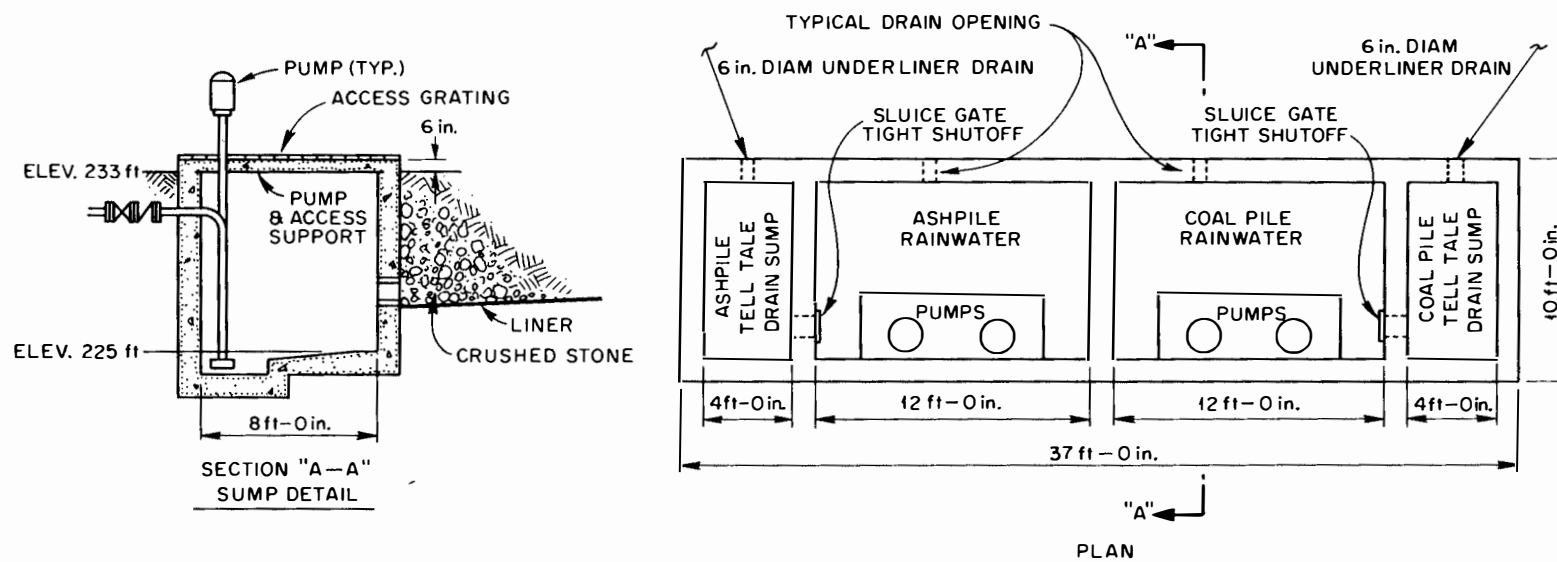


Fig. 4.5. Schematic of waste and coal storage areas.

2. Most of the remaining sections of these pipelines north of the site will be located on Presidents Island in existing rights-of-way and under city streets and will not cause a disturbance of other uses. The water supply pipeline will connect with an existing water main and will be less extensive than the product gas distribution system.

The water and natural gas pipelines to the Allen Generating Plant and the sanitary sewer pipeline to the Maxson Wastewater Treatment Facility will be in the access road right-of-way and will cause no impact. Power and telephone lines from the vicinity will also be in the road right-of-way and will cause no impacts.

The wastewater pipeline will be through the undeveloped area west of the plant site, and its construction will cause no immediate impact. Although there are currently no plans to develop this area and the area is the floodplain between a northern extension of the existing levee (south of the plant site) and the Mississippi River, building over the pipeline will be precluded by the possible need for pipeline servicing while the pipeline is in operation.

#### 4.1.6.2 Operational impacts

Once constructed, the product gas, water supply, natural gas, and wastewater pipelines will produce no adverse impacts on land use. Because the area is zoned for heavy industry, no zoning changes are necessary. Except for the construction of the new Mitchell Road, no major regional land use changes are anticipated. Potential effects of air pollutants on agriculture are discussed in Sect. 4.1.7.2.

#### 4.1.7 Terrestrial ecology

##### 4.1.7.1 Construction impacts

##### Vegetation

Onsite and offsite construction activities will disturb 62.8 ha (155 acres), including 42.8 ha (105.8 acres) of successional bottomland forest (of which 28 ha are wetlands), 16 ha (40 acres) of meadow, and 4 ha (9.9 acres) of nonvegetated land and water area. The Corps of Engineers has discontinued the annual disposal of dredge spoils on the site and is currently using a disposal lagoon on the western end of the site peninsula adjacent to the Mississippi River. The proposed use of the site may result in the use of other unknown areas for dredge-spoil disposal.

The loss and clearing of floodplain and riparian forests is a significant national problem. As much as 90% of the nation's original riparian wetlands may have already been lost, and current losses of the remaining areas approximate 6% per year.<sup>26</sup> Floodplain forests are highly important in many ways, including the support of a large number of wildlife species (many threatened and endangered species), storage and slow release of floodwaters, water quality maintenance (e.g., sediment entrapment), groundwater recharge, and very high productivity.<sup>27</sup>

The 42.8 ha (106 acres) of successional bottomland forest disturbed would be about 30% of the successional bottomland forest within 3 km of the site center. This figure indicates that a significant fraction of the successional bottomland forest in the 3-km-radius region occurs on the site. In contrast, there are several mature bottomland forests in the region, but none will be affected by construction. About 28 ha (70 acres) of disturbed low- to medium-quality wetland (successional bottomland forest, Sect. 3.1.7) will be affected. The forested medium- to high-quality wetland (mature bottomland forest) on Presidents Island has been avoided in pipeline routing, although the edge of this forested wetland along Lake McKellar might be slightly affected. The pipeline routes would revegetate and be maintained in an early stage of succession as a meadow habitat (personal communication, W. A. Beimborn, Energy Impact Associates, to W. W. Tolbert, Oct. 12, 1979). In addition, part of the site itself would be maintained as a meadow habitat. The total construction area represents 2.2% of the area within 3 km of the site.

Vehicle exhaust fumes and fugitive dust (Sect. 4.1.1.1) should have only minor effects on adjoining vegetation. Permanent roads will be paved, and unpaved roadways will be sprinkled with water to control dust.

##### Wildlife

Wildlife in construction areas will be displaced to surrounding habitats or eliminated. Populations of permanent and summer resident wildlife species will be reduced at least in proportion to the amount of their required habitat lost. Estimates of the reductions, based on habitat loss, are approximate because of a lack of knowledge of habitat requirements and wildlife reaction to various human disturbances. The following projected reductions may occur in the 3-km-radius area

because of the proposed industrial use of the site and adjacent offsite areas: cottontail, swamp rabbit, whitetail deer, and gray fox — 25%; fox squirrel, gray squirrel, and opossum — 50%; red fox and raccoon — 40%; and bobcat — 10%. Other important species whose populations will be affected include the bobwhite quail, wood duck, woodcock, wild turkey, Mississippi kite, marsh hawk, and sharp-shinned hawk. Subsequent to disturbance, species such as the meadowlark, robin, common grackle, several sparrow species, and a few herptile species (which prefer open meadow habitat) might increase slightly in abundance on the site.

According to the Tennessee Heritage Program personnel, the six-lined race runner (*Cnemidophorus sexlineatus sexlineatus*) requires "special management" in Tennessee. The race runner is relatively abundant (4.4 animals per hectare) in meadow and meadow-forest edges on the site, especially on open sandy dredge spoil hills with sparse to dense herbaceous vegetation. Restoration of portions of the site to a poor-quality grassland is a planned mitigation measure that should benefit the race runner. David Shupe, A-95 Review Coordinator for the Tennessee Heritage Program, provided the following information on the ecological requirements of the race runner, which should be considered in such a habitat management program (letter to W. W. Tolbert, Oct. 24, 1979). The race runner requires dry, well-drained areas with loose and/or sandy soil. Cover such as boards, rocks, vegetation, or burrows is required for shelter. Basking sites are also a prime habitat component. Dr. Jim Jacobs, biologist at Memphis State University, is conducting additional ecological research on this species at the site.

Uncommon or rare species in the site area that are associated primarily with bottomland forests are the swamp rabbit and the Mississippi kite. Currently, the forest on the site appears to be low-quality habitat for swamp rabbits, because of the lack of understory cover caused by dredge spoil disposal. The Mississippi kite does not nest on the site but nests in other forests in the area which have larger trees. The onsite forest is potential future nesting habitat, but the probability of nesting at the site may be reduced because of the proximity of the Allen Generating Plant. Current nesting populations of the Mississippi kite should not be significantly affected, although industrial use of the site would preempt any future use of the site by kites.

Other uncommon or rare species that breed in the area are the six-lined race runner and the bobcat. The race runner is not associated primarily with floodplain habitats. It is common on the site in well-drained meadow habitat. Bobcats have rarely been recorded in the site area and are not associated primarily with floodplain habitats, although they show some preference for such habitats.

#### Threatened and endangered species

No threatened or endangered plant species on lists of the U.S. Department of the Interior<sup>28</sup> or the State of Tennessee<sup>29</sup> were observed within 3 km of the site during the site survey. The Tennessee Heritage Program staff ran a computer check of Shelby County, Tennessee, and reported no records of endangered, threatened, or special management plant species at the site. The USFWS has reviewed the information for the site and believes that there are no threatened or endangered species in the impact area of the project (Sect. 3.1.7 and Appendix B.3.1).

Other wildlife considered by the state of Tennessee as threatened, endangered, or in need of special management include the swamp rabbit, marsh hawk (winter resident), sharp-shinned hawk (winter resident), Mississippi kite (summer resident), and six-lined race runner (see Table 3.11). The Mississippi kite would lose 42.8 ha (105.7 acres) of successional bottomland forest, which is foraging habitat and potential future nesting habitat. The marsh and sharp-shinned hawks would lose winter foraging habitat and could thus experience minor population declines.

Populations of the Mississippi kite (*Ictinia mississippiensis*) have decreased because of a loss of forest habitat.<sup>29</sup> Fred J. Alsop, Associate Professor of Biological Sciences, East Tennessee State University (letter to W. A. Beimborn, April 13, 1979) stated that habitat loss through deforestation for agriculture (e.g., soybeans) in the Mississippi River floodplain seems to be the single most important factor contributing to the decline of this species' population in West Tennessee. Construction of the site facilities will remove an area of successional bottomland forest that is used for foraging but not for nesting. Suitable foraging areas for the kite appear to be much more extensive than are suitable nesting sites. Because no mature bottomland forest (which is required for nesting) will be affected, impacts on current Mississippi kite populations should be minimized.

#### 4.1.7.2 Operational impacts

Ecological and land use impacts could result from particulate and gaseous emissions, vehicular traffic, noise, human presence, and production of waste products. Because the effects of vehicular traffic, noise, production of waste products, and human presence would be minor, only

air pollution effects are addressed in this section. The analysis focuses on impacts on vegetation, because air pollutants in general have not been shown to have direct effects on wildlife populations, except in extremely high concentrations.<sup>30</sup>

The maximum expected concentrations of the major air pollutants ( $\text{SO}_2$ ,  $\text{NO}_x$ , particulates) resulting from operation of the proposed plant are roughly one-tenth of the existing concentrations at the site. The existing concentrations could already adversely affect extremely sensitive plant species. The small increment from plant operation would slightly increase any existing levels of impacts. Any such increases would be very difficult to detect by monitoring and could probably not be distinguished from effects caused by air pollution from other industries in the area. Applicable EPA air quality standards will not be violated during normal plant operation (Sect. 4.1.1.2). Detailed analyses and background information are given in Appendix C.6.

At the specific locality where pollutant concentrations will be maximal as determined by wind direction (about 2 km northeast of the facility), the normal operation of the plant is expected to increase ambient ground-level concentrations of  $\text{SO}_2$  by  $85 \mu\text{g}/\text{m}^3$  for the 3-h maximum,  $24 \mu\text{g}/\text{m}^3$  for the 24-h maximum, and  $2 \mu\text{g}/\text{m}^3$  for the annual average (Sect. 4.1.1.2). These concentrations compare with current ambient  $\text{SO}_2$  levels of 523, 214, and  $34 \mu\text{g}/\text{m}^3$  and represent increases in these levels by 16, 11, and 6% respectively (Table 3.1). During the growing season (April to September), the maximum levels would be  $45 \mu\text{g}/\text{m}^3$  for the 3-h maximum and  $13 \mu\text{g}/\text{m}^3$  for the 24-h maximum. For sensitive plants, it has been projected that the 4-h  $\text{SO}_2$  concentrations required to produce threshold injury are from 262 to  $2620 \mu\text{g}/\text{m}^3$ .<sup>31</sup> Therefore both the short-term existing ambient levels and the resulting ambient level during plant operation could affect sensitive species. Soybean, which is grown in the area, is considered a sensitive species.<sup>31</sup> Therefore soybeans grown on Presidents Island in areas of maximum  $\text{SO}_2$  concentrations could experience slightly reduced productivity. Maximum  $\text{SO}_2$  concentrations at other areas, including other areas on Presidents Island will be less (Figs. 4.1-4.3); any effects on soybeans will also be less.

Plants are several times less sensitive to  $\text{NO}_x$  than to  $\text{SO}_2$ .<sup>32</sup> Normal plant operation is expected to increase the ambient annual average  $\text{NO}_x$  concentration of  $30 \mu\text{g}/\text{m}^3$  (Table 3.1) by a maximum of  $2 \mu\text{g}/\text{m}^3$  (Sect. 4.1.1.2). Therefore there should be no significant effects on plants from  $\text{NO}_x$  emissions.

The predicted maximum concentrations of carbon monoxide represent less than 1% of the air quality standard. Most hydrocarbons are expected to be consumed by the controlled combustor and the plant flare; therefore, the air quality standard of  $160 \mu\text{g}/\text{m}^3$  should be easily met during normal operation. Particulates from coal handling and storage will settle primarily within 100 m of the facility (Sect. 4.1.1.2) and should therefore have no significant effects on vegetation surrounding the site. Normal plant operation (excluding coal handling and storage) is expected to increase the ambient annual average particulate concentration of  $58 \mu\text{g}/\text{m}^3$  (Table 3.1) by only  $0.2 \mu\text{g}/\text{m}^3$  (Sect. 4.1.1.2).

The formation of secondary pollutants such as peroxyacetyl nitrate (PAN) and the occurrence of acid rain are regional, rather than site-specific, problems. Operation of the proposed plant will cause a very small increment to these problems.

Operation of the cooling towers will result in deposition on vegetation and soils of small amounts of chromium, zinc, and various salts. Cooling tower installations at industries throughout the United States have not caused significant ecological problems. Therefore operation of the relatively small cooling towers at the proposed site should have no significant impacts (see Appendix C.6 for more detailed analysis). In addition, small amounts of organics may be emitted. However, their concentrations would be so small that no significant effects on vegetation should occur.

#### Threatened and endangered species

Operation of the proposed facility would not affect any Federally protected plant species. There should also be no significant adverse effects on animals. However, uncertainties regarding some facility effluents and their long-term effects on the biota have been discussed above.

#### 4.1.8 Economic, social, and cultural impacts

In the following analysis of the economic, social, and cultural impacts of the MLGW facility, primary attention will be focused on the direct impacts of the MLGW facility. Currently, a sufficient number of existing industries have expressed interest in the MLGW industrial fuel gas to completely utilize the plant output. However, no firm commitments have been made to actually purchase the product gas once the plant is operational. Therefore, the actual number of existing industries which will buy the product gas cannot be specified. Should a surplus gas exist,

MLGW officials estimate that within 5 years of construction of the facility between 7 to 14 satellite industries that could utilize the MLGW product gas will move to the area.\* The most likely location for the satellite firms will be either the Pidgeon Industrial Park or Rivergate Industrial Park. Both of these areas are alternative sites for the MLGW facility and are within five miles of the proposed MLGW site. The presence of these satellite industries would represent direct economic impacts by the MLGW facility. In turn, each additional facility will generate direct impacts that may interact with the impacts of the MLGW facility over several years and result in cumulative impacts in any of the variety of impact areas discussed in the document. The magnitude of these impacts can only be estimated.

#### 4.1.8.1 Construction impacts

The construction phase of the MLGW facility is scheduled to begin with site buildup; it will peak about 2 years later. Construction will cease and operation will begin about 3.5 years after start of construction.

#### Demography and labor force impacts

Construction labor demand is the major factor affecting population and labor-force impacts. At this time, the peak manpower requirement for construction of the MLGW facility is estimated to be 703 workers and an average requirement 614 workers (Table 4.1.8-2).

Given that work-force requirements for construction projects are often underestimated,<sup>33</sup> a high probability exists that the estimate of 703 workers is low. In addition, some satellite industries may be built late in the MLGW construction phase, creating further demands for construction labor. However, neither the predicted demand for construction labor nor any anticipated expansion in demand is anticipated to exceed the available labor supply in the Memphis SMSA. As a consequence, the primary labor-force impact (i.e., demand for construction labor) will be to maintain employment levels and to contribute slightly to a reduction in unemployment in some trades during the construction phase.

Because the demand for labor will be met for the most part from the local labor supply there will be only about 30 in-migrants to the area. These individuals primarily will fill nonmanual jobs. Currently, it is estimated that the MLGW facility will generate 40 professional jobs. MLGW expects to fill 10 of these jobs locally, and 30 jobs will be filled by nonresidents who will migrate to the area. Based on U.S. population statistics and TVA construction experience, 70 to 75% of in-migrating workers would be married with an average of 3.2 children. The resulting total in-migration is calculated to be approximately 90 people. Such an in-migration has an insignificant impact on existing demographic trends. This conclusion would hold even if the in-migration were substantially larger because of the estimation error on the combined in-migration from the MLGW facility and some of its satellite industries. Only if additional and competing, large construction projects were undertaken simultaneously with the MLGW plant might the above conclusions be erroneous. No such projects are currently planned in the area.

#### Secondary employment and economic benefits

Construction of the MLGW facility will have a positive effect on the local and regional economy. In addition to the primary plant-related construction jobs that will create an estimated daily employment of 703 at peak and 614 average, it is estimated that approximately 570 secondary jobs will be supported in the local economy. This figure is based on an employment multiplier of 1.93. These secondary jobs will not be newly created because the Memphis economy has enough surplus service capacity to absorb most of the effects from the construction project. Incomes, however, and industrial output will increase somewhat as a result of the construction. An estimated \$50 million (1978 dollars) in wages will be paid to the construction labor force over the construction period. Applying a multiplier of 1.83, the effect of the wages should be to provide \$91,500,000 of business to the Memphis SMSA economy. Additional benefits will result from the purchase of materials and services for plant construction. An estimated \$70 million (35% of the capital cost of the plant of \$200 million) will be spent locally. These will be expenditures for materials, fuel, and miscellaneous items.

#### Housing

The estimated low number of in-migrants to the area should have no noticeable impact on the housing markets in the impact area. Given the availability of housing, no shortages will occur (see Sect. 3.1.8.1). Neither should the demand alter existing trends in building starts or prices.

\*Based on marketing studies prepared by MLGW and personal communications with MLGW officials.



## Services

Given the variety of residential choices and the low number of predicted in-migrants to the area, it is not necessary to determine the locating patterns of in-migrants to describe specific service impacts by jurisdiction. However, residential choice patterns are assumed to follow existing trends in population growth and housing development. Growth areas, particularly in southeast Shelby County and Germantown, are likely choices for the few in-migrants.

Impacts on specific public services will in most instances not be noticeable. The estimated 22 new school children can easily be absorbed in the school systems. Health care services are abundant, and other services such as sewage disposal have additional capacity. Impact on traffic control, which is to be provided by the Memphis City Police Department, will probably be noticeable. Traffic flows to and from the site may require some control measures on the single access road (Mitchell Road) to the primary site. Not only will an increase in traffic volume occur, which will include a considerable number of trucks, but also portions of Mitchell Road will be under construction for part of the time. Increased traffic control at Mitchell Road School and Ford Road School may be required.

Construction activities also will contribute to the volume of dust and refuse in the environment. The city of Memphis recognizes that construction debris and improper handling of solid waste during hauling are major polluting factors and has already requested that measures be taken to reduce these impacts, Peter R. Pettit, Memphis City Beautiful Commission, personal communication, Nov. 6, 1980. The measures to be carried out include placing tarps on open-bed trucks, fencing the construction area, transporting dirt, watering down exposed dirt areas, and providing adequate refuse containers on site.

Private service section within the Memphis SMSA should easily absorb the increase in demand without new development or hiring.

## Finance

This section identifies the impacts of the proposed project on public revenues and expenditures. These impacts are considered at two levels: (1) in the broad context — how the facility and related developments will affect all governments and (2) in the manpower view — how the project will affect local and regional government impacts where fiscal impacts could be descriptive.

Almost no direct tax payments will be made during the construction period. The MLGW Division is exempt from property taxes on the facility and no in-lieu-of-tax payments will be made during construction. Local capital expenditures estimated at \$70 million may be subject to local sales taxes, but the tax is limited to the first \$500 of a purchase, and the revenue would be small. The city of Memphis has introduced legislation to exempt the construction of the facility from any state or local sales tax.

The only direct tax that is applicable to the plant during construction is a 1.5% use tax (1.0% state; 0.5% local) on equipment upon installation. Although it is not clear what portion of the estimated \$200-million capital cost would qualify for these taxes, the revenues would not exceed \$3 million if the total were taxable. The maximum revenue the city of Memphis could earn from this use tax would be \$1 million, the current estimate, however, is \$285,000.

Local construction wages of \$50 million annually would produce total personal income of \$91.5 million through direct and multiplier effects. This income, assuming a 50% level of consumption and sales tax exemptions, could be responsible for sales tax revenues. In Shelby County, a 6% sales tax is levied; 1.5% remains in local coffers and 4.5% is sent to the state. Total local revenues amount to \$686,000; however, these are not necessarily new revenues. Because most workers will already reside in the area (i.e., little anticipated in-migration) and are assumed to have been previously employed, insignificant increases in personal property tax revenues can be anticipated during the construction phase.

Only minor state-level expenditures will be associated with the proposed project.

Because of the small number of residents relocating during the construction phase, the fiscal impact on local services will be minimal. The primary local fiscal impacts during the construction phase would result from the construction of the new Mitchell Road, causing an expense that will exceed \$185,000 per year (assuming a capital cost of \$2.5 million and 7% tax-free municipal bonds repayable in 30 years). The only direct local tax applicable during the construction phase is the 0.5% use tax on labor and installation. For a \$200 million capital investment, these revenues will amount to \$285,000 annually. As a result, construction-phase fiscal impacts are likely to be minor but positive.

### Transportation

During the construction phase, most large equipment components will be delivered to the site by barge. Other equipment and supplies will be delivered by truck or by rail. These deliveries are not anticipated to cause adverse impacts.

Most of the construction workers will drive private cars. Primary access to the plant site is along Mitchell Road, west of the intersection of Mitchell Road and Weaver Road. West of this intersection, Mitchell Road passes through T. O. Fuller State Park. In 1979, average daily traffic between Horn Lake Road and Weaver Road of Mitchell Road was 5370 vehicles.

At the peak of construction approximately 600 new vehicles will be added to existing traffic. This estimate is based on the assumption that there will be 1.2 workers per car (a national average) and that there will be some delivery traffic. These 600 vehicles will make approximately 1200 trips/day, and will increase the traffic load on Mitchell Road by 18%. This traffic will be concentrated during the time periods 6:00 to 7:00 AM and 3:00 to 4:00 PM, 5 days a week. The additional traffic generated by plant construction should not seriously affect transportation in the vicinity of the site or in surrounding residential areas along the access route. Because the traffic will occur during the work week at times when most people are not using park facilities, the effect in Fuller Park should be minimal. Similarly traffic from commuting workers during the school year should not present any impacts to the school areas or increased risks to students because the workers will be arriving before school begins and returning home after dismissal. Traffic problems caused by additional truck traffic and road construction may, however, occur and require traffic control measures. The new Mitchell Road is scheduled for completion in 1984 and will provide an additional capacity of 20,000 vehicles per day, which will reduce the volume on old Mitchell road by 3000 vehicles per day.

#### 4.1.8.2 Operational impacts

##### Demography and labor force

Plant operation will require a permanent plant staff of 270 persons, which will include clerks, maintenance craftsmen, maintenance apprentices, maintenance laborers plus additional supervisory and professional staff. An additional 140 jobs will be contracted for maintenance and support services representing a total labor force of 410 persons. Most of these jobs can be filled from the Memphis SMSA labor pool, but persons having certain skills necessary for plant operation are not believed to be available in sufficient numbers in the Memphis area. Individuals having these skills will be recruited from outside the area. MLGW estimates that approximately 75 workers out of the total demand for labor will relocate to the area. This will create a total in-migration of approximately 195 persons (workers and their families). Such an increase will not alter existing demographic trends.

If as previously suggested, MLGW is successful in attracting new industries to the Memphis area, these industries will provide additional permanent employment opportunities to those mentioned above. The number of jobs created will depend on the nature of the firms that migrate, their size, and the number of new facilities. One estimate produced for MLGW is that 400 new permanent jobs will be created between 1985 and 1990 as a result of the development of 9 satellite industries to the MLGW facility.<sup>34</sup> Such estimates at this time are speculative. In-migration from any potential satellite industries in addition to that created by the MLGW facility, however, should not alter existing demographic trends in the area nor create an excessive demand on the local labor pool.

##### Housing

Approximately 75 families will relocate to the Memphis SMSA during the operation phase of the demonstration plant. Housing in the various communities surrounding the facility including Memphis is more than adequate to meet this demand.

##### Economic base

The effect of plant operation on the local and regional economy should be strongly positive. The number of primary jobs and contracted service jobs for the plant, as stated previously, will be approximately 410. Applying a multiplier of 1.93, 383 secondary service jobs will be maintained. These will not be new jobs because the Memphis area has excess service capacity and can absorb the new demand without new hires.

An estimated \$6.4 million (1978 dollars) will be paid annually in wages to the direct operation staff. The contracted maintenance and services staff will receive wages of \$2.8 million (1978

dollars) annually over the life of the plant. This influx of wages could ultimately result in \$16.8 million (1978 dollars) of annual income to the Memphis and Shelby County economies.

Whether or not MLGW attracts new industries and creates long-term industrial growth in the Memphis area will depend on future economic conditions: (1) the supply of natural gas and its price; (2) the amount of competition between existing MLGW customers, other potential Memphis customers, and new firms migrating to the area; (3) and the market locational advantage of Memphis relative to other SMSAs.

It is not possible to predict the result of the interaction of these factors at this time.

### Services

Given the variety of residential choices and the low number of predicted in-migrants to the area, it is not necessary to determine locating patterns for in-migrants to describe specific service impacts by jurisdiction. Residential choice patterns are assumed to follow existing trends in development (Sect. 3.1.8.1) and many in-migrants are assumed to choose to live in the growth communities (e.g., Germantown) surrounding Memphis or in southeastern Shelby County.

Impacts on specific services will not be noticeable. During operation of the demonstration plant, an estimated 56 additional children of the MLGW facility will attend Memphis SMSA schools. Because attendance at these schools is well below capacity, no adverse impacts are foreseen. Similarly, the projected operation-phase increase of 198 persons is not expected to impact adversely on the health care services of the area. Fire and police are also not expected to be adversely impacted. Because of the reduced traffic following completion of plant construction, the additional concern for traffic control will also be removed. Although the Memphis City Fire Department will have the additional responsibility for protection of the facility, no new personnel, equipment, or specialized training activities are anticipated at this time. The Memphis Fire Department is large, has a high fire protection rating, and is trained and experienced in the handling of hazardous material fires, Kerry Koen, Planning Coordinator, Memphis Fire Department, personal communication, January 20, 1981.

Because of the large number of people currently served by water and sewer systems in Shelby County and the low number of relocating workers associated with operation of the plant, no adverse effects are expected to result. The plant sewage disposal needs will be accommodated via connection with the nearby Maxson Wastewater Treatment Facility. The MLGW plant is expected to account for 1% of the current load on the sewage treatment facility and should be easily accommodated.

Operation of the plant and the low level of relocation associated with it are not expected to result in adverse impacts to delivery of electric power, natural gas, or telephone service. The output of the plant — product gas — will provide an assured supply of energy to industry and commerce and will allow for future growth in these sectors. The existing systems of electric power and telephone service have more than adequate capacity to serve these workers.

The private service sector should easily absorb any increase in demand without new development or hiring.

### Finance

Operators wages are expected to provide \$16.8 million in annual income through direct and multiplier effects. These wages will generate most of the annual tax revenues.

The plant will be exempt from the same taxes during operation as it was during construction. The only significant direct tax will be the use tax on new equipment installed. New local residents are likely to be the major contributors to local tax revenues. The following estimates of the operation's fiscal impact are based mostly on the nonresident estimate discussed earlier and on the assumptions (1) that the total work force will be located in the Memphis and Shelby County area and (2) that the estimated project-related \$16.8 million annual income will be spent in the local area.

As a result, sales taxes will produce \$0.5 million annually, assuming that 50% of personal income will be consumed on taxable goods. The state will receive \$380,000. Property taxes will constitute only a small part of the total local revenues. During the operations phase, the plant will pay a 1.5% gas sales tax to the state.

In Memphis, the major fiscal impacts during the operations phase will continue from the prior construction period. The new facilities will continue to produce some revenues, although limited by the tax-exempt status of the MLGW utility. As was stated earlier, few revenues are paid directly to Memphis because of the exemptions for sales and property taxes. The revenues that

will be collected by Memphis from use tax during operation should amount to approximately \$50,000 per year.

The primary local expenditure will be the financing of the new Mitchell Road, which will be initiated in the construction phase, the yearly cost of which is \$185,000. During the operations period, local use and sales tax will produce \$176,000. Because the full annual cost of constructing Mitchell Road cannot be attributed to the MLGW facility, the fiscal balance remains favorable during the demonstration operations phase.

Based on historical personal income and tax revenue relationships, the \$16.8 million estimated annual income could produce a total state and local revenue of \$1.7 million, \$660,000 of which would be raised in Memphis. The difference between this potential tax revenue and the \$176,000 identified above can be related to the tax-exempt status of the utility and the short demonstration operations period.

#### Transportation

During operation, plant transportation requirements will be confined primarily to water and highways. Western Kentucky coal for the gasifier will be delivered weekly by barge (approximately fourteen 1500-ton barges per week). The barges will be moored at the barge unloading facility on the north shore of the turning basin that separates the plant site from the Allen Generating Plant. Barge delivery is not expected to result in adverse effects on other transportation in the plant vicinity.

Numbers of workers commuting to and from the plant site will decrease sharply in the operational period, compared with the construction period. Vehicle trips along the new and old Mitchell Roads will drop to 390 daily, down from the 1200 vehicle trips daily estimated during construction. This traffic will also be distributed over a 24-h period because the plant will operate on three 8-h shifts. This increase in traffic will be approximately 7% over the 1979 average daily traffic along Mitchell Road nearest the plant site (5370 vehicles per day) and will not pose a significant impact. Traffic from satellite industries locating in the Pidgeon industrial park could increase this estimate but not significantly affect transportation.

Truck traffic to and from the site will be minimal. Approximately one truck per week is estimated to be required to remove waste materials. Should offsite disposal of nonhazardous solid wastes be necessary, this would require about one 3-by-3 barge cluster per month or about 15 trucks per day.

#### Historical, cultural, and archaeological features

No historic or prehistoric relics have been found on the site; therefore, operation of the plant is not anticipated to result in adverse impacts (Appendix B.4).

Similarly, no significant visual features are present on the plant site or its immediate environs. The plant in its operational form will blend in with the industrial character of its surroundings and should not adversely affect the view from Fuller State Park or other recreational areas. Water vapor plumes from the cooling tower will be visible on certain occasions. The frequency of plume occurrence will be determined by prevailing meteorological conditions. Plume length is predicted to be in the range of 300 to 500 m (985 to 1640 ft) and should not result in a significant adverse visual impact from offsite vantage points.

### 4.2 ALTERNATIVE SITE NO. 1 — RIVERGATE, SHELBY COUNTY, TENNESSEE

#### 4.2.1 Air quality and noise

##### 4.2.1.1 Construction impacts

Construction at the Rivergate site could require extensive earthmoving activities to provide foundation stability and to elevate the site above the project design flood level. These activities could result in large quantities of fugitive dust being carried off site unless the affected area is kept moist or revegetated. Exhaust emissions could be larger than those calculated in Sect. 4.1.1.1 and would result in slight offsite increases.

##### 4.2.1.2 Operational impacts

Routine emissions would be similar to those predicted in Sect. 4.1.1.2, and the resultant concentrations would be nearly equal. Synergistic effects of the pollutants emitted by the proposed

facility and the Delta refinery and other industrial sources in the area are unknown and unquantifiable. Quantifiable impacts could be considered equal at the two sites.

The impacts of pollutants released during accidents could be greater at the Rivergate site because of the proximity of the Delta refinery and the populated areas of Memphis. These impacts are not currently quantifiable, but the results of an accident would be significant at either site.

Offsite noise exposure during construction and operation is dependent on the specific locations of noise-producing equipment. Impacts at the Rivergate site should be comparable with those at the proposed site, where little or no offsite noise impact is anticipated.

#### 4.2.2 Hydrology

##### 4.2.2.1 Construction impacts

###### Surface water

The primary hydrologic impacts that would occur with site development are an increase in surface runoff to Lake McKellar and a slight reduction of floodplain storage capacity for flooding above the 71-m (230-ft) elevation. This impact is expected to have little effect on the Lake McKellar hydrologic system; however, improper handling of increased runoff could result in additional erosion of the fill embankments. Protection of the site from flooding by floods of the project-design magnitude requires construction of a 1-m-high dike at the site perimeter or a general site buildup of 1 m. The effect of this measure would be a slight, but, approached realistically, unmeasurable reduction in floodplain storage capacity.

###### Groundwater

Construction on the Rivergate site may require consolidation of material in the existing fill or removal of existing fill and subsequent refilling of the site, and dewatering of parts of the foundations may be required. Temporary lowering of the water table and reduction of permeability in near-surface sediments will have a minor local effect on groundwater availability. Infiltration of spilled fuels or chemicals during construction activities could result in deterioration of groundwater quality in the alluvial aquifer. Mitigation of this impact, should it occur, could require dewatering of the contaminated area and treatment of effluent water.

##### 4.2.2.2 Operational impacts

###### Surface water

During operation of the facility on the Rivergate site, surface runoff will be increased over that of the undeveloped site. Runoff from the plant area is routed through the wastewater treatment system, and holding basins would be provided to contain runoff produced by a ten-year 24-h rainfall. This retained water would be treated and gradually released to either the Mississippi River or Lake McKellar, minimizing immediate impacts on the surface water hydrologic system. Assuming that plant design and layout would be the same on the Rivergate site as on the Allen site, the operational impacts on hydrology would be minor at either site.

###### Groundwater

The potential groundwater impact of greatest concern during operation of the facility is contamination of the Memphis water supply caused by failure of liners beneath the coal storage or waste storage areas. The possible hydrologic connection between the alluvial aquifer and the 500-ft sand has been discussed previously. The location of the Rivergate site at the mouth of Nonconnah Creek increases the possibility that contamination of the alluvial aquifer could ultimately affect the quality of the potable water supply. Higher water treatment costs in the future would result from aquifer contamination. Mitigation of this potential hazard depends on the long-term integrity of liners beneath coal and waste storage areas and on an effective groundwater monitoring system to detect leakage of contaminants.

The probability of a liner failure cannot be quantified. If toxic substances contaminate the alluvial aquifer beneath the Rivergate site, there is a greater possibility that the drinking water aquifer would be contaminated than if the facility were located on the Allen site.

#### 4.2.3 Water quality

##### 4.2.3.1 Construction impacts

Potential impacts on surface water quality from construction of the MLGW demonstration plant at the Rivergate site include the effects of dredging for site buildup, construction of a wastewater discharge pipeline into the Mississippi River, site runoff into Lake McKellar and Nonconnah Creek, shoreline disturbance during any additional site preparation, construction of water supply and product gas distribution pipelines, and construction of dock facilities in the barge canal.

The effects of constructing a buried wastewater discharge pipeline running southwest into the Mississippi River would be as described in Sect. 4.1.3.1. Other impacts listed above would be qualitatively similar to impacts of construction at the Allen site. Site preparation required at the Rivergate site is uncertain. As a result, site runoff impacts and shoreline disturbance effects could be less or greater than at the Allen site if removal of the existing fill is necessary. However, although less dredging would be required at the Rivergate site than at the Allen site, dredging in Lake McKellar would have a more prolonged effect than an equivalent effort in the Mississippi River because of the smaller dispersive capacity of the lake.

##### 4.2.3.2 Operational impacts

It is assumed that if the MLGW facility were sited at the Rivergate location, its wastewater would be discharged into the Mississippi River. In this case, impacts from wastewater discharge will be as discussed in Sect. 4.1.3.2. Other operational impacts, qualitatively similar to those discussed in Sect. 4.1.3.2, could include effects of runoff or leachates from solid wastes, barge traffic and associated activities (maintenance dredging), and coal spillage. As is the case at the Allen site, the water supply would be obtained from groundwater. Therefore, no direct surface water quality effects would result.

#### 4.2.4 Aquatic ecology

##### 4.2.4.1 Construction impacts

Ecological impacts on the aquatic biota are expected to be similar to those described for the Allen site in Sect. 4.1.4.1.

##### 4.2.4.2 Operational impacts

Ecological impacts to the aquatic biota are expected to be similar to those described for the Allen site in Sect. 4.1.4.2.

It is not expected that construction or operation of the MLGW facility at the Rivergate site would have any adverse effects on aquatic species designated by Federal or State authorities as being endangered, threatened, or otherwise of concern (Sect. 3.2.4).

#### 4.2.5 Geology and soils

##### 4.2.5.1 Construction impacts

###### Geology

Construction impacts related to geology include (1) foundation failure caused by differential settlement and (2) seismically induced foundation failure. Poorly consolidated sediment lenses or compactible clays in the subsurface may pose a hazard of differential settlement, with resultant damage to spread footing foundations. Preliminary subsurface information for the Rivergate site indicates that portions of the fill are uncompactible silty clay, which would have to be excavated, disposed of, and replaced to provide a foundation capable of bearing the loads anticipated for the proposed project.

###### Soils

Soils on the Rivergate site consist of gravelly sand of recently dredged alluvial fill. The fill was emplaced for the purpose of raising the area above flood elevation prior to industrial development. No adverse soil impact is anticipated as a result of site development.

The impact of fill emplacement has already occurred on the Rivergate site, and previously existing soils are apparently buried beneath the fill. The ability to excavate and stockpile surficial soils on the Allen site will lessen the impact on existing soils of that site. Construction impacts to obtain dredge/fill material from the Mississippi River will be the same for both sites.

#### 4.2.5.2 Operational impacts

##### Geology

Geology-related operational impacts concern the stability of foundation materials and the possible hydrologic connection between the alluvial aquifer and the 500-ft sand aquifer beneath Nonconah Creek. The Rivergate site is located closer to the area in which this hydrologic connection is proposed than is the Allen site. This location increases the possibility that contamination of the alluvial aquifer could ultimately result in contamination of the water supply for the city of Memphis. Quantification of this hazard is not possible because of the lack of data locating permeable zones in the Jackson clay and uncertainties as to the likelihood of hazardous materials being leached into the groundwater.

The seismic hazard of the Rivergate site is equivalent to that of the Allen site. The site may be susceptible to foundation failure in the event of a serious earthquake. The probability of a severe earthquake occurring during the operational lifetime of the facility is low; however, to minimize the hazard to the plant, a thorough foundation analysis would be required.

##### Soils

Materials in the fill that form the site are permeable and have a low attenuating capacity for infiltrating contaminants. Conditions are favorable for mobility of infiltrating contaminants in the site soils. A gradual accumulation of pollutants could occur in the fill material and adversely affect the soils; however, the potential for contamination of the alluvial aquifer appears to be a greater hazard.

Potential operational impacts on soils would be essentially the same for both sites because both are underlain by similar materials.

#### 4.2.6 Land use

##### 4.2.6.1 Construction impacts

Construction of the MLGW facility at the Rivergate Industrial Park would be consistent with existing and planned land use.

The Rivergate site has been filled to above the 100-year flood stage but below the project design flood stage and is zoned for heavy industrial land uses. Detailed land use impact analysis has not been conducted, but the impacts should generally be comparable with impacts at the proposed site. Because the Rivergate site is in an industrial park and should be attractive to private development, use of this site by MLGW could result in the loss of potential tax revenue.

Constructing the wastewater discharge pipeline at this site would require disturbance along a longer right-of-way than constructing the wastewater discharge pipeline at the proposed site. The precise right-of-way location for the Rivergate site has not been identified.

##### 4.2.6.2 Operational impacts

The Rivergate site has been filled to above the 100-year flood stage and is zoned for heavy industrial land uses. Detailed land use impact analysis has not been conducted, but the impacts should generally be comparable with impacts at the proposed site. Because the Rivergate site is in an industrial park and should be attractive to private developers, use of this site by MLGW could result in the loss of potential tax revenue.

#### 4.2.7 Terrestrial ecology

##### 4.2.7.1 Construction impacts

Effects on terrestrial ecology will be very small at the Rivergate site because of the sparse early successional vegetation of the site and because there are already plans for industrial

development of the area. The six-lined race runner is probably as abundant on this site as in the meadows of the proposed site. This habitat will be destroyed when the development is completed. No other rare, threatened, or endangered species should be affected.

#### 4.2.7.2 Operational impacts

Operational effects on land at the Rivergate site would be essentially identical to those at the nearby proposed site because the emissions and meteorology would be the same. Effects on agricultural and natural systems would be somewhat less because of the greater proximity of this site to developed areas of Memphis.

#### 4.2.8 Economic, social, and cultural impacts

##### 4.2.8.1 Construction impacts

Although no detailed analysis has been done for the Rivergate site, the close proximity to the proposed site would result in essentially identical impacts very close to the site.

Construction at the Rivergate site would require the development of a better access road since the series of roads leading to the Rivergate site has not yet been completed. An at-grade railroad crossing must be crossed to get to the site. Because the Rivergate site is potentially attractive to private industry, possible tax loss could result if MLGW used this site.

##### 4.2.8.2 Operational impacts

Impacts would be essentially identical to those for the proposed site except for possible displacement of private tax-paying industrial development.

#### 4.3 ALTERNATIVE SITE NO. 2 — PIDGEON, SHELBY COUNTY, TENNESSEE

Analysis of impacts at this alternative site includes the analysis, where appropriate, of two possible locations for the barge facility. One location is adjacent to the Mississippi River to the west of the site; the other is at the Lake McKellar barge turning basin.

##### 4.3.1 Air quality and noise

###### 4.3.1.1 Construction impacts

Construction at the Pidgeon site would require some earth-moving activity to build up the site. The fill used for this activity would be dredge spoils, similar to those proposed at the Allen site. Quantities of fugitive dust could be carried off site unless the fill is kept moist or revegetated. Impacts on air quality resulting from construction activities would be similar to those discussed in Sect. 4.1.1.1.

###### 4.3.1.2 Operational impacts

Routine emissions would be similar to those predicted in Sect. 4.1.1.2, and resultant concentrations would be nearly equal at both the Allen and the Pidgeon sites. Locating the barge facility to the west of the site along the Mississippi River would result in greater fugitive particulate emissions because a longer coal conveyor would be required. Locating the barge facility at the Lake McKellar barge turning basin would result in fugitive emissions similar to those expected at the proposed site. Synergistic effects of the pollutants emitted by the proposed facility located on the Pidgeon site, the Allen Generating Plant, and other nearby industrial sources are unknown and unquantifiable. Quantifiable cumulative effects could be considered approximately equal for the proposed facility were it located at either the Allen or the Pidgeon site.

Offsite noise exposure during construction and operation is dependent on the specific location of noise-producing equipment in relation to noise-sensitive areas. Since the Pidgeon site is located in an area remote from residence and recreational areas, noise impacts at the Pidgeon site should be comparable with those at the proposed site, where little or no offsite noise impact is anticipated.



### 4.3.2 Hydrology

#### 4.3.2.1 Construction impacts

##### Surface water

Construction impacts on the hydrologic system which would be associated with development of the Pidgeon site are related to construction of the barge terminal and conveyor. Since the plant area is within a leveed zone, no impacts are expected from site development.

Options for locating the barge facility include placing it west of the site in the Mississippi River and locating it along the barge turning area in Lake McKellar, north of the Pidgeon site. If located in the river, the docking area would be practically in the navigation channel and would be subjected to strong current flows, especially during high-flow stages. Any area dredged adjacent to the river channel in the floodplain will be subject to rapid siltation and will require maintenance dredging. Siting the barge facility in Lake McKellar is complicated because the south shore of the existing turning basin west of the Allen Generating Plant is being reserved as a terminal for other Pidgeon Park industries. A coal conveyor would be required to move coal from the barges to the plant from either of the terminal sites. Hydrologic impacts related to construction of the conveyor are expected to be minimal.

##### Groundwater

Construction impacts on groundwater are primarily related to infiltration of spilled fuels or chemicals into the alluvial aquifer. Small spills are likely to be absorbed by surficial soils. Should a large spill occur, infiltration could allow contaminants to reach the alluvial aquifer, resulting in degradation of water quality in a local area. Handling fuels and chemicals in controlled areas where spills can be properly handled will minimize the potential for groundwater contamination.

#### 4.3.2.2 Operational impacts

##### Surface water

Operational impacts related to the development of the Pidgeon site are expected to be dependent upon how coal is received at the facility. The operation of a terminal on the Mississippi River may complicate river navigation for other vessels. Docking facilities, if located on the main stream of the river, are likely to require a moderately high level of maintenance. Locating the coal conveyor on the floodplain is expected to have little impact on the hydrologic system. The conveyor would have to be elevated above flood stage to prevent flood damage. Locating the barge terminal in Lake McKellar would pose fewer navigational and maintenance problems; however, a longer and more complicated conveyor routing would be required, and the availability of water-front on the south shore of the lake is uncertain.

##### Groundwater

Operational impacts on groundwater at the Pidgeon site would be similar to those projected for the Allen and Rivergate sites. Under normal operating conditions, no impact is anticipated. Infiltration of wastewater or leachates derived from coal or solid waste could result in local deterioration of water quality in the alluvial aquifer.

Deterioration of liners beneath coal and waste storage areas and piping in the wastewater handling system could allow contaminants to infiltrate into the soil. The attenuating capacity of site soils has not been tested; however, the fine texture of the surficial soils is favorable for the physical attenuation of infiltrating liquids.

Should groundwater contamination occur on the Pidgeon site, a contaminant plume would form beneath the site. It is assumed that the plume would migrate toward the south or southwest because of the hydrologic interaction between the alluvium and the river.

### 4.3.3 Water quality

#### 4.3.3.1 Construction impacts

Impacts of constructing the MLGW plant at the Pidgeon site would arise from the following: (1) dredging for site diking or buildup, (2) discharge of dredge decant fluids, (3) constructing the barge dock (either on the Mississippi River or adjacent to the TVA Allen Steam Generating

Plant), and (4) dredging and laying the product gas pipeline across Lake McKellar. Impacts of constructing the barge dock in the turning basin and the construction of the pipeline would be very similar to those projected for the proposed site (Sect. 4.1.3.1).

Developing the Pidgeon site for the MLGW plant would require either constructing a secondary dike surrounding the site within the levee or building up the site elevation to a level above the 100-year flood stage. These operations would require fill material, which would presumably be obtained from dredging in the Mississippi River, as is planned for the Allen site. The impacts of dredging would resemble the impacts for the proposed site (Sect. 4.1.3), and the magnitude would depend on the amount of dredging necessary. Dredging only the amount of fill needed for diking would cause substantially less impact than dredging fill for the entire site. Decant fluids from the fill operation would probably be discharged to the Mississippi River. The results of elutriate testing suggest that the concentration of ammonia nitrogen might be elevated in this discharge, but, due to the dilution capacity of the Mississippi River, no significant impact on water quality would be expected.

Construction of the barge dock on the Mississippi River would cause only minor impacts, such as temporary increases in turbidity and the concentration of oxygen-demanding substances such as ammonia.

#### 4.3.3.2 Operational impacts

Water quality impacts from operating the MLGW facility at the Pidgeon site would result primarily from wastewater discharge. The impacts would be very similar to those for the proposed site (Sect. 4.1.3.2), with the added complication that discharge would occur downstream from the combined discharge of the Allen Generating Plant and the Maxson Wastewater Treatment Facility. As noted in Sect. 3.3.3, the water quality adjacent to the Pidgeon site is not fully characterized and is probably somewhat variable. Under most flow regimes, the water quality would probably be indistinguishable from that of water upstream from the Maxson Wastewater Treatment Facility discharge (Table 3.6). The MLGW effluent would be rapidly diluted to ambient concentrations, and the only impacts to water quality would be the small incremental loadings of those constituents for which ambient concentrations exceed the recommended levels. Under conditions of very low river flow and/or unusually heavy loading from the Maxson Wastewater Treatment Facility, water quality at the point of MLGW discharge might be detectably degraded by the Maxson Wastewater Treatment Facility discharge. The Maxson Wastewater Treatment Facility discharge might cause a decrease in dissolved oxygen and elevated concentrations of numerous heavy metals, trace elements, or organic compounds. Thus, the MLGW discharge, as an incremental source of contaminants, could be considered to have a greater impact at the Pidgeon site because of its poorer water quality. However, the quantity of the MLGW discharge is, comparatively, very small and only very minor degradation of water quality, if any, could be attributed to the discharge.

#### 4.3.4 Aquatic ecology

##### 4.3.4.1 Construction impacts

The dredging of the fill material for the Pidgeon site will cause temporary defaunation of the dredge area. The location and size of the dredged area are unknown, but the dredged area is assumed to be close to the plant site. Because of the poor conditions for benthic organisms in this area, the loss of benthos is expected to be of minor significance. Fish are likely to avoid the dredge area, while the water quality impacts of dredging (especially a decrease in dissolved oxygen) may produce very local ecological effects. Construction of a barge dock along the Mississippi River will also modify benthic habitat and have minor impacts on water quality. As noted in Sect. 4.1.4.1, the construction of the product gas pipeline will disturb only 0.04% of the area of Lake McKellar, causing insignificant impacts on aquatic communities.

If the barge dock were located in the turning basin near the Allen plant, dredging and other construction would cause adverse impacts to the aquatic communities (see Sect. 4.1.4.1). The sediment quality of this area has not been characterized, and the dissolved constituents that might be released during dredging are unknown. The quantity of water available for dilution in the turning basin is relatively small, and the mixing in Lake McKellar is somewhat sluggish. The release of oxygen-demanding substances, heavy metals, and possibly toxic substances adsorbed to sediments could cause acute or chronic stress to organisms in or near the turning basin. Characterization of the sediments in the dredge area would be necessary to determine the magnitude of these impacts.

#### 4.3.4.2 Operational impacts

The impacts on the aquatic biota from the operation of the MLGW facility at the Pidgeon site would result primarily from the wastewater discharge. The impacts would be similar to those for the proposed site (Sect. 4.1.4.2) with the added complication of possible interaction between the mixing zone of the proposed facility and the mixing zone created by the combined discharge of the Allen Generating Plant and the Maxson Wastewater Treatment Facility (Sect. 4.3.3.2). Chronic exposure to concentrations of chemicals exceeding the ambient levels may adversely affect aquatic organisms. However, because the dimensions of the mixing zone (even if under worst-case conditions it extends into the Allen-Maxson mixing zone) are projected to be relatively small, it is anticipated that the MLGW discharge will have only a localized impact.

#### 4.3.5 Geology and soils

##### 4.3.5.1 Construction impacts

The Pidgeon site is located on alluvium similar to that occurring on the other sites under consideration. No subsurface investigations have been performed on the site to indicate what type of foundation pretreatment is required. The potential for foundation problems on the Pidgeon site cannot be evaluated because no field investigations have been performed. Site development would require foundation investigation and an evaluation of possible construction methods.

During construction, site soils would be affected by compaction and grading, and possibly some areas would be covered by fill or additional diking. The erosion potential is low on the site except where dikes or embankments are left unprotected. Construction on the site would affect approximately 49 ha (120 acres) of prime farmland soils, which are currently used for soybean production. The degree of impact on site soils depends on whether fill is emplaced to raise the site above flood elevation, additional diking is constructed around the site perimeter, or soils are densified and the facility is constructed at the existing grade elevation. Engineering design for development of the Pidgeon site is not available.

##### 4.3.5.2 Operational impacts

Significant impacts related to geology and soils which are of concern during operation of the facility include the possibility of foundation settlement, which could affect plant operation, and the removal of agricultural land from production. The Pidgeon site, like the Allen and Rivergate sites, lies in an area of moderately high seismic risk and is underlain by poorly consolidated river sediment. Geotechnical investigation coupled with foundation pretreatment and design would be required to minimize the potential for future foundation problems.

Removing agricultural land from production would be an unavoidable impact of developing the Pidgeon site.

#### 4.3.6 Land use

##### 4.3.6.1 Construction impacts

Construction of the MLGW facility at the Pidgeon site would result in the removal of approximately 49 ha (120 acres) from agricultural production (soybeans), the disturbance of several additional acres of bottomland forest by barge coal delivery and coal transport facilities, and potentially slight soybean crop reduction from atmospheric emissions.

The Pidgeon site is zoned for heavy industrial land use. Because the Pidgeon site is in an industrial park and could be attractive to private developers, use of this site by MLGW could result in the loss of potential tax revenue.

##### 4.3.6.2 Operational impacts

Operational effects on land use at the Pidgeon site should be essentially identical to those at the nearby proposed site. Locating the barge facility in Lake McKellar would require a long coal conveyor visible from the Mississippi River and adjacent wetlands and forests. This would be an undesirable visual feature.

#### 4.3.7 Terrestrial ecology

##### 4.3.7.1 Construction impacts

Because the existing soybean fields on this site are not important habitat for native vegetation and wildlife, construction would have little impact on the biota. However, the land at this site is very productive and, in the absence of intense agriculture, could provide excellent wildlife habitat.

Construction of a coal conveyor would affect either the floodplain forest just west of this site or primarily soybean field and meadow to the north, depending on where the barge facility is located. If the barge facility is located along the Mississippi River west of the site, about 20 ha (50 acres) of floodplain forest would require clearing for a barge slip, since the U.S. Army Corps of Engineers will not permit construction of a barge facility in the Mississippi River Channel. The disturbance could have adverse impacts on any Mississippi kites nesting in this forest, depending on how sensitive the kite is to nearby disturbance or development. Impacts on other wildlife would probably not be as significant, because other wildlife species are more abundant and only a small area of their habitat would be affected. Construction of a coal conveyor to the north would have significantly less impact on the terrestrial biota. Impacts of constructing a barge facility on Lake McKellar would be the same as those for constructing it at the proposed site (Sect. 4.1.7.1).

##### 4.3.7.2 Operational impacts

Operational effects at the Pidgeon site would be very similar to those at the nearby proposed site because the meteorology and vegetation at the two sites are very similar. Operation of a coal conveyor through the floodplain forest west of the site and the proximity of the coal conversion facility to this forest might prevent Mississippi kites from nesting nearby.

#### 4.3.8 Economic, social, and cultural impacts

##### 4.3.8.1 Construction impacts

Because of the proximity of the Pidgeon site to the proposed site and because both sites would use the same access road, the impacts should be essentially identical for both sites except for differences very close to the site. Potentially, the Pidgeon site would have greater visual impact on the Chucalissa Indian Village. Also, because the Pidgeon site is potentially attractive to private industry, possible tax loss could result if MLGW used this site.

##### 4.3.8.2 Operational impacts

Impacts would be essentially identical to those at the proposed site except for a potentially increased visual impact on the Chucalissa Indian Village and a possible displacement of private tax-paying industrial development.

#### 4.4 OCCUPATIONAL AND PUBLIC HEALTH

MLGW prepared and submitted to DOE several documents that emphasize MLGWs commitment to a safe plant.<sup>35-37</sup> These documents state the procedures that will be followed during Phase II (construction) and Phase III (operation) on worker health, safety, and industrial hygiene. The documents also discuss potential health issues related to occupational exposure and to possible public exposure from the kinds of compounds to be formed in the IFGDP.

Identified chemicals of concern in the IFGDP include various metallic and nonmetallic trace elements (e.g., As, Hg, Ni, Cr, Pb, Cd, Se), PAHs, and other organics like aromatic amines, phenols, cresols, and gaseous compounds containing nitrogen, sulfur, and other coal-bound elements. Some of these chemical species may vary with a change in the coal feedstock. The U-gas process is advantageous because its high temperature of operation [i.e., 1024°C (1875°F)] leads to very low or zero production of many potentially hazardous materials, including organic species such as tars, oils, and PAHs. The IFGDP produces no organic base liquid process streams.

The materials of special concern are generally present in the IFGDP process streams at only minor or trace concentrations (see Table 4.10 for representative data from a U-gas pilot plant). Although many chemical species can be listed as having been detected in coal-conversion process streams, the quantities of these various compounds actually present, the magnitudes of their toxicities, and their exposure pathways determine the significance of health impacts.

The major species present are gases such as hydrogen, carbon monoxide, carbon dioxide, methane, and oxygen. The handling of these species also poses health and safety concerns, which must be incorporated into plant design considerations, but techniques for the safe handling of such gases are already in use by industry.

The preliminary and final safety analysis reports that will be prepared by MLGW will continue to make a thorough identification and evaluation of both health and safety hazards in the plant. These documents will also describe in detail mitigation measures for controlling and minimizing the hazards.

The IFGDP is being designed in strict accordance with applicable codes and regulations covering material selection, component specification, equipment performance, and worker and public safety as well as environmental impact. Worker exposure criteria specified by OSHA and NIOSH for materials of concern found in the plant will be met by the design.

Health effects related to many of the chemicals found in the IFGDP have been studied. Some criteria for worker exposure have also been developed.<sup>38-40</sup> These are being used by MLGW as a guide in detailed design and in the development of a final definitive industrial hygiene program, including work-place monitoring (Sects. 4.5.10 and 4.6.10).

Pilot plant studies have shown that the compositions of the coal-conversion process streams, products, and wastes may vary and are sensitive to changes in coal feedstock and process conditions such as temperature and residence time. This variability, combined with the fact that only a small pilot facility and a design for the demonstration plant exists at this time, reduces ability to predict the specific compounds and exact concentrations of such compounds that will be present in products, intermediate streams, wastes, and occupational environments of the demonstration plant. This, in turn, limits the ability to quantitatively predict occupational and public health consequences of altered plant operation conditions. Implementing worker education, protective clothing, medical, and monitoring programs will serve to minimize the potential for exposure-related illnesses. The accumulated evidence does suggest that if exposures are reduced<sup>41</sup> as measured by PNA content, coal tar pitch volatiles, or benzene-soluble particulates, cancer incidence may also be reduced. Evidence for PNA carcinogenesis in humans is predominantly from high exposure levels, where the agent induces a significant amount of "cancer-potential" through processes of hyperplasia, necrosis, cytotoxicity, inflammation, etc.<sup>42-44</sup> At very low exposure levels, potentiation stems primarily from endogenous mechanisms, and the dose-response curve may even become flat,<sup>45</sup> as illustrated by the typical "hockey-stick" response.<sup>46</sup> This behavior is most common for low doses given intermittently with sufficient separations in time. It is well-known from studies of mouse-skin, rodent-hepatocarcinogenesis, and epidemiological/pathological lesions of lung tissue in cigarette smokers that permanent metaplastic lesions without sustained promotion (above a threshold level) are insufficient to provoke carcinogenesis during a normal lifespan.<sup>42</sup> However, currently there is insufficient scientific basis for selecting among several possible dose-response relationships.

At the present, it is not possible to restrictively specify the precise molecular processes of importance in carcinogenesis, atherosclerosis, teratogenesis, mutagenesis, etc.; however, several studies have suggested that changes in cell proliferation/disruptions in tissue homeostasis and heritable changes in the genetic material of cells encompass most of the parameters likely to be important in the fundamental response mechanisms. These "indicator effects" may serve to complement dose or exposure concepts much in the same manner as in internal medicine, where the entire therapeutic plan is usually based on indicator events or monitored effects. Only rarely is the original insult known or even considered, and even less frequently is the offending insult quantified.

There is a general trend to focus on cancer. Much less is known about atherosclerosis although current evidence suggests that its etiology may be similar to cancer. The developmental period of an embryo (or even an infant) is a critical time. There is continual and rapid growth, and any insult that can breach the placenta and change the genetic material of a single stem cell should be of utmost concern, although genetic duplication may provide some degree of protection from low-level insults.

In this document, carcinogenesis is the primary concern for occupational exposures. It is possible to establish laboratory and mathematical cancer analogues that can be used to select energy alternatives and regulatory guidelines. This may also provide adequate protection for atherosclerosis and teratogenesis if similar response mechanisms are involved. In any event, it is clear that the best worker (or general population) health protection is to give priority to efforts to minimize exposure to relevant toxic materials. In addition to reducing exposure through emission controls, plant design, and maintenance procedures, a vigorous industrial hygiene program (Sect. 4.5.8) that will monitor and assess potential occupational health problems is essential. Exposures in modern coal-conversion facilities are expected to be, at worst, much lower than was the case for the coal utilization technologies previously discussed because exposures will be monitored and controlled in adherence to current and future occupational

health standards. However, potential exposures vary widely from technology to technology, and continual monitoring will be performed. As is later discussed, available data indicate that concentrations of toxic materials will be low relative to the indicator carbon monoxide concentration for the U-gas process.

The epidemiological study of coke oven workers<sup>41</sup> that related CTPV exposure groups to death rates concluded that "the established TLV of 0.2 mg/m<sup>3</sup> is considered to be adequate, as this level of exposure for an average period of 30 years does not increase the risk of dying from lung cancer." This is the principal type of internal organ cancer associated with coke oven exposure, although other cancers (liver, kidneys, etc.) may occur less frequently. Engineering controls will be designed to keep exposures within the limits specified by OSHA<sup>47</sup> for CTPVs. However, routine monitoring (Sect. 4.5.8) will be carried out in conjunction with operation of the plant to guide the selection of adequate protection procedures.

Assessment of occupational health risks required evaluation of the two major components of risk: the hazards posed by stream constituents, and the exposure of occupational personnel to these hazardous stream constituents. The generic approach is described in Sect. 1.4.8.3.

Classes of potential stream constituents were identified through operating experience of pilot facilities using other synthetic fuel processes and from a review of the literature regarding chemical characterization of streams from Lurgi/Fischer-Tropsch facilities, indirect liquefaction processes, and gasification processes. Several classes of compounds were selected for inclusion in this analysis based upon their association with gasification and liquefaction processes and their potential for adverse effects on human health.

Whereas the assessments of public health risks and ecosystem risks emphasize facility streams released to the environment under normal operating conditions, the assessment of occupational health risks also considers (and emphasizes) internal process streams, which may release toxic substances as a result of leaks, fugitive emissions, spills, and other nonroutine events. For the U-gas process, the hot raw gas was selected to represent a "worst-case" process stream. Preliminary measurements of toxic materials in this stream were used (J. G. Patel, personal communication, to R. W. Laza, March 16, 1981).

With the above inputs, problematic stream constituents may be identified by using the indicator compound concept.<sup>38,39</sup> In this approach, the concentrations of gaseous components in process streams that may leak into the occupational environment are compared with their appropriate threshold limit values (TLV) that are based upon the toxicities of the materials. The potential stream constituents considered in assessing occupational health risks are as follows: (1) aromatic amines, (2) carbon monoxide, (3) carbonyl sulfide, (4) hydrogen cyanide, (5) hydrogen sulfide, (6) mercaptans, (7) methane, (8) nickel carbonyl, (9) nitrosamines, (10) phenols, (11) polynuclear aromatic hydrocarbons, (12) sulfur oxides, (13) tars and oils, (14) thiophenes, (15) trace elements, and (16) heterocyclic organics. The process stream concentration to TLV ratio is computed for each constituent and then compared with a similarly derived ratio for an indicator compound (i.e., reference agent). The indicator compound is a process stream constituent that can be monitored frequently and accurately in the workroom environment as part of standard industrial hygiene programs. Thus, the relative differences between the reference agent ratio (i.e., concentration:TLV) and the ratios for other gaseous, toxic stream constituents can be used to identify the potentially hazardous constituents that may be present but undetected in the workroom air. Certain materials, then, such as carbon monoxide (CO), may become indicator agents because of (1) their great abundance in the process stream or because of high toxicity (i.e., a low TLV) and (2) because of the availability of reliable area monitors. This method was selected for this study because potential risks could be evaluated without requiring specific details such as leakage rates, room volumes, and air flow rates, and indicator compounds can be specified whose concentrations, if kept less than or equal to a fraction of their TLVs in the workroom, should ensure that other hazardous compounds in the same streams do not build up faster than the reference agent and will be below their TLVs. However, the current application of this approach involves several limitations: absolute health risks were not determined; compounds without TLVs were not addressed; nongaseous constituents were not evaluated; and risks associated with interaction between compounds was not considered. Currently, adequate methodologies do not exist for evaluating these factors. However, based upon the preliminary pilot plant data, the exposures to many of the materials of concern will be very low relative to carbon monoxide and hydrogen sulfide, and liquids are not present.

Although actual leak rates can be determined only during operation, it can be assumed that the levels of toxic materials in actual practice will be controlled such that their concentrations in workplace air will not exceed appropriate TLVs.

The application of the procedure described in Appendix C.0 applied to data from a U-gas pilot plant is discussed below and shown in Table 4.10. Concentrations of the various constituents in the U-gas process pilot plant are also given in this table. Indeed, it can be seen that the

Table 4.10. Relative allowable leak rate ratios for toxic materials present in U-Gas Pilot Plant reactor gas

| Component                         | Concentration <sup>a</sup><br>(10 <sup>-6</sup> lb/SCF dry gas) | TLV <sup>b</sup>                       |     | Relative allowable<br>leak rate |
|-----------------------------------|-----------------------------------------------------------------|----------------------------------------|-----|---------------------------------|
|                                   |                                                                 | mg/m <sup>3</sup>                      | ppm |                                 |
| CO                                | 2.0 X 10 <sup>4</sup>                                           | 55                                     | 50  | 1                               |
| NH <sub>3</sub>                   | 45                                                              | 18                                     |     | 146                             |
| H <sub>2</sub> S                  | 7.0 X 10 <sup>2</sup>                                           |                                        | 10  | 5.7                             |
| COS                               | 30                                                              | (4.4 X 10 <sup>2</sup> ) <sup>c</sup>  |     | 5.3 X 10 <sup>3</sup>           |
| CS <sub>2</sub>                   | 25                                                              | 30 <sup>d</sup>                        |     | 438                             |
| <b>PAHs</b>                       |                                                                 |                                        |     |                                 |
| Benzene                           | 1.1 X 10 <sup>2</sup> <sup>e</sup>                              | 30                                     |     | 99                              |
| Naphthalene                       | 7.5                                                             | 50                                     |     | 2.4 X 10 <sup>3</sup>           |
| All others                        | 0.34                                                            | 0.2 <sup>f</sup>                       |     | 214                             |
| TOTAL                             | 1.178 X 10 <sup>2</sup>                                         |                                        |     |                                 |
| Tar and oil                       | 1.2                                                             | 0.2 <sup>f</sup>                       |     | 61                              |
| Phenols                           | 0.2                                                             | 19 <sup>d</sup>                        |     | 3.5 X 10 <sup>4</sup>           |
| Mercaptans                        | <1.4 <sup>g</sup>                                               | 1 <sup>h</sup>                         |     | 260                             |
| Thiophenes                        | 1.6 X 10 <sup>-2</sup>                                          | [4.5] <sup>c</sup>                     |     | 1.02 X 10 <sup>5</sup>          |
| HCN                               | 1.7                                                             | 10 <sup>d</sup>                        |     | 2.14 X 10 <sup>3</sup>          |
| Aromatic amines                   | <3 X 10 <sup>-4</sup>                                           | 10 <sup>d,i</sup>                      |     | 1.2 X 10 <sup>7</sup>           |
| Nitrosamines                      | <3 X 10 <sup>-4</sup>                                           | [6.5 X 10 <sup>-2</sup> ] <sup>j</sup> |     | 7.9 X 10 <sup>4</sup>           |
| Carbonyls                         | <3 X 10 <sup>-4</sup>                                           | 0.35 <sup>k</sup>                      |     | 4.2 X 10 <sup>5</sup>           |
| <b>Trace elements<sup>l</sup></b> |                                                                 |                                        |     |                                 |
| Sb                                | 4 X 10 <sup>-4</sup>                                            | 0.5                                    |     | 4.5 X 10 <sup>5</sup>           |
| As                                | 8 X 10 <sup>-4</sup>                                            | 0.2                                    |     | 9.1 X 10 <sup>4</sup>           |
| B                                 | 0.50                                                            | 10                                     |     | 7.3 X 10 <sup>3</sup>           |
| Be                                | 3.0 X 10 <sup>-6</sup>                                          | 2 X 10 <sup>-3</sup>                   |     | 2.4 X 10 <sup>5</sup>           |
| Cd                                | 4 X 10 <sup>-5</sup>                                            | 5 X 10 <sup>-2</sup>                   |     | 4.5 X 10 <sup>5</sup>           |
| Cl                                | 17.8                                                            | 3                                      |     | 61.3                            |
| Cr                                | 1.6 X 10 <sup>-3</sup>                                          | 5 X 10 <sup>-2</sup>                   |     | 1.14 X 10 <sup>4</sup>          |
| F                                 | 7.2 X 10 <sup>-2</sup>                                          | 2                                      |     | 1.01 X 10 <sup>4</sup>          |
| Fe                                | 7.7 X 10 <sup>-3</sup>                                          | 5                                      |     | 2.4 X 10 <sup>5</sup>           |
| Pb                                | 4 X 10 <sup>-3</sup>                                            | 0.15                                   |     | 1.4 X 10 <sup>4</sup>           |
| Hg                                | 3.5 X 10 <sup>-5</sup>                                          | 1 X 10 <sup>-2</sup>                   |     | 1.0 X 10 <sup>5</sup>           |
| Ni                                | 1.2 X 10 <sup>-2</sup>                                          | 1.0                                    |     | 3.0 X 10 <sup>4</sup>           |
| Se                                | 2.4 X 10 <sup>-3</sup>                                          | 0.2                                    |     | 3.0 X 10 <sup>4</sup>           |
| Cu                                | 1.9 X 10 <sup>-4</sup>                                          | 1                                      |     | 1.9 X 10 <sup>6</sup>           |
| Ag                                | 3 X 10 <sup>-4</sup>                                            | 0.1                                    |     | 1.2 X 10 <sup>5</sup>           |
| Zn                                | 3 X 10 <sup>-4</sup>                                            | 5                                      |     | 6.1 X 10 <sup>6</sup>           |
| TOTAL                             | 18.4                                                            |                                        |     |                                 |
| Priority metals only              | 2.18 X 10 <sup>-2</sup>                                         |                                        |     |                                 |

<sup>a</sup>Determined from raw condensates, acid, base and organic scrubs, except CO which is from process data.

<sup>b</sup>Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1980, American Conference of Government Industrial Hygienists, ISBNIO-936712-29-5, 1980.

<sup>c</sup>Minimum Acute Toxicity Concentration, Air, Health, from Multimedia Environmental Goals for Environmental Assessment. Vol. II. MEG Charts. J. E. Cleland and G. L. Kingsbury, EPA-600/7-77-1366, Nov. 1977.

<sup>d</sup>TLV-skin.

<sup>e</sup>Part of benzene may come from solvent.

<sup>f</sup>Assumed to be the same as coal tar pitch volatiles (benzene soluble).

<sup>g</sup>Found in one sample only.

<sup>h</sup>TLV for methyl mercaptan.

<sup>i</sup>TLV for aniline.

<sup>j</sup>Minimum Acute Toxicity Concentration, Air, Health for Dimethylnitrosamine from Multimedia Environmental Goals for Environmental Assessment, Vol. III. G. L. Kingsbury, R. C. Sims and J. B. White, EPA-600/7-79-176a, Aug. 1979.

<sup>k</sup>TLV for nickel carbonyl.

<sup>l</sup>Form of compound in gas phase is not known with certainty as they are determined from raw condensate.

concentration of CO is much higher than all other constituents with the exception of the other main combustion gas,  $H_2$ . Calculation of relative allowable leak rates by Eq. (6) of Appendix C.0 (see Table 4.10) indicates that controlling CO and  $H_2S$  concentrations (in the main process stream) in workroom air to below TLV levels will provide significant margins of safety in controlling all other contaminants to below their respective TLVs. Adequate control of CO appears to suffice for ensuring that levels of tars, oils, and trace elements will be below TLV values, even for trace elements such as Be, which have extremely low TLVs. Carbon monoxide may not be acceptable as an indicator during maintenance, spill cleanup, or a high temperature release of tars, oils, and other liquids under pressure. For these events, other procedures are being developed.

TLV values in brackets in Table 4.10 are not strictly TLVs but are minimum acute toxicity concentrations taken from EPA's MEG charts for health effects from air exposure. In several cases, in Table 4.10, TLVs are for a single compound from a class of compounds (e.g., aniline as a surrogate for aromatic amines); in all applicable cases, the surrogate compound for the class is indicated in the footnotes to the table. In cases where a surrogate compound was used, an attempt was made to choose this compound as having the lowest TLV compared to similar chemicals in the same class. In this way, a deliberate attempt was made to maximize the potential toxicity of a given chemical class. Even using such worst-case assumptions, no class of organic compounds stood out as requiring special monitoring attention.

Even though some may debate the quantitative use of TLVs or minimum acute toxicity effluent values in the current application, the levels of most of the toxic materials, given control based on CO, are several orders of magnitude below these available standards.

Computer modelling of the U-gas reactor has been performed by IGT as part of the MLGW design effort. The model studies show that there is no reason to expect different concentrations of the major constituents ( $CO$ ,  $NH_3$ ,  $H_2S$ , and  $COS$ ) in the pilot and full-scale units (see Table 4.11 for numerical values). The model also indicates that because the bed depth and coal injector-to-bed surface distance in the full-scale unit exceed the corresponding pilot scale dimensions, the destruction of trace organic species (PAHs, thiophenes, tars and oils, phenols, mercaptans, and amines) will be more complete in the demonstration plant than in the pilot plant. The higher operating pressure of the demonstration unit will also improve fluidization quality and lead to a more complete destruction of organics.

Table 4.11. Relationship of concentrations of materials of concern in the pilot plant and the demonstration plant

| Compound        | Concentration —<br>pilot plant<br>( $10^{-6}$ lb/scf dry gas) | Concentration —<br>demonstration plant <sup>a</sup> |
|-----------------|---------------------------------------------------------------|-----------------------------------------------------|
| CO              | $2.0 \times 10^4$                                             | Same as pilot plant                                 |
| $NH_3$          | 45                                                            | Same as pilot plant <sup>b</sup>                    |
| $H_2S$          | $7.0 \times 10^2$                                             | Same as pilot plant <sup>c</sup>                    |
| COS             | 30                                                            | Same as pilot plant <sup>d</sup>                    |
| $CS_2$          | 25                                                            | Same as pilot plant <sup>e</sup>                    |
| PAHs            | $1.178 \times 10^2$                                           | Less than pilot plant <sup>f</sup>                  |
| Tar and oil     | 1.2                                                           | Less than pilot plant <sup>f</sup>                  |
| Phenols         | 0.2                                                           | Less than pilot plant <sup>f</sup>                  |
| Mercaptans      | <1.4                                                          | Less than pilot plant <sup>f</sup>                  |
| Thiophenes      | $1.6 \times 10^{-2}$                                          | Less than pilot plant <sup>f</sup>                  |
| HCN             | 1.7                                                           | Same as pilot plant                                 |
| Aromatic amines | $<3 \times 10^{-4}$                                           | Less than pilot plant <sup>f</sup>                  |
| Nitrosamines    | $<3 \times 10^{-4}$                                           | Less than pilot plant <sup>f</sup>                  |
| Carbonyls       | $<3 \times 10^{-4}$                                           | More than pilot plant <sup>g</sup>                  |
| Trace elements  | 18.4                                                          | Same as pilot plant                                 |

<sup>a</sup> Based on computer modeling.

<sup>b</sup> Depends on coal-nitrogen content.

<sup>c</sup> Depends on coal-sulfur content.

<sup>d</sup> Equilibrium  $H_2S + CO = COS + H_2$ .

<sup>e</sup> Equilibrium  $2H_2S + CO = CS_2 + H_2 + H_2O$ .

<sup>f</sup> Demonstration plant provides greater residence time for organics' destruction.

<sup>g</sup> Demonstration plant pressure 90 psia vs pilot plant tests at up to 60 psia  
equilibrium  $M + n(CO) = M(CO)_n$ .



#### 4.5 MONITORING PROGRAM

One of the objectives of the Memphis Industrial Fuel Gas Demonstration Plant project is to demonstrate the feasibility of making industrial fuel gas from coal in an environmentally acceptable manner. Monitoring programs to ensure that mitigative measures are adequate to minimize environmental impacts must be developed in the planning, construction, and operation stages of a major energy facility such as the proposed plant. The purposes of monitoring programs include (1) documentation of baseline conditions prior to any construction or associated development of the project to predict and to describe the expected impacts and to propose appropriate mitigation measures, (2) determination of the extent of any unavoidable impacts as they occur, especially significant impacts that are associated with the greatest uncertainties, and (3) development of adequate data at all stages of the project to optimize modifications in the monitoring and mitigation programs and to detect unanticipated significant impacts.

As was stated earlier, the proposed plant involves development of a new gasification technology for which the effluents and associated environmental impacts are not fully characterized. Although the industrial partner will have the responsibility of developing and conducting routine operational monitoring programs to satisfy regulatory agencies such as EPA, DOE would supplement<sup>48</sup> the operational monitoring activities of the industrial partner by undertaking the following:

1. Operational monitoring will be supplemented by supporting investigations on the release and effects of novel effluents.
2. Quarterly reports will be prepared and made public, with program modifications where appropriate.

Permits related to air quality, water quality, and solid waste disposal will contain requirements for certain routine monitoring activities. In keeping with these objectives and mandates, a monitoring program will be conducted during the construction and operation phases of the project.

The discussion presented in this section (4.5.1-4.5.8) includes the highlights of the detailed environmental construction and operational monitoring programs being developed by MLGW. These programs are planned for implementation by MLGW independent of DOE's involvement in the project.

This summary of the monitoring programs covers a number of categories which can be grouped into three general areas:

1. Process and source monitoring (Sect. 4.5.1),
2. Environmental monitoring (divided into individual technical disciplines in Sects. 4.5.2 through 4.5.7), and
3. Occupational monitoring (Sect. 4.5.8).

Data from each area will be mutually supportive and interfaced as appropriate to ensure optimization of the overall program.

Data will be collected, reviewed, and evaluated throughout phases II and III for each monitoring category. As a result of these analyses, changes in the monitoring program will be made to eliminate any unnecessary monitoring or to alter the parameters or locations being monitored to provide more useful data.

##### 4.5.1 Process and source monitoring

Environmental process and source monitoring involves the monitoring of specific emission points, within both plant process units and environmental control units, in order to establish the following basic objectives:

1. to ensure compliance with all applicable discharge requirements (i.e., gaseous-, liquid-, and solid-waste streams) and with the monitoring and implementation schedules set forth in the discharge permits;

2. to maintain sufficient control of in-plant operations to prevent violations of permit specifications; and
3. to develop the necessary data for the proper operation and optimization of both the environmental treatment facilities and many of the process units.

Additional process and source monitoring related to health concerns is described in Sect. 4.5.8. The phase III monitoring program will not be limited to discharge point (i.e., source) monitoring. As a part of the extensive process monitoring required to efficiently operate the proposed facility, selected parameters of intermediate streams will be monitored as an indication and warning of abnormal conditions. Such intermediate monitoring will serve as a check on the efficiency of plant operations and as a positive means of anticipating and correcting conditions which might otherwise result in reduced treatment efficiency.

Examples of streams that will be monitored and the types of parameters for which they will be monitored are

1. Process wastewater influent to wastewater treatment for those parameters which are specified by the discharge permit.
2. Intermediate streams within the wastewater treatment system for key indicator parameters.
3. Final treated effluent from the wastewater treatment system prior to discharge to the Mississippi River, in conformance with the required monitoring program defined by the NPDES permit.
4. Drainage from the ash pile prior to discharge (i.e., if monitoring indicates direct discharge is allowable) or treatment.
5. Other wastewater influent and effluent streams — coal pile drainage, cooling tower blowdown, process area runoffs — to verify their compositions and the efficiencies of their respective treatment systems.
6. The flue-gas desulfurization stack for sulfur dioxide.
7. Boiler flue gas for sulfur dioxide, nitrogen oxides, and oxygen.
8. A complete emissions performance test will be conducted after the facility has achieved its maximum production rate; this test will be performed for particulates, sulfur dioxide, carbon monoxide, nitrogen oxides, and hydrogen sulfide.
9. Fugitive emissions from valves, compressor seals, and pump seals as part of a comprehensive periodic maintenance program.

The monitoring program will verify the performance of the proposed mitigation and control techniques.

#### 4.5.2 Air quality and noise

##### 4.5.2.1 Air quality

###### Construction

The primary air quality concern during construction will be potential increases in ambient total suspended particulate (TSP) concentrations from particulate fugitive emissions attributable to construction activities (i.e., vehicle traffic, earth moving, debris removal). Changes in ambient concentrations of other criteria pollutants (i.e., sulfur dioxide, nitrogen oxides, carbon monoxide, ozone) during construction are expected to be negligible. Therefore, the construction air-quality monitoring program will be primarily limited to sampling TSP.

Total suspended particulates will be sampled at two locations — one upwind of the plant site and one downwind. Meteorological data (wind speed and direction) will also be gathered at one of these two locations.

The construction monitoring program will begin simultaneously with construction activities and will continue throughout site buildup, earth-moving, and major structure erection phases. The Environmental Protection Agency's six-day sampling schedule will be adhered to throughout the construction monitoring program.

During the last year of the construction period, the monitoring program at the downwind monitoring station will be expanded to include continuous monitoring of additional criteria pollutants (such as sulfur dioxide, nitrogen oxides, and carbon monoxide) and periodic monitoring of other potentially hazardous atmospheric pollutants monitored during phase I baseline studies. The location of this monitoring station on Presidents Island will be near the location of maximum predicted air quality effects resulting from plant operation.

The additional criteria pollutants will be monitored at the same downwind sampling location being used to monitor TSP. The high-volume sampler at the downwind sampling location will be used to collect particulate matter samples periodically, and this material will be analyzed for potentially hazardous atmospheric pollutants and particle size distribution.

#### Operational

Air monitoring during operation will establish the effect that gaseous emissions from the plant have on ambient air quality in compliance with permit requirements. The downwind air quality monitoring station utilized during construction monitoring will be maintained during phase III, and the same parameters sampled during the last year of construction monitoring will continue to be sampled.

#### 4.5.2.2 Noise

##### Construction

A slight increase in noise levels is expected because of construction activities. A monitoring program will be conducted to quantify this increase during selected periods. The program will complement that conducted during the preconstruction baseline surveys. The same locations will be monitored because they represent areas of sensitivity to noise.

Measurements will be taken annually during fair weather periods of the summer months. Monitoring will occur during periods of the highest noise levels generated by construction activities.

##### Operational

The noise program for phase III, including the monitoring locations, will be similar to the program conducted during the preconstruction baseline surveys.

#### 4.5.3 Surface water quality

##### 4.5.3.1 Construction

Effects on surface water quality are expected from the following construction activities: (1) dredging operations in the Mississippi River for obtaining site fill and for installation of the wastewater discharge line and (2) dredging in Lake McKellar for installation of the water supply and product gas pipelines and for construction of the barge unloading facilities. In addition, runoff during the site fill activities will affect Lake McKellar.

Water quality parameters to be measured during the construction phase will vary with the activity being monitored and on-going data analysis. In general, water samples from the construction sites will be monitored for in situ parameters, dissolved and suspended solids, nutrients, organic indicator parameters, and organic priority pollutants. In addition, drainage from site fill will initially be monitored for trace elements. Control stations will be established and used in the program. Sampling and analytical methods will be consistent with those used during the baseline program.

Sampling locations will also vary with activity. Baseline stations will be used in some cases as activity monitoring stations and in other cases as controls. Additional stations will be established to monitor dredging operations in the river, site drainage, and installation of the product gas pipeline. These stations may also be used as control stations against which barge facility construction effects can be determined.

Water quality sampling will be performed before, during, and after each major construction activity having a potential effect on water quality. The extent of sampling during and after a particular activity will vary depending on the duration of the activity and the magnitude of anticipated impacts.

#### 4.5.3.2 Operational

Operational monitoring of surface water quality will be directed at verifying incremental increases in various parameters resulting from the wastewater discharge and determining effects of the discharge and operations at the barge facilities.

Parameters to be measured will vary with location. Monitoring the Mississippi River near the wastewater discharge point is currently expected to include in situ parameters and selected constituents sampled during the baseline surveys, especially heavy metals and PAHs. Sampling in Lake McKellar near the barge facilities will be directed at in situ parameters, metals, and selected constituents monitored during the baseline surveys. Methods will be the same as those used during the baseline surveys to ensure comparability of results.

Several river stations will be used to characterize wastewater discharge effects on surface water quality. These will include stations upstream and downstream of the discharge to monitor the behavior of the dispersion plume. The barge turning basin will also be monitored, as in the baseline surveys.

Frequency of sampling during phase III will be scheduled to coincide with plant operation periods. Surface water sampling to evaluate the discharge will be scheduled to coincide with initial startup, normal startup, and normal shutdown procedures as well as during any off-specification periods of operation.

#### 4.5.4 Groundwater

##### 4.5.4.1 Construction

Groundwater beneath the plant site will be monitored during construction by the following well system:

1. A 40-ft-deep well located between the plant site and the Mississippi River, since the direction of groundwater flow in the shallow aquifer is from the plant site to the river.
2. A 40-ft-deep well to be drilled after site buildup located near the solid-waste storage area.

Water samples will be analyzed for parameters identified in the fill leachate during early construction monitoring.

The wells will be monitored quarterly during the last two years of construction. This time frame is based on the permeability of soils in the area.

In addition, water quality data for the 500-ft aquifer will be compiled from ongoing analyses routinely performed by MLGW.

##### 4.5.4.2 Operational

During Phase III operation, groundwater from beneath the plant site will continue to be monitored by the same well system used during the construction period. The parameters analyzed for and the sampling frequency will also be the same.

#### 4.5.5 Aquatic ecology

##### 4.5.5.1 Construction

Several construction activities are expected to produce localized, temporary disruptions of aquatic ecology in the vicinity of the plant site. These include laying the water supply and product gas pipelines, installing the discharge structure, and dredging a localized area in the Mississippi River for site fill. More extensive work, including permanent modification of some existing habitat, will occur in the turning basin.

The biological parameters to be studied are those groups that are expected to be most affected by construction activities: fish, ichthyoplankton, and benthic invertebrates. Other groups of organisms (phytoplankton, zooplankton, periphyton, and macrophytes) are not expected to be significantly affected by project construction, so they will not be monitored. Methods and analyses will correspond to the extent feasible with those used during the baseline program to ensure valid comparisons.

The sampling locations will include the areas to be directly affected by construction activities within Lake McKellar and the Mississippi River. Control stations will be located in areas removed from construction disturbance to provide information on background changes. Wherever possible, construction monitoring and control stations will coincide with those studied during the baseline program.

The sampling schedule will vary for each construction activity. For expected minor impacts, a limited number of sampling efforts will occur before and after construction. Where impacts are anticipated to be more extensive, predisturbance and postdisturbance sampling will be more extensive.

#### 4.5.5.2 Operational

The operational monitoring program for aquatic ecology will focus on the wastewater discharge area in the Mississippi River and the turning basin.

Operational impacts are expected to occur primarily to fish and benthic invertebrates; consequently, sampling will be restricted to these groups. Impacts on other groups are expected to be negligible. Collection and analytical methods will, for the most part, correspond to those used in the baseline program. Suitable artificial substrates will be used during sampling of benthic invertebrates in riprapped areas.

Sampling locations for operational monitoring will center on the river shoreline near the discharge and the turning basin, with control stations in other locations. Stations will conform in general to those used previously to allow valid comparison of results, but a new station may be added in the river to more precisely define the effects of the discharge.

Sampling will be conducted seasonally during the demonstration phase.

#### 4.5.6 Terrestrial ecology

##### 4.5.6.1 Construction

Plant construction will affect terrestrial organisms because of vegetation removal, associated habitat loss and noise, and dust from construction activities.

Construction monitoring will occur in the vicinity of the plant site and will continue elements of the baseline program using the same methods and analyses. Efforts will concentrate on species expected to be most affected by construction activities, including

1. game animals (e.g., deer, turkey, and raccoon);
2. potentially affected threatened and endangered wildlife (Mississippi kite, marsh hawk, and sharp-shinned hawk);
3. potentially affected special management wildlife (swamp rabbit and six-lined racerunner);  
and
4. spotted cats controlled by international agreement (bobcat).

Sampling will be conducted during the summer and winter seasons and will continue as needed until operational monitoring begins.

##### 4.5.6.2 Operational

Potential impacts of plant operation on terrestrial biota result mainly from gaseous and particulate emissions and continuing effects of habitat loss.

Operational monitoring will continue to use the construction monitoring program methods and analyses. Efforts will concentrate on the same key organisms, with the addition of SO<sub>2</sub>-sensitive plant species (i.e., soybeans).

Sampling will be conducted during the summer and winter seasons in representative habitats and areas.

#### 4.5.7 Economic, social, cultural

##### 4.5.7.1 Construction

The socioeconomic monitoring function focuses on documenting the size of the construction work force and on determining possible traffic flow impacts on routes leading to the plant site. Since the plant is located in a major urban area with a large resident labor force, a significant influx of relocating project employees is not expected. Furthermore, the size of the expected work force (700) is small compared with the available labor in the area. Even with a high percentage of relocating workers in the project labor force, any impact on the local infrastructure in Memphis would be minimal.

The work force size will be monitored semiannually, beginning within six months of construction startup. This will involve obtaining documentation from construction personnel supervisors regarding the number of workers employed at the time, their addresses, and whether or not they relocated for purposes of employment.

Traffic will be monitored at selected locations on arterial roads approaching the plant site. The monitoring will begin during the school year before the start of construction to collect baseline average daily traffic counts and will continue at periodic intervals after construction begins.

##### 4.5.7.2 Operational

The size of the work force for operations (410) will be even smaller than the construction work force (700); therefore, fewer impacts are expected. For this reason, no socioeconomic monitoring of the operations work force will be required.

#### 4.5.8. Occupational monitoring program

The occupational monitoring program will help protect workers at dangerous work locations and against resulting adverse health effects from possible exposure to toxic materials and physical agents. The program is composed of two major monitoring activities involving (1) worker exposure and work place monitoring and (2) medical monitoring. The first category of monitoring is conducted to determine existing exposure levels (area monitoring and personnel monitoring) and to avoid excessive exposures (leak detection monitoring). The second category provides prevention and/or early identification of adverse health effects resulting from work-related exposure (medical monitoring).

##### 4.5.8.1 Exposure and work place monitoring

Worker exposure and work place monitoring will be conducted to provide effective worker protection against exposure to toxic materials or agents. The information necessary to determine and provide this protection will be derived from three types of monitoring: area monitoring, personnel monitoring, and leak detection monitoring.

Each type of monitoring is designed to yield specific information that will contribute to worker exposure protection. Therefore, the parameters to be monitored, as well as the location and frequency of monitoring, will vary with the type of monitoring conducted.

##### Area monitoring

The area monitoring program will be developed to assess the hazards associated with each plant area as determined by process conditions and by the constituents that may be present. This program will identify regions of increased exposure potential and establish areas of the plant which require continuous monitoring leak detection systems and alarm systems. It will also provide information that will aid in the interpretation of personnel monitoring results. Area monitoring will also be used in determining the adequacy of exposure control methods, and where appropriate, indicator parameters will be used in the monitoring program. Examples of areas and respective parameters that will be monitored are as follows:

| <u>Area</u>                                                                                          | <u>Parameter monitored</u>                                                                                           |
|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Gasification process units and process streams including the gasifier and gas purification processes | Major gas stream constituents:<br>Carbon monoxide (CO)<br>Hydrogen sulfide (H <sub>2</sub> S)                        |
| Gasification process units, process streams, and waste handling processes                            | Trace gas stream constituents:<br>Organic compounds (including organic vapors and PAHs) and other aromatic compounds |
| Waste handling processes                                                                             | Metals and organometallic compounds                                                                                  |
| Ash collection area                                                                                  | Airborne particulates                                                                                                |
| Coal storage, handling, and preparation areas                                                        | Coal dust                                                                                                            |
| Methanation unit                                                                                     | Methane (CH <sub>4</sub> ) and nickel                                                                                |
| Coal preparation area and areas identified by plant noise survey                                     | Noise                                                                                                                |
| Areas where nuclear instrumentation is used                                                          | Radiation                                                                                                            |
| Wastewater treatment facility                                                                        | Ozone                                                                                                                |

#### Personnel monitoring

Personnel monitoring provides an evaluation of the levels of toxic materials or physical agents to which a worker is being exposed. This monitoring will

1. determine the adequacy of controls designed to minimize worker exposure and establish additional control requirements,
2. fulfill OSHA compliance monitoring requirements, and
3. provide a basis for development of specific medical surveillance requirements.

Personnel monitoring of airborne contaminants is conducted by using a portable sampling unit that is attached to the worker and operates continuously as he moves throughout work areas in the plant. Parameters selected for personnel monitoring will parallel those selected for area monitoring.

Monitoring will be conducted for conventional toxic materials and physical agents common to refineries and chemical operations as well as those unique to coal gasification facilities. The parameters monitored for each employee in a specific work location will be determined by evaluation of the contaminants or agents associated with each work area or job task. This evaluation will be conducted by an industrial hygienist based on information obtained from process and area monitoring, material inventories and reviews of plant unit processes, and job descriptions. The industrial hygienist will also review the application of indicator monitoring to assess employee exposures.

Indicator monitoring would be conducted by collecting personnel samples for major parameters (e.g., CO, H<sub>2</sub>S, and CH<sub>4</sub>). Results of sampling major parameters would then be used to provide an index of employee exposure to those and other contaminants in the gas stream. An indicator monitoring program will be evaluated by methods equivalent to or more current than those specified by the National Institute of Occupational Safety and Health (NIOSH). Techniques for monitoring skin contamination will be reviewed for their application in the personnel monitoring program. Employee monitoring of exposure to physical agents will be conducted in accordance with established practices.

#### Leak detection monitoring

Monitoring to detect process leaks will minimize worker exposure resulting from low-pressure leakage. Parameters monitored will depend on the process area but will include the major gas

stream constituents, carbon monoxide, hydrogen sulfide, and methane, which can be rapidly detected by reliable direct reading instrumentation.

Monitoring will be conducted in the gasification, gas purification, and gas treatment sections of the plant. Stationary monitors with alarm systems will be located in regions that have the highest probability of leakage. Leak inspections using portable monitors will be conducted routinely and in response to reports or indications of possible leaks.

#### 4.5.8.2 Medical monitoring

The medical monitoring program consists of pre-employment examinations, employee medical surveillance, and examinations upon termination of employment. Pre-employment physical examinations are provided to ensure that prospective employees are physically suited for the job and are not unusually susceptible to potential hazards. The medical surveillance program protects worker health by

1. early detection, treatment, and prevention of work-related problems;
2. determining that the employee's health status and physical fitness continue to be compatible with safe job performance; and
3. providing a documented record of employee health status.

The medical surveillance program will be designed to fulfill applicable OSHA requirements. Employees working in areas with the potential for exposure to toxic materials or agents will be encouraged to participate in medical surveillance. Medical surveillance will include physical examinations and tests appropriate to determining worker health status. The parameters monitored will be determined by a physician in consultation with an industrial hygienist.

#### 4.6 MITIGATING MEASURES

The following list of mitigation measures is indicative of site- and process-specific control measures that are responsive to real or perceived environmental concerns. Some mitigation measures cannot be specified in detail at this time. In some cases, the detailed mitigation techniques will be developed along with the final plant design. The following commitments are made by MLGW:

1. The necessary mitigating actions will be taken, including those summarized in Sect. 4.6 of this FEIS, during construction and operation of the plant to avoid adverse environmental impacts.
2. Sufficient records shall be maintained to furnish evidence of compliance with all the environmental conditions herein.
3. In addition to preoperational monitoring programs, the monitoring recommendations included in Sect. 4.5 of this document shall be followed.

To minimize or avoid potentially adverse environmental impacts, mitigating measures and guidelines have been developed for the preconstruction, construction, and operational phases of the Industrial Fuel Gas Demonstration Plant (IFGDP). These measures include legal and institutional codes and regulations as well as guidelines to enhance the safety, reliability, and economy of the facility without needlessly sacrificing portions of the existing environment.

Required measures during the preconstruction phase of the project have already been addressed in the September 1978 publication, *Guidelines for Preconstruction Activities at the Proposed Coal Gasification Site*. These guidelines were included as contract requirements for preconstruction work on the site (e.g., topographic surveys and soils programs).

#### 4.6.1 Air quality

##### 4.6.1.1 Construction

To minimize potential adverse impacts on air quality during construction, the best available control technology (BACT) for the control of fugitive emissions will be used (Sect. 4.1.1.1). The mitigating measures are as follows:



1. Upon completion of site filling and site settling, all roadways and parking areas will be placed as soon as possible to control any dust emanating from them. Prior to paving, roadways will be sprinkled with water to suppress dust. Prior to planting grass, other dust-source surfaces, such as fill materials, will be sprinkled with water or another appropriate dust suppressant. Fugitive dust control will be implemented as often as necessary.
2. There are no plans for open burning of material during site cleaning or any other time during construction. Refuse will be disposed of at a licensed disposal site.
3. Trucks and construction equipment will be maintained in a manner that will minimize particulate and other exhaust emissions.
4. During construction, the plant property will be seeded with grass wherever possible to minimize dust generated by the wind.

#### 4.6.1.2 Operation

1. Potential coal and coke handling and storage fugitive emissions will be minimized by dust collection systems consisting of fabric filters, blowers, and adequate hooding and ducting. Dust suppression systems, consisting of chemical water or foam-type sprays, will be used where it is inherently difficult to contain dust for collection and pickup.
2. A controlled-combustor will be provided to oxidize undesirable pollutants, including trace hydrocarbons, in certain gaseous streams (Sect. 2.2.1.10).
3. A smokeless flare system will be provided for safe burning of combustible vapors released during equipment commissioning, decommissioning, and upset conditions. There will normally be no flow of waste gas to the flare (Sect. 2.2.1.10).
4. Particulates from boiler flue gas will be removed by either a bag filter (fitted with specially treated bags to withstand acid gas at elevated temperatures) or an electrostatic precipitator. Following particulate removal, the flue gas will be treated for removal of sulfur oxides by either the FMC concentrated double alkali system or the Chiyoda Thoroughbred system.
5. A sulfur recovery system will be provided to recover sulfur from the Selexol hydrogen sulfide stripper and sour-water stripper effluents.
6. Nitrogen oxides control from the combustion section of the steam generator will be achieved by the planned design of the combustion equipment, such as low excess air firing, staged combustion, water injection, and reduced air preheat.

Additional process information related to air quality is found in Sect. 2.2.1.

#### 4.6.2 Noise

##### 4.6.2.1 Construction

The conclusions of Sect. 4.1.1.1 indicate that construction noise will not produce noise impacts that exceed currently acceptable criteria. Even though no adverse construction noise impacts are anticipated, several steps are planned to ensure that this is true in practice. These measures are as follows:

1. All construction equipment will be required to meet OSHA standards. This means that for operation over an 8-h day, the equipment operator and nearby workers will not be exposed to noise levels greater than applicable OSHA standards.
2. When or where necessary, additional equipment noise abatement devices will be used.

##### 4.6.2.2 Operational

The noise level predictions indicate that there are no adverse reactions expected from operation of the plant (Sect. 4.1.1.2). Plant noise will be of the same order or quieter than the existing ambient noise levels, except at or near the site boundary.

While no problems are expected, all plant equipment to be acquired will meet OSHA requirements. Should measurements show that OSHA requirements are exceeded, noise abatement equipment will be

installed. This action will be carried out not only for the large equipment items but also for the smaller ones. In addition, close attention will be paid to prevent steam leaks, to muffle vents to the atmosphere, and to treat other similar items so that they do not become generators of significant sound energy.

#### 4.6.3 Water quality

##### 4.6.3.1 Construction

Construction activities affecting hydrology and water quality include dredging and filling operations related to site buildup, wastewater and product IFG pipeline installation, and barge unloading area construction (Sect. 4.1.3).

The following mitigating measures will be employed to minimize the water quality impacts of the activities.

1. Hydraulic dredging methods will be used in dredging to reduce disturbance of bottom sediments.
2. During and after site buildup, runoff from the site will be diverted to a settling basin to control runoff volumes and settle suspended particles.
3. Care will be taken to prevent the introduction of chemicals such as soaps, detergents, paints, cleaning fluids, concrete mixtures, gasoline, petroleum, and diesel oil into surface water or groundwater systems.

##### 4.6.3.2 Operational

Impacts on water quality from operation of the proposed plant will be related to the items listed in Sect. 4.1.3.

The following mitigating measures will be observed.

1. Best available wastewater treatment will be employed to remove aqueous contaminants (Sect. 2.2.1.2).
2. The position of the effluent outfall has been selected to provide as much dilution within the plume as possible, under the constraint that its location must be compatible with navigation.
3. The periphery of built-up areas will include riprap where necessary to ensure bank stability and thereby reduce erosion and suspended solid loads to Lake McKellar.
4. The coal storage area will be lined with a commercially available plastic liner. This liner will prevent runoff from this area from entering the groundwater system. Runoff from this pile will be collected and treated before being discharged (Sect. 2.2.1.6).
5. The short-term ash disposal area will be lined with a commercially available plastic liner that will contain leachates from these wastes and will preclude leachates from entering the groundwater system. Runoff from this area will be treated, if necessary, and then discharged. The long-term ash disposal area will be lined if necessary when it comes into use (Sect. 2.2.1.8).
6. Care will be taken to prevent the introduction of chemicals such as soaps, detergents, paints, cleaning fluids, and gasoline into surface water or groundwater systems.
7. Any solid wastes deemed hazardous, as defined by RCRA, will be trucked to an approved offsite disposal area.
8. Gasifier ash, the largest source of solid waste, will be landfilled on site if final leaching studies confirm the results of preliminary studies. Alternatively, MLGW will seek external markets for commercial use of this ash.
9. Flue gas desulfurization (FGD) sludge can be mixed with boiler fly ash and bottom ash prior to onsite landfill disposal. Again, the possibility exists that a market for the boiler fly ash and perhaps even the FGD sludge exists. Such markets will be sought and, to the maximum extent possible, used to reduce the onsite disposal areas required for these wastes.

10. Wastewater treatment sludges will be tested as a part of a comprehensive pilot-scale characterization and treatability program. Should these wastes be nonhazardous, as defined by RCRA criteria, they will be landfilled onsite. Should the leachate quality be unacceptable, however, these sludges will be trucked to an approved offsite disposal area.
11. Spent catalysts, wherever possible, will be reclaimed by the catalyst vendor. Where the value of the spent catalyst does not warrant reclamation, an onsite landfill area will be used.
12. Coal pile runoff and leachate will be collected and equalized before treatment by neutralization, aeration, and clarification.
13. Process area runoff will be collected and equalized before treatment for oil and solids removal.
14. All earthen basins will be lined by an appropriate impoundment liner to limit seepage into groundwater or surface waters.
15. Process wastewaters will be stripped to remove ammonia and hydrogen sulfide to levels compatible with downstream treatment by physical-chemical means (lime addition, flocculation, clarification, two-stage filtration, ozonation, and carbon adsorption). In addition, ozone is expected to promote biological activity on the second-stage filter media and on the activated carbon surface, thus resulting in a symbiotic relationship between the physical and biological removal mechanisms.
16. Cooling tower blowdown treatment will consist of an electrochemical system that will remove hexavalent chrome and zinc to less than 0.05 mg/liter. The inherent reliability of this system is enhanced by the use of three separate electrochemical cells, each complete with its own instrumentation, piping, and power supply.

#### 4.6.4 Aquatic ecology

##### 4.6.4.1 Construction

Construction activities affecting aquatic organisms are limited to dredging and filling activities associated with site buildup, barge unloading facility construction, and water, wastewater, and product gas pipeline installation (Sect. 4.1.4.1). Negative impacts to aquatic organisms will be minimized by the following actions:

1. Site fill will be from high sand areas in the Mississippi River, which are poor habitats for aquatic organisms and are currently regularly dredged by the U.S. Army Corps of Engineers. The total area dredged will be minimized, based on the sand replenishment rate (Sect. 4.1.3.1).
2. Dredging will use hydraulic techniques to minimize suspension of sediments and resulting increases in turbidity.
3. Excavating of trenches for submerged pipelines will be minimized, consistent with engineering requirements and U.S. Army Corps of Engineers regulations. Water supply and product gas pipelines will be in close proximity, thus minimizing the bottom area in Lake McKellar that will be disturbed.
4. Runoff from the work site will be collected, and suspended materials will be allowed to settle before discharge to Lake McKellar (Sect. 2.1.2.1).

##### 4.6.4.2 Operational

Impacts on aquatic biota associated with operation of the IFGDP are associated with the wastewater discharge to the Mississippi River and disturbance of aquatic habitat in the barge unloading area (Sect. 4.1.4.2). These impacts will be minimized by the following steps:

1. All liquid wastes, including runoff where appropriate, will be treated using the best available control technology (BACT) to remove as many pollutants as practicable before discharge (Sect. 2.2.1.2). Sanitary wastes will be routed to the Maxson Wastewater Treatment Facility.
2. Dredging and other activities associated with the barge unloading area will be kept to a minimum, consistent with normal plant operation.

3. Since the source of water for the plant is the city of Memphis system, no intake will be built in the Mississippi River or Lake McKellar. Thus, there will be no impacts from impingement (entrapment of larger organisms on intake screens) or entrainment (drawing of smaller organisms into or through a water system) commonly associated with such structures.
4. Shorelines of the site will be riprapped where necessary for stability, thereby creating new rocky habitat for bottom-dwelling organisms and potential spawning areas and cover for fish.

#### 4.6.5 Geology and soils

##### 4.6.5.1 Construction

Construction activities at the site will include grading, filling, and compacting the site with sandy material dredged from the Mississippi River, a continuously replenished source. No other offsite material will be used for fill material (Sect. 4.1.5.1).

The limited amount of top soil on the site will be reclaimed to the maximum extent practical. This soil may be used for fill on the outer edges of the access road.

To prevent potential settling and soil liquefaction, some existing soils may need to be relocated. Compaction of soils and fill will mitigate potential foundation settling. In addition, structure foundations are being designed in accordance with recommendations for seismic risk-zone 3 (Sect. 2.3.1.1 and 4.1.5.1).

##### 4.6.5.2 Operational

Pavement, vegetation, and riprap will be used where necessary during plant operation to reduce soil erosion (Sect. 4.1.5.2).

#### 4.6.6 Land use

##### 4.6.6.1 Construction

MLGW will coordinate its offsite construction activities with landowners to minimize disturbance of current land uses. As currently envisioned, additional mitigation in this area should not be required (Sect. 4.1.6.1).

##### 4.6.6.2 Operational

Effects of plant operation on land use characteristics will not require mitigation (Sect. 4.1.6.2).

#### 4.6.7 Terrestrial ecology

##### 4.6.7.1 Construction

During construction of the IFGDP, impacts on terrestrial vegetation and wildlife will be reduced in the following ways (Sect. 4.1.7.1):

1. To the extent possible, pipeline and utility access will be constructed at the same time along common corridors, thereby reducing land surface disturbances as much as possible. The dredge slurry pipeline will follow nonvegetated roads and the discharge canal where possible. The wastewater pipeline will follow an existing trail to the extent practical.
2. Topsoil will be returned to the top of pipeline trenches to maintain high soil productivity. Disturbed lands will be seeded with a mixture of native grasses as much as possible, thereby providing food for native wildlife and reducing soil loss from erosion.
3. Nesting habitat of threatened or endangered wildlife, and other wildlife of special concern, will be avoided.
4. Construction personnel will be discouraged from disturbing or feeding wildlife that traverse disturbed land and from entering adjacent vegetation, especially forested lands.

5. Environmentally acceptable chemical sprays will be used to control flying insects.
6. Part of the site itself will be maintained as a meadow habitat.

#### 4.6.7.2 Operational

During operation of the IFGDP, impacts on terrestrial vegetation and wildlife will be reduced in the following ways (Sect. 4.1.7.2):

1. Strobe-type aircraft warning lights, rather than incandescent lights, will be used where required on tall structures. This action will reduce the attraction of migratory birds to these structures and the associated bird mortality during low visibility conditions.
2. Personnel will be discouraged from disturbing or feeding wildlife and will be discouraged from entering adjacent vegetation, especially forested lands.
3. Pipeline maintenance will be scheduled for nonnesting times (early spring and late fall) to the extent possible to minimize disturbance to wildlife.

#### 4.6.8 Economic, social, and cultural

##### 4.6.8.1 Construction

The only area in which mitigation may be required is in the area of transportation (Sect. 4.1.8.1). Negative impacts will be avoided by the following actions:

1. Car pooling or van pooling will be encouraged to reduce the total number of vehicles entering and leaving the site each day.
2. Whenever practical, alternative routes will be used to avoid the school zone along Mitchell Road east of the Weaver Road intersection and to avoid congesting the community.
3. If future conditions dictate the need, traffic control devices, such as stop lights or stop signs, will be installed along specific uncontrolled road segments, such as Peebles Road.

##### 4.6.8.2 Operational

Plant operation is projected to result in primarily beneficial impacts. No adverse impacts have been identified that require mitigation (Sect. 4.1.8.2).

#### 4.6.9 Mitigation of occupational health and safety hazards

Occupational health and safety hazards will be minimized by a system of controls which incorporates

1. engineering control;
2. process design, process specifications, and equipment specifications that minimize hazard potential associated with plant operation;
3. a maintenance program that reduces the potential for equipment failure;
4. a comprehensive industrial hygiene program; and
5. administrative control.

Engineering controls and design specifications that reduce the probability of exposure to toxic materials include (1) isolation or full enclosure of process units; (2) full enclosure of gas transport streams; (3) full or partial enclosure, supplemented with ventilation, of solid transport streams; (4) general and local ventilation systems; and (5) design considerations to prevent failure of vessels and piping. In addition, the outdoor siting of the plant reduces the potential of accumulation of airborne contaminants, which would occur in confined areas.

Process and equipment specifications, included in plant design, that reduce potential hazards include specifications that reduce the probability of fire or explosion, enhance reliable operation and minimize release of contaminants, and reduce noise generated during equipment operation.

Where conditions exist that cannot be eliminated by engineering controls or a change in process, personal protective devices will be used to supplement existing controls.

A comprehensive industrial hygiene program will be developed that will enhance worker protection. Major elements of this program are worker education and training, the promotion of good work and hygiene practices, the use of personal protective equipment, and instructions for safe work practice.

Elements of the industrial safety and hygiene program to be followed include

- a worker education program to instruct employees of potential hazards and of the necessity for industrial hygiene practices;
- the use of appropriate protective clothing (e.g., gloves and coveralls);
- the use of appropriate protective equipment (e.g., safety goggles and hard hats);
- a clean change room with storage for street clothing;
- shower facilities;
- restricted eating areas;
- restricted smoking areas;
- labeling of all regulated areas;
- a medical surveillance program; and
- a work place monitoring program using indicator species.

Maintenance procedures on process equipment significantly increase the probability of exposure to hazardous materials for those employees directly involved in the operation. The greatest dangers are dermal exposure to liquid or solid materials and inhalation of gases, aerosols, or dust.

Therefore, in addition to the industrial hygiene practices used during routine plant operation, those workers involved in maintenance will also follow additional safety precautions as necessary:

- wear specific protective clothing (e.g., specially treated jackets, boots, eyeglasses, trousers, and gloves);
- use specific protective equipment (e.g., face shields and safety belts and lines);
- use respiration equipment; and
- undergo postexposure monitoring of skin.

Administrative controls will be instituted to limit worker access to areas of increased hazard potential. For additional information concerning occupational health and safety, see Sect. 4.4.

#### 4.7 FLOODPLAIN AND WETLAND ASSESSMENT

##### 4.7.1 Introduction

President Carter, on May 24, 1977, issued Executive Orders 11988 and 11990 governing the activities of the Federal government in floodplain and wetland areas of the United States. The essence of these statements is a directive to all Federal agencies to avoid impacts on floodplain and wetland resources unless no practicable alternatives exist. The executive orders and subsequent implementing guidelines and regulations promulgated by the U.S. Water Resources Council<sup>49</sup> and DOE<sup>50</sup> prescribe evaluation of the practicability of alternatives and assessment of floodplain and wetland impacts as part of the agency review process under NEPA.

The DOE has published a Preliminary Statement of Findings<sup>51</sup> and a more detailed supporting report. The factors used in determining practicability include schedule, cost, environmental, and engineering/technical (see Appendix C.8).

This assessment deals with floodplains-wetlands impacts related to the construction and operation of the proposed MLGW facility at alternative sites. Impacts of other types, such as foundation conditions and air quality, will influence the relative merits of each of the sites considered. A broader more detailed discussion of environmental impacts is given in Sects. 4.1, 4.2, and 4.3.

The DOE review considered five sites in Shelby County, Tennessee, and evaluated the engineering, cost, scheduling, and environmental characteristics of each site. Of these five sites, the three considered in this DEIS — Allen, Rivergate, and Pidgeon — are considered to have the highest potential for the IFGDP because they currently are zoned for industrial uses. The DOE's Preliminary Statement of Findings identified the Allen site, although in the Mississippi River floodplain and containing wetland resources, as the only practicable site within Shelby County for the IFGDP.

The purpose of this assessment is to evaluate (1) the floodplain and wetland impacts of the Allen site, (2) possible actions to minimize damage to life and property and to restore and preserve natural and beneficial floodplain values, and (3) alternative actions and mitigative measures.

This floodplain-wetland assessment considers the impacts of the project design flood. This flood, as defined by the U.S. Army Corps of Engineers, is estimated to be less frequent than once in 500 years.

This floodplain-wetland assessment has identified no positive impacts of the proposed project on floodplain and wetland resources. The following negative impacts have been identified:

1. Short- and long-term project risks from direct support of floodplain occupancy. In the short term, floods occurring when fill is deposited on the Allen site could erode the fill already in place. In the long term, occurrence of a flood greater in magnitude but even smaller in probability than the project design flood could jeopardize the plant at any of the three sites.
2. Long-term dispersed flooding impacts. Floodplain modifications would cause minor increases in flood levels elsewhere in Lake McKellar, posing no threat to lives or property.
3. Short- and long-term concentrated wetland impacts. Destruction of 28 ha (70 acres) of wetland resources on or near the sites would eliminate wildlife habitat and would otherwise adversely affect natural wetland values.
4. Indirect support of floodplain occupancy. The project may provide incentives for other developments in the floodplain, although this possibility is largely precluded if the U.S. Army Corps of Engineers levee line remains in its current position.

#### 4.7.2 Project description

The Allen site is located in the floodplain of the Mississippi River on a peninsula adjacent to Lake McKellar and 1219 m (4000 ft) east of the river at normal stage. The site is subject to periodic and frequent flooding and is predominantly under water during floods of smaller magnitude and greater probability than the 2-year flood. The 100-year-flood elevation at the site (Fig. 4.6) is estimated by the U.S. Army Corps of Engineers to be about 68.6 m (224.9 ft) above sea level. The standard project design flood elevation at the site is 70.96 m (232.8 ft) (Fig. 4.7).

Since the current elevation of most of the site is approximately 62 m (203 ft), the site is inundated by as much as 7.5 m of water during the 100-year flood and by 10.0 m of water during the project design flood.

Approximately two-thirds of the site is currently covered by disturbed bottomland and wetland forest, and the remainder is meadow. The natural ecological value of these resources has been limited by the previous use of the site by the U.S. Army Corps of Engineers for disposal of dredging spoils. Because this activity has reduced the availability of food for wildlife, the site's wetlands are considered by USFWS to be of low or medium quality compared with other wetlands in the region.

During the 100-year flood, portions of the site would be inundated by as much as 7.5 m of water. The site would therefore require substantial filling and dike work, with a total of  $4.6 \times 10^6$  m<sup>3</sup> of fill needed. It is estimated that hydraulic dredging from the Mississippi River to obtain this fill would require 250 d and would disturb approximately 15.0 ha (37.1 acres) of riverbed. The site coal pile would be raised to 71 m (233 ft) above mean sea level. The short-term ash storage area and the long-term coal storage area would be graded to 68.6 m (225 ft) and would be surrounded by a levee to an elevation of 71 m (233 ft). In addition, the wastewater treatment facility will be protected to a height of 71 m (233 ft). Figure 4.7 displays a representative cross section of the proposed dike and fill work. The vertical scale in this figure has been exaggerated by a factor of 7.5:1 to present the various design elevations.

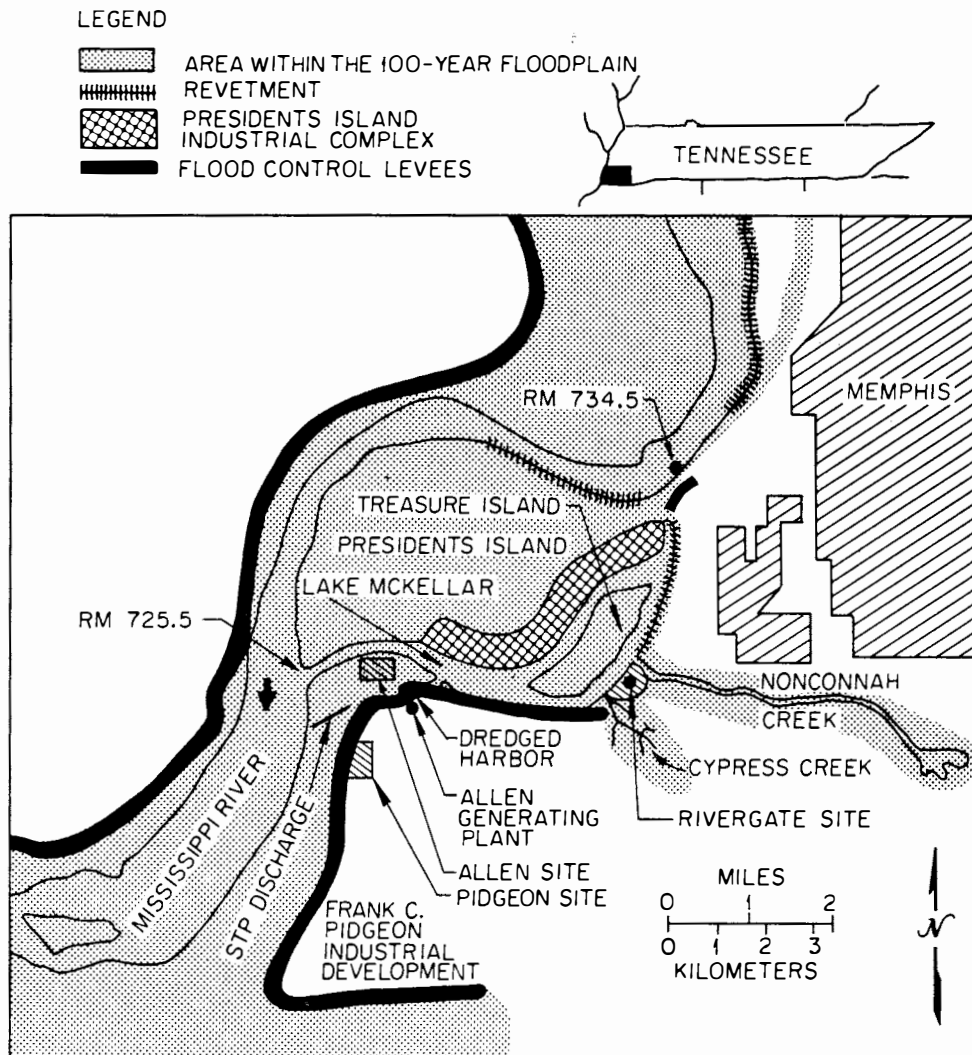


Fig. 4.6. Mississippi River area within the 100-year floodplain in the vicinity of the three sites. Source: Modified from ER, Fig. 3-9, p. 3-28.

#### 4.7.3 Floodplain/wetland effects

The occurrence of a major flood prior to completion of the dike could erode the fill already applied, thus destroying the work completed before the flood. Sediment loads to Lake McKellar and the Mississippi River in the immediate downstream reach of the river would be greatly increased as the fill material is washed away. This erosion would require that lost fill be replaced, and these additional filling activities also would be subject to the risk of flooding.

To offset the possible occurrence of such an event, the dredge-fill operation would be scheduled, to the extent practicable, during periods that historically have a minimum risk of flooding. Although major flooding can occur at any time, the months from August to November typically experience less frequent flooding, and thus are optimum times for dredging and filling. However, if weather permits, dredging and filling could occur before or after this time.

Groundwater recharge and water quality in this area are dominated by the Mississippi River and Lake McKellar, and it is unlikely that significant impacts on groundwater recharge and water quality will occur because of the proposed plant's construction.

During construction prior to application of the fill, a rise in water level in Lake McKellar could cause groundwater flooding of the site and could result in construction delays. In addition, the



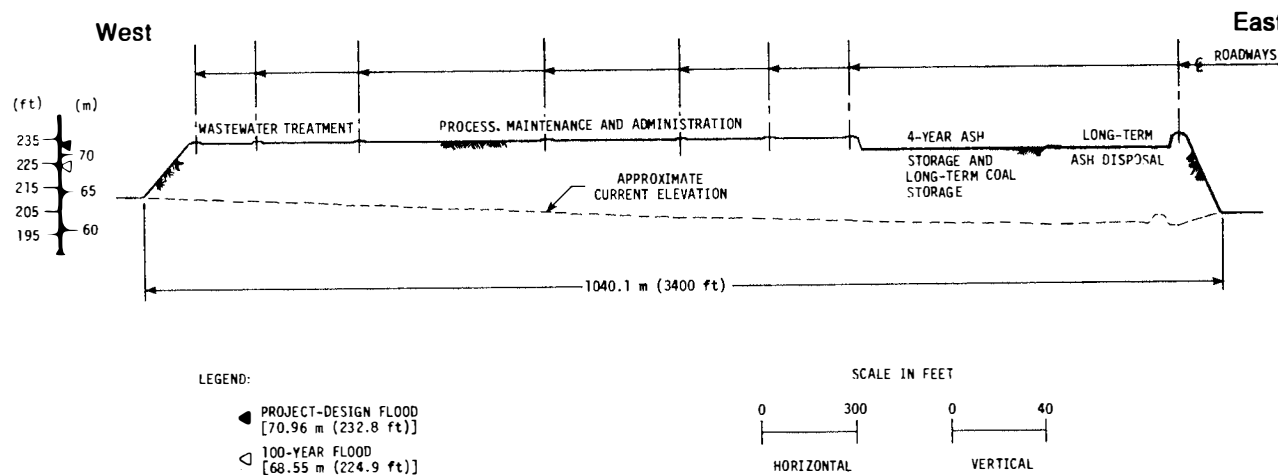


Fig. 4.7. Schematic representation of dike and fill work for MLGW SGDP at the Allen site.

shallow water table will lengthen the time required for dewatering the dredge material to be placed on site by retarding the loss of water through vertical percolation. During periods of high water level in the lake, groundwater levels could be expected to rise into the dredge material and further impede the dewatering process.

As recently as 100 years ago, the Allen site was within the confluence of the Tennessee and Arkansas chutes of the Mississippi River, totally submerged at normal flow. If the river moves back into its former channel, which is possible but unlikely, the IFGDP and other facilities in the area would be in jeopardy.

During periods of major flooding of the Mississippi River, portions of the site inside the levees would be below river stage. A levee failure, although improbable, is a potential operational risk. Should a levee fail, the long-term ash storage area could be flooded. This flood damage could cause the release of contaminants into the environment. The potential sink for these contaminants is Lake McKellar and the Mississippi River. The project has been designed to minimize this flood risk to the facility and the environment.

Once the site is filled to design elevation, during floods it will become a peninsula bound by the Mississippi River and will obstruct flood flows and alter existing flow patterns. To determine the severity of the increased flood hazard resulting from such a fill placed over the site area, a U.S. Army Corps of Engineers physical model of the Mississippi River (the Mississippi Basin Model, located in Clinton, Mississippi) was used to predict flood heights in the area (see Appendix C.2). The east-west portion of the Ensley Levee and the southern edge of Presidents Island would be affected by the proposed development. The flow line along a portion of the Ensley Levee would be raised about 0.2 m (0.7 ft) for the standard project design flood. With this rise in the flow line, 0.9 m (3 ft) of levee freeboard would still be available, except for one short reach where the clearance would be slightly less. The project design flood was used to design the Ensley Levee. Flow line increases along Presidents Island would be about 0.06 m (0.2 ft). Although the hydrologic impact is minor, it is unavoidable because of the location of the Allen site.

Onsite and offsite construction activities would disturb 63 ha (155 acres), including 43 ha (106 acres) of successional bottomland forest, 16 ha (40 acres) of meadow, and 4 ha (10 acres) of nonvegetated land and water area. The 43 ha of successional bottomland forest disturbed represents about 30% of the successional bottomland forest within 3 km of the center of the site. There are several mature bottomland forests in the region, but none would be affected by construction. The medium- to high-quality wetland (mature bottomland forest) on Presidents Island has been avoided in pipeline construction. Part of the site itself would be maintained as a meadow habitat, although the disturbed low- to medium-quality wetland would be lost.

Wildlife in construction areas would be displaced to surrounding habitats or eliminated. Populations of permanent and summer resident wildlife species probably would be reduced, at least in proportion to the amount of their required habitat lost. The following wildlife reductions may result from industrial use of the site and offsite areas within a 3-km (1.9-mile) radius: cottontail, swamp rabbit, whitetail deer, and gray fox, 25%; fox squirrel, gray squirrel, and opossum, 50%; red fox and raccoon, 40%; and bobcat, 10%. No threatened or endangered species have been identified on this site (Appendix B.3.1).

The floodplain forest occupying the Allen site provides potential habitat for several species that are rare in Tennessee. Rare species in the site area that are associated primarily with bottomland forests are the swamp rabbit and the Mississippi kite. The forest on the site appears to be low-quality habitat for swamp rabbits because of the lack of understory cover, a result of dredge spoil disposal. The Mississippi kite nests in other forests in the area, which have larger trees than those on the site. The onsite forest is potential future nesting habitat, but the probability of nesting at the site may be reduced because of the proximity of the Allen Generating Plant. Current nesting populations of the Mississippi kite should not be significantly affected, although industrial use of the site would preempt any future use of the site by kites.

Other rare or uncommon species that breed in the area are the six-lined racerunner and the bobcat. The racerunner is not primarily associated with floodplain habitats but is common on the site in well-drained meadow habitat. Bobcats have rarely been recorded in the site area and are not primarily associated with floodplain habitats, although they show some preference for such habitats.

The ecological community is relatively young, since the site area was under water in the main flow channel of the Mississippi River in the late 1800s and was subsequently built up by dredging activities. Loss of this area will not appreciably affect terrestrial and aquatic wildlife within a 4.8-km (3-mile) radius of the plant because of the presence of more than 405 ha (1000 acres) of high-quality wetlands in this region that will not be affected by site development.

The site is currently zoned for heavy industry, and use of the site can occur without negatively affecting the future industrial or recreational potential of the Memphis area. Use of the site will provide community and national benefits that would otherwise not be realized.

Field surveys show no evidence of prehistoric, architectural, or historic remains. The project area lies within the 1881 to 1893 channel of the Tennessee Chute (now Lake McKellar), which forms the southern boundary of Presidents Island. Most likely the 1820 to 1830 channel of the Tennessee Chute flowed through the project area, which would indicate that the project area was recently (post-1893) formed and that any prehistoric or early historic sites that may have existed in the project area would almost certainly have been destroyed by the recent meanders of the Tennessee Chute.

The site contains no unique visual features, but there are many designated and undesignated areas of visual interest around the general site area.

Since the site contains successional bottomland forest (as opposed to mature bottomland forest), meadow, and low- to medium-quality wetlands, there will be no significant impacts on forestry. The site does not support agricultural or aquacultural activities, and therefore no impacts on these areas are expected.

The project presents some inducement to additional encroachment on the Mississippi River floodplain. This inducement is limited, however, by the current location of the U.S. Army Corps of Engineers levee line.

The floodplain peninsula on which the Allen site is located would not be entirely occupied by the proposed plant. The area immediately to the west of the plant site and adjacent to the river would still remain undeveloped. This area has essentially the same wetland characteristics as the Allen site.

The levee line of the U.S. Army Corps of Engineers currently is drawn just west of the Allen site. The Corps of Engineers currently refuses building permits beyond the levee line; therefore little or no additional development can take place on the peninsula.

Distribution plans for the product gas over a 39-km-pipeline (24-mile) network are oriented to existing industrial users. Consequently, the commercial viability of the proposed plant is not dependent on industrial development of adjacent floodplain and wetland areas.

#### 4.7.4 Alternatives

##### 4.7.4.1 Alternative sites

The Rivergate site, a tract of approximately 65 ha (160 acres), is located 4 km (2.5 miles) east of the Allen site (see Fig. 4.6). The site is adjacent to Lake McKellar and south of Nonconnah Creek. The site lies on the floodplains of the Mississippi River and Nonconnah Creek and is covered by a dredged fill of about 70 m (230 ft). The site lies above the 100-year-flood stage [69.4 m (227.6 ft) at this location].

Vegetation on the site is early successional, ranging from sparse vegetation on bare, recently deposited spoil to late old field vegetation with small trees. A remnant of highly disturbed floodplain forest bounds the site along Lake McKellar and Nonconnah Creek. The site is utilized by field sparrows, voles, and other common, old field species.

Some additional fill or dike work would be required to raise the site above the project design flood level of 70.96 m (232.8 ft). Because foundation conditions at the site are unsuitable, the existing fill may require compaction or replacement in order to make it suitable for the project. The cost of removing and disposing of the soil on the site to achieve acceptable foundation conditions makes this site unacceptable for the proposed project. For more detail, see Appendix C.8.

The Pidgeon site lies in the 100-year floodplain of the Mississippi River but is protected from flooding to the elevation of the project design flood by existing dikes (see Fig. 4.6). The site is agricultural bottomland devoted to soybean production, although it is zoned for heavy industrial use. The site is part of the Frank C. Pidgeon Industrial Park, owned by the Memphis and Shelby County Port Commission. A high-quality bottomland forest lies in the floodplain west of the site between the dike and the river. If the barge facility is located along the Mississippi River, 20 ha (50 acres) of high-quality wetlands would be destroyed. This alternative was unacceptable for this project. See Appendix C.8 for greater detail.

#### 4.7.4.2 Alternative action

##### Resolicit new industrial partner to construct outside Shelby County

Selection by DOE of a site outside Shelby County could not involve MLGW and would result in a time delay to the project of at least 18 months, including time to resolicit a new industrial partner, to negotiate a suitable new contract, and to modify the existing design with respect to the new site. The added project cost under these circumstances would exceed \$90 million for the most economic alternative, and the cost differential could, in fact, be several times greater for some sites.

#### 4.7.4.3 No action

If no action is taken at the Allen site, floodplain and wetland impacts due to the proposed plant would be precluded. However, actions (dredging and ash disposal) by other agencies might affect wetland resources. Moreover, the economic benefits to the Memphis area associated with the plant, including construction and operating jobs, increased tax revenues, and availability of industrial fuel gas, would be lost with the use of the Allen site for ash disposal and dredge deposition. The plant is an important element in MLGW's program to provide a reliable gaseous energy supply for industry in the Memphis area.

Failure to implement the proposed project will not provide the intended information or advancement of technology nor assist in solving Memphis' long-range energy needs. Although another project could be initiated to demonstrate this technology, significant delay in this portion of the national and local coal gasification demonstration program would result.

#### 4.7.5 Mitigative measures

##### The Allen site

The increases in flood heights elsewhere resulting from filling the Allen site are minor but unavoidable.

The extent of loss of low- to medium-quality wetland resources will be minimized by confining the disturbance to within the proposed plant boundaries. These wetlands represent 30% of the wetland resource located within 3 km (1.9 miles) of the site center.

Mitigation measures are being reviewed with the Fish and Wildlife Service pursuant to the Fish and Wildlife Coordination Act. As part of this review, consideration is being given to measures that will compensate for the net reduction of wildlife habitat units lost because of the construction of the proposed project. The details of this aspect of the mitigation program will be finalized during the Corps of Engineers' review of the Section 404 and Section 10, dredge and fill, permits.

The site will be raised above design flood elevation, using dredge material from the Mississippi River.

Site runoff will be collected and treated, if appropriate, prior to discharge.

### 4.8 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

#### 4.8.1 Land and mineral resources

The site on which the plant is located will be committed to the project for as long as it is in operation. After the plant ceases to operate, the site will be available for other uses, although nonindustrial uses would be unlikely because of the topographic disruption required to build the plant.

Plant operation will consume annually  $1 \times 10^6$  tons of coal and  $0.11 \times 10^6$  m<sup>3</sup> of natural gas (see Appendix B.0.3 for a complete list of the material requirements of the project). These resources would be irreplaceable and irreversibly committed to the project, although the quantities required are small compared with available supplies.

#### 4.8.2 Water and air resources

Operation of the plant will consume  $5.09 \times 10^6$  m<sup>3</sup> per year of water, while additional water will be required for construction. Some of this water is eventually recycled to the biosphere, while the remainder is irreversibly converted into other chemical forms. The project will not significantly affect the rate of recharge of the aquifers supplying the water.

Degradation of air and water resources, which occurs during construction and operation of the plant, ceases after the plant stops operating. The adverse air and water quality effects of the project consequently cannot be considered irreversible.

#### 4.8.3 Vegetation and wildlife resources

Restoration of vegetation and wildlife on land disturbed for the project is possible but unlikely. The land could eventually be returned to its preproject state, although the costs of doing so probably would be far greater than the costs of converting the plant to other industrial uses. It is likely, therefore, that the project constitutes an economically irreversible loss of vegetation and wildlife resources at the site, although not a technically irreversible loss.

#### 4.8.4 Commodity resources

The project will require irreversible and irretrievable commitments of a number of commodity resources in its construction and operational phases. These include concrete, steel, fuels, glass, pipe, and many industrial chemicals. To the extent that these commodities are derived from exhaustible natural resources, they are irreplaceable under current technologies. The quantities of these resources needed, however, are miniscule compared with readily available supplies.

### 4.9 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

This section contains a summary of the principal unavoidable adverse environmental impacts that would result from the construction and operation of the MLGW facility. The details of these impacts can be found in Sect. 4.1.

#### 4.9.1 Air quality

Vehicle exhaust and fugitive dust emissions during construction will have a small short-term adverse effect on ambient air quality in the area of the site. Ground-level pollutant concentrations resulting from vehicle exhausts, however, are below ambient air quality standards. In addition, most of the fugitive dust emissions are controllable if the fill material is kept wet.

During the operational phase of the project, pollutants emitted from the facility include fugitive coal dust, sulfur dioxide, oxides of nitrogen, and hydrocarbons. Coal dust emissions should not be significant beyond 100 m (330 ft) of the plant under routine meteorological conditions, although strong winds would carry these dust particles farther. Sulfur dioxide emissions during routine operation would not result in violations of air quality standards, but nonroutine emissions (such as during plant startup and emergency venting) would be higher. Nitrogen dioxide and hydrocarbon emissions are likely to have negligible effects on air quality.

#### 4.9.2 Hydrology

Since the Allen site is located within the Mississippi River floodplain and subject to annual flooding, the site can be used for the project only if it is filled above flood level. Current plans include raising the site by as much as 9 m (30 ft) to protect the project from flood hazards. This action will reduce the floodplain's temporary water storage capacity. The result of the floodplain modification is a small but unavoidable increase in flood elevations in Lake McKellar along the Ensley Levee and the southern edge of Presidents Island. The added risk of flood damage caused by the project is quite small, however, since flood protection structures already in place would provide adequate protection against the increased flood elevations.

Groundwater is available in sufficient quantities to supply the construction and operational needs of the project without reducing water availability to other users. At the same time, the quality of the groundwater in the area could be compromised by storm water seepage from the plant's coal storage and solid waste disposal areas. These areas are being designed to minimize this risk — including installation of impermeable liners, thorough compaction of the ground beneath the liners, and use of monitoring systems to detect potentially harmful seepage.

#### 4.9.3 Surface water quality

Construction impacts on the water quality of the Mississippi River consist primarily of localized, short-term perturbations (turbidity, increased levels of some chemicals, and increased oxygen demand of sediments) resulting from dredging. Lake McKellar may be adversely affected by site

preparation operations (buildup and grading) and product gas pipeline construction because of inflowing sediment and perhaps ammonia in dredge fluids. The barge turning basin may suffer impacts from dredging, similar to those described above.

Wastewater discharge to the Mississippi River will be a potential impact occurring during demonstration plant operation. With dilution of the wastewater in a mixing zone, the impact to river water quality would be small incremental loadings of those constituents for which ambient concentrations exceed water quality criteria for water uses for which the affected reach of the river is classified. These uses do not include domestic use. Wastewater discharge will be permitted under the NPDES, administered jointly by the Tennessee Department of Public Health, Water Quality Division, and EPA. Coal spillages and increased turbidity may result from increased barge traffic in Lake McKellar's turning basin. Periodic maintenance dredging may result in short-term perturbations in this same area.

#### 4.9.4 Aquatic ecology

Aquatic habitat may be eliminated or modified by all construction activities (dredging, installation of wastewater discharge structures and product gas and water supply pipelines, site preparation, and barge dock construction). There will be loss and degradation of medium-quality aquatic habitat in the turning basin in Lake McKellar.

Outside of the mixing zone, operational impacts from wastewater discharge into the Mississippi River are anticipated to be minor. Increased barge traffic and periodic maintenance dredging may modify localized portions of aquatic habitat in the barge turning basin.

#### 4.9.5 Geology and soils

Prior to commencement of construction activities, the site will receive approximately  $4.6 \times 10^6 \text{ m}^3$  ( $6.0 \times 10^6 \text{ yd}^3$ ) of hydraulically dredged fill material. Filling is necessary to raise the process areas from their current elevation of about 62 m (203 ft) to 71 m (233 ft), in order for the plant to lie above the project design flood level. This filling and grading is unavoidable if the site is to be used for industrial development. The impact on topography cannot be avoided or mitigated.

Structure foundations are being designed in accordance with recommendations for seismic risk zone 3. The preliminary design includes a factor of safety of 3 for foundations bearing on soil. Final foundation design is included in phase II of the project. If a seismic event results in release of contaminants, potential sinks for these materials are Lake McKellar, the Mississippi River, and the alluvial aquifer.

All soils currently on the site would be covered by emplacement of the fill. Occurrence of a major flood prior to completion of the fill could result in erosion of the fill already in place. This erosion would require replacement of lost fill. Upon completion, soil losses can be minimized by using vegetative cover or riprap or by paving to protect the site.

#### 4.9.6 Land use

Use of the site for the proposed facility will prevent the site from being used by the U.S. Corps of Engineers for the annual disposal of dredge spoils from the Mississippi River and Lake McKellar. At the present time, the Corps has discontinued this use of the site and has begun using an area to the west of the proposed site. Also, benefits provided by the floodplain forest (support of many wildlife species important for recreation, storage and slow release of floodwaters, water quality maintenance through sediment entrapment, and groundwater recharge) will be lost.

Use of the site for the proposed facility is consistent with the site's heavy industrial zoning classification and will preclude other potential uses of the site. Most of the offsite facilities (pipelines, utility lines, and access road) will be on existing rights-of-way, under water, under city streets, or in common rights-of-way and will have little effect on land use. Emission of air pollutants may have slight adverse effects on soybean yields in the vicinity of the facility, although these impacts may be so small that they are undetectable.

#### 4.9.7 Terrestrial ecology

Onsite and offsite construction will disturb 63 ha (156 acres), including 43 ha (108 acres) of medium-age floodplain forest, 16 ha (40 acres) of meadow, and 4 ha (10 acres) of nonvegetated land and water area. The proposed project would consequently contribute to the serious losses

of floodplain forests that have occurred in the United States. Mature bottomland forests in the area would not be affected. Operation of the facility will contribute slightly to the effects of air pollutants on vegetation.

Wildlife species of concern would be virtually eliminated from the site but would continue to exist in areas surrounding the site. No endangered or threatened species listed by the Federal government will be affected. The Mississippi kite (listed by Tennessee as endangered) and the six-lined racerunner and swamp rabbit (listed by Tennessee as needing special management because of the scarcity of their habitat) will lose breeding or foraging habitat, although the kite does not appear to nest on the site.

#### 4.10 Alternative fates

The proposed action can be approved, rejected, or modified, or a decision may be delayed until some future date. If the project is approved, final design and construction will occur during a period of approximately four years (phase II). Following a 20-month-long demonstration-operation period of phase III, MLGW shall have the right to purchase the proposed facility. During this postphase III period, the MLGW facility could experience three potential alternative fates: continued operation at the demonstration plant capacity, mothballing, or total decommissioning. Expansion of the gasification plant to a larger capacity after the demonstration period, although possible to a very limited extent, was not considered a likely alternative because of space limitation at the site. Therefore, no additional impacts are expected as a result of commercial operation at the proposed plant.

During continued operation, the processing facilities will continue to operate as a commercial venture after the demonstration period, with minimal modification. The plant capacity will continue to process 3155 tons/d of coal, producing  $4.3 \times 10^6 \text{ m}^3$  (154 million scf) of medium-Btu gas (300 Btu/scf) and  $0.12 \times 10^6 \text{ m}^3$  (4.3 million scf) of high-Btu pipeline gas (950 Btu/scf), for an assumed operational period of 20 years.

#### Mothballing and decommissioning

Mothballing the demonstration plant implies that it would be shut down for an indefinite period of time. All production operations at the facility would cease, although there would be little or no disassembly of the equipment at the site.

There are several reasons why the plant might be mothballed. If, for example, the production process proves to be technically feasible in most, but not all, respects, it may be necessary to shut down the plant until the technological problems are solved. Alternatively, the plant may prove to be technically feasible but not economically viable at the product and input prices prevailing when the demonstration phase ends. In this case, the plant might be shut down for the short term with the expectation that future market prices would make commercial operation worthwhile.

Should the proposed facility prove to be technically or economically unsuccessful over the long term, the plant would be decommissioned. Production operations would cease, and the site would either be restored to the extent feasible or converted to another industrial use. Since it is impossible to speculate about the nature of other industrial uses, the analysis presented here is limited to the impacts of the site restoration option only.

Continued operation at the demonstration plant capacity is addressed in Sect. 4.1 and summarized in Sect. 2.3.1.1. Therefore, impacts associated with this fate will not be repeated here; rather, the thrust of this analysis is to highlight the major issues that would be faced under the mothballing and decommissioning fates. These issues are discussed below in greater detail. Reference is made to impacts of continued operation where appropriate.

#### Air quality

As a result of mothballing or decommissioning, both direct source and fugitive emissions associated with the operation of the demonstration plant would be eliminated. However, short-term fugitive dust emissions can be anticipated during decommissioning of the demonstration plant. The impact of these emissions will be similar to those experienced during the construction of the demonstration plant.

It is not currently clear whether an indefinitely mothballed demonstration plant would be maintained in the State's emissions inventory or whether other future emission sources would have to consider the emission from the mothballed plant in their permitting process. If the mothballed plant is maintained on the emissions inventory, the remaining PSD increment for other emission sources would be smaller, which could affect future industrial development.

### Water quality

During normal plant operations, runoff and leachate from potentially contaminated areas (coal storage, main process areas, ash disposal, and product loading areas) will be collected and pumped to wastewater reclamation facilities for treatment prior to discharge or reuse within the plant. During the mothballing period, the wastewater treatment system may be shut down. If necessary, during the mothballing period or during decommissioning activities, runoff will be collected and pumped to the T. E. Maxson Wastewater Treatment Facility for treatment prior to being discharged.

The RCRA of 1976 requires the continued groundwater monitoring of hazardous waste disposal sites during and after disposal operations. Although studies of the pilot plant ash indicate that it is nonhazardous, if further research conducted during the demonstration period concludes otherwise, suitable treatment and monitoring programs will be adopted. If it is determined that the RCRA applies, then continuous monitoring will be conducted if the plant is mothballed or decommissioned. If the groundwater monitoring program detects that leachate has penetrated the protective liners provided at the disposal site, the leak will be located and the liner will be repaired. Leachate will be sent to the Maxson Wastewater Treatment Facility.

### Ecology

The termination of facility emissions to the environment as a result of mothballing or decommissioning would have a general beneficial impact on local ecological systems. However, if uncontrolled, the water quality impacts on Lake McKellar resulting from site runoff could have adverse effects on aquatic biota. During the mothballing period or after decommissioning, herbaceous meadow vegetation similar to that originally found on the site could likely be established.

### Land use

Currently there are no other identified competing uses for the proposed site; however, mothballing the proposed demonstration plant would preclude other development opportunities for the site.

The land used for the processing facility and for solid waste disposal would be available for alternative uses after facility decommissioning. This availability is important because the site is in a prime industrial location. Proper closure of the waste disposal areas would be required to enable the future productive use of these areas.

### Socioeconomics

Most of the permanent operational labor force of 270 and the service staff of 140 employed during the demonstration period will be terminated if the facility is mothballed or decommissioned; however, to decommission the facility, a work force somewhat smaller than the number of persons employed during construction of the demonstration plant will be required for a short time.

If the demonstration plant is mothballed or decommissioned, the industries developed to support the facility would suffer economic loss.

Because only minor expansion of community services would be required to support the demonstration plant, only minor impacts on community services would be anticipated if the demonstration plant were mothballed or decommissioned.



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Walsh is Health and Safety Research Division Coordinator for the ORNL Life Sciences in Synfuels Program. His groups is the focal point for overall health risk assessments in this program. He recently cochaired the third ORNL Life Sciences Symposium on Health Risk Analysis, which included national and international leaders in the field.

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| M.S. | 1972 | Mechanical and Aerospace Sciences | University of Rochester |

|       |      |                                         |                         |
|-------|------|-----------------------------------------|-------------------------|
| Ph.D. | 1975 | Mechanical and<br>Aerospace<br>Sciences | University of Rochester |
|-------|------|-----------------------------------------|-------------------------|

Years of experience: 5

Total publications: 13





Appendix A

COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT AND DOE RESPONSES



## Appendix A

## COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT AND DOE RESPONSES

The Draft Environmental Impact Statement (DEIS) (DOE/EIS-0071-D) was filed with the Environmental Protection Agency on October 24, 1980, and a notice of availability was published in the *Federal Register* on October 31, 1980. Copies of the draft statement were sent to Federal, State, and local agencies and interested groups and individuals with a request for comments on the document. Copies of the statement were also provided to interested parties on request. The official comment period ended December 15, 1980. In addition, the opportunity to comment on the draft statement was provided at a public hearing conducted in Memphis, Tennessee, on December 3, 1980.

The following agencies, groups, and individuals submitted letters regarding the Memphis Light, Gas and Water Division (MLGW) DEIS:

Congressman Robin Beard  
 Congressman Ed Jones  
 U.S. Environmental Protection Agency  
 U.S. Air Force  
 U.S. Army Corps of Engineers  
 U.S. Department of Housing and Urban Development  
 U.S. Department of Agriculture, Soil Conservation Service  
 U.S. Department of the Treasury  
 U.S. Department of Health and Human Services  
 U.S. Department of the Interior  
 Memphis and Shelby County Office of Planning and Development  
 American Gas Association  
 Natural Resources Defense Council  
 Memphis Audubon Society  
 Memphis City Beautiful Commission  
 Civic Research Center  
 National Wildlife Federation  
 Memphis State University  
 Carol B. Fitzgerald

Statements were made by the following agencies, groups, and individuals at the public hearing:

Memphis Light, Gas and Water  
 Memphis and Shelby County Office of Planning and Development  
 Memphis City Beautification Commission  
 U.S. Environmental Protection Agency  
 Jerry Barron for Senator Howard Baker  
 Jennifer Johnson for Congressman Harold Ford  
 Willie Miles for Senator Jim Sasser  
 Memphis and Shelby County Bureau of Economic Development  
 Null Adams for Congressman Ed Jones  
 John T. Williams for Congressman Robin Beard  
 Elaine deLashmit  
 Jane Rousseau  
 Allen Fitzgerald  
 NAACP — Memphis Branch  
 Citizens for a Better Environment  
 Natural Resources Defense Council  
 Memphis Audubon Society  
 Plato Toulfatos  
 Katherine Hunnenin  
 Jack Threohold

Consideration given to the comments received by the Department of Energy (DOE) is reflected partly in revisions to the pertinent sections of the text of this document and partly by the discussions provided in this appendix.

Comments for which no responses are required are reproduced in Sect. A.1. Comments requiring responses are reproduced in Sect. A.2. Individual comments within each letter are identified by a comment code, such as EPA-12. These codes are shown on each letter in Sect. A.2. Responses to these comments are provided in Sect. A.3. Individual comments are not reproduced in this section. The responses are given in the order in which the comments appear in Sect. A.2 and are identified by the same identifier code as appears on the letters. Where appropriate, full responses are not given, but a previous response to a similar comment is referenced.

Substantive comments made at the public hearing that were not transmitted in writing or adequately addressed at the hearing are excerpted from the hearing transcript and reproduced in Sect. A.4. Each of these comments has an associated identifier code. Responses to these comments are provided in Sect. A.5. Following the public hearing, the presiding board provided a letter commenting on the draft statement. This letter is reproduced in Sect. A.4, and responses are provided in Sect. A.5.

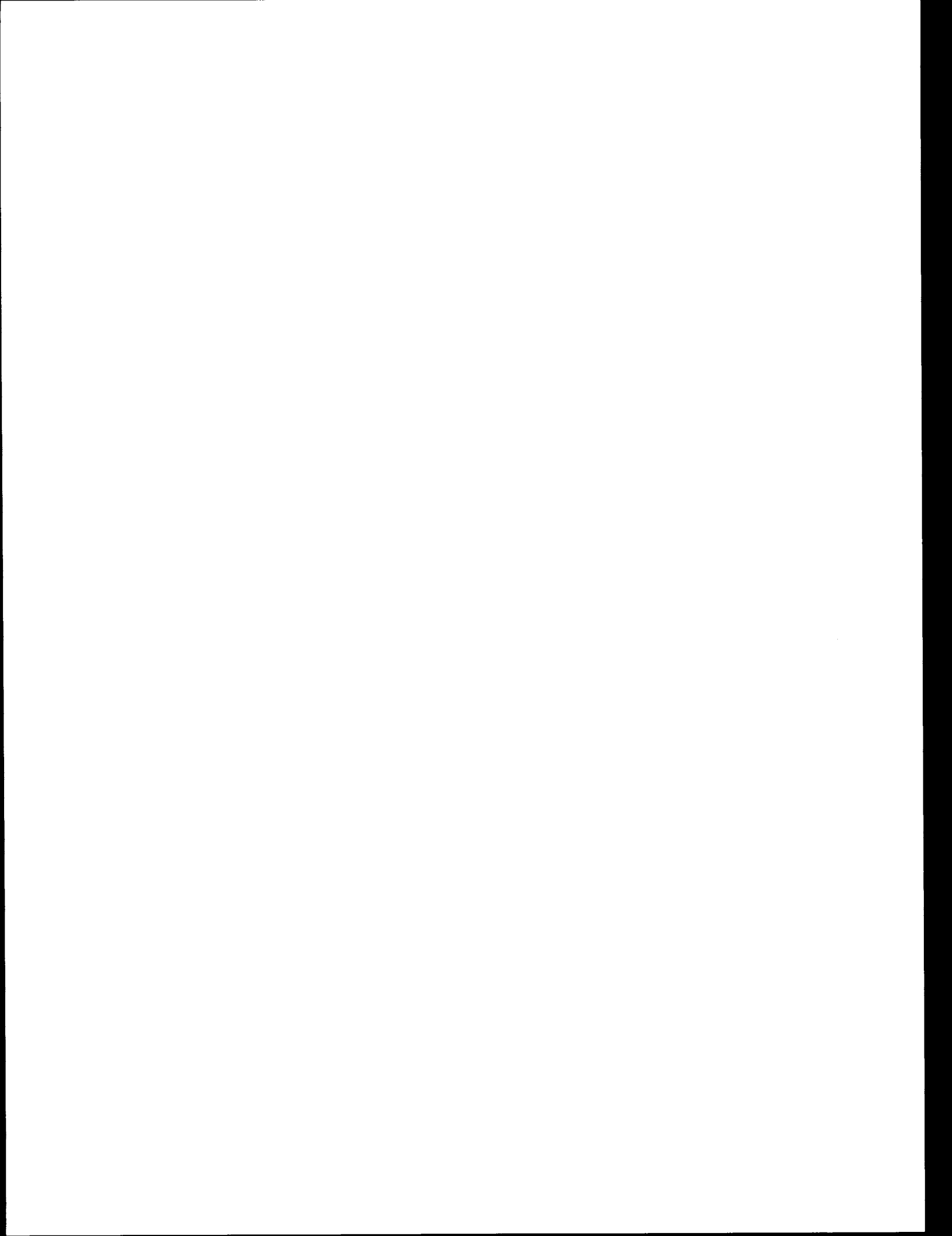
A significant number of comments were received in three areas: site selection, health effects, and plant makeup-water sources. Specific responses to these comments are given in this appendix. However, because of the number of comments in these three areas, some general remarks are given here.

Site selection. The selection of a site for a facility such as MLGW involves the consideration of environmental factors, as well as other factors such as costs, institutional constraints, and schedule. This Final Environmental Impact Statement (FEIS) largely deals with environmental factors. Any recent information influencing predicted environmental impacts at the proposed or alternative sites has been included in the FEIS. A complete discussion of other factors influencing the ultimate selection of a site is beyond the scope of an EIS; however, some discussion of these other factors is provided in Appendix C.8.

Health effects. Section 1.4.8.3 has been expanded to provide greater detail regarding the complete health risk assessment to be performed prior to plant operation. Also, since issuance of the draft statement, new data from pilot plant studies have become available. Based on this data, a preliminary risk assessment has been performed and is provided in Sect. 4.4 of the FEIS.

Plant makeup water. An analysis of impacts resulting from the use of aquifer water for plant makeup, along with analyses of impacts resulting from alternative makeup sources, have been performed. Results of these analyses are given in Sect. 2.3.2.1 of the FEIS.

A.1 COMMENTS NEEDING NO RESPONSES



ROBIN BEARD  
6TH DISTRICT TENNESSEE

WASHINGTON OFFICE:  
229 CANNON HOUSE OFFICE BUILDING  
WASHINGTON, D.C. 20515  
(202) 225-2811

Congress of the United States  
House of Representatives  
Washington, D.C. 20515

DISTRICT OFFICES:  
5579 POPLAR  
SUITE 815  
MEMPHIS, TENNESSEE 38117  
(901) 767-4652  
—  
22 PUBLIC SQUARE  
COLUMBIA, TENNESSEE 38401  
(615) 388-2133

STATEMENT FROM:

DECEMBER 3, 1980

CONGRESSMAN ROBIN BEARD  
SIXTH DISTRICT TENNESSEE  
229 CANNON HOUSE OFFICE BUILDING  
WASHINGTON, D.C. 20515

I THINK MY POSITION ON THE PROPOSED COAL GASIFICATION PLANT IS WELL KNOWN, AND I REGRET THAT SOME RATHER SHODDY POLITICAL ACTIVITIES IN THE PAST SEVERAL WEEKS HAVE NECESSITATED MY REPEATING THAT POSITION.

I AM STRONGLY IN FAVOR OF THE TIMELY COMPLETION OF THIS PROJECT. WHILE I DISAGREED WITH SEVERAL OF THE SYNFUELS BILL'S PROVISIONS, I WHOLEHEARTEDLY ENDORSED THE CONCEPT OF ESTABLISHING PILOT PROJECTS THAT WOULD DEVELOP COST-EFFICIENT METHODS OF BURNING MORE OF THIS NATION'S COAL.

NATURALLY, I AGREE THAT MEMPHIS IS AN IDEAL LOCATION FOR SUCH A PLANT. THE MEDIUM BTU GAS THAT WILL BE PRODUCED IS PERFECTLY SUITED FOR AN URBAN ENVIRONMENT AND MEMPHIS OFFERS UNIQUE ACCESS TO RAIL AND BARGE TRANSPORTATION FACILITIES FOR THE NECESSARY COAL SHIPMENTS.

MOST IMPORTANTLY, CONSTRUCTION AND OPERATION OF THE PLANT WILL HELP PROVIDE MANY MUCH-NEEDED JOBS WITHIN THE MEMPHIS COMMUNITY. IN SHORT, MEMPHIS BOTH NEEDS AND DESERVES THIS FACILITY, AND I WILL DO ALL IN MY POWER TO INSURE THAT IT WILL BE CONSTRUCTED. AS I SAID EARLIER, IF THE PRESIDENT'S DIRECTOR OF HIS OFFICE OF MANAGEMENT AND BUDGET PERSISTS IN HIS ATTEMPTS TO CUT FUNDING, I WILL WORK TO MAKE SURE THAT THE NEW ADMINISTRATION REVERSES THAT DECISION.

I WOULD ALSO LIKE TO ACKNOWLEDGE ALL THE WORK THAT THE MEMPHIS COMMUNITY HAS DONE TO ATTRACT THIS PROJECT. IT IS AN INDICATION OF THE VISION AND INNOVATION THAT IS FAST BECOMING THE SYMBOL OF THE NEW MEMPHIS.



ED JONES  
7TH DISTRICT, TENNESSEE  
106 CANNON HOUSE OFFICE BUILDING  
(202) 225-4714

COMMITTEE ON  
AGRICULTURE  
  
CHAIRMAN:  
SUBCOMMITTEE ON  
CONSERVATION AND CREDIT

COMMITTEE ON  
HOUSE ADMINISTRATION

CHAIRMAN:  
SUBCOMMITTEE ON  
HOUSE SERVICES

Congress of the United States  
House of Representatives  
Washington, D.C. 20515

December 2, 1980

DISTRICT OFFICES:  
ROOM B-7, POST OFFICE BUILDING  
JACKSON, TENNESSEE 38301  
(901) 423-4848

3179 NORTH WATKINS  
MEMPHIS, TENNESSEE 38127  
(901) 358-4094

P.O. Box 128  
YORKVILLE, TENNESSEE 38389  
(901) 643-6123

Mr. Dave Hansen  
President  
Memphis Light, Gas and Water Division  
P.O. Box 430  
Memphis, Tennessee 38101

Dear Dave:

Thank you for your recent letter inviting me to attend the Department of Energy's public hearing being held in conjunction with the Industrial Fuel Gas Demonstration Project. I appreciate your keeping me informed of the progress of this project, but regret that I will be in Washington attending the scheduled session of the House on this date. I would appreciate, however, this letter being read into the record of the public hearing.

I have supported the efforts to obtain this demonstration project for the Memphis area since it was conceived. I think that such a pilot project will provide an opportunity to advance the coal gasification technology that already exists, thus preparing our country for the future when we may be depending more heavily on synthetic fuels. With the long lead time needed to fully develop these technologies, I think it is imperative that such a project be pursued as quickly as possible so that our nation is prepared for its future energy needs. The use of coal to produce a medium BTU gas for industrial use accomplishes both our goal to use more coal and simultaneously develop technologies that will be needed for future use in our continuing effort to reduce dependency on foreign energy sources.

I commend the City of Memphis and the Light, Gas and Water Division for your efforts in this regard and look forward to full development of the project in Memphis.

With kindest regards and best wishes, I am

Sincerely,



Ed Jones, M.C.

EJ:aw

PMD80-2821

DM, RL  
12/16

DEPARTMENT OF THE AIR FORCE  
REGIONAL CIVIL ENGINEER, EASTERN REGION (HQ AFESC)  
526 TITLE BUILDING, 30 PRYOR STREET, S.W.  
ATLANTA, GEORGIA 30303



REPLY TO  
ATTN OF: ROVI

11 December 1980

SUBJECT: Draft Environmental Impact Statement (DEIS), Memphis Light, Gas and  
Water Division Industrial Fuel Gas Demonstration Project, Memphis,  
Shelby County, TN

TO: U. S. Department of Energy  
Chicago Operations and Regional Office  
Attn: Dr. Robert Laza  
9700 South Cass Avenue  
Argonne, IL 60439

1. As the U.S. Air Force point of contact for federal regional offices in Federal Regions I - IV, we have been designated by HQ USAF to provide Air Force comments on the subject DEIS. Our review of this DEIS reveals that this project would have no impact on Air Force active or reserve activities in the area. Therefore, we have no comments on the subject DEIS.

2. We thank you for the opportunity to review this DEIS. If you have any questions, please call Captain John Giarnese, 404-221-6776/6618 or FTS 242-6776/6618.

*Ronald H. Waters*

RONALD H. WATERS  
Lt. Colonel, USAF  
Deputy Regional Civil Engineer

Cy to: SAF/MIQ  
HQ USAF/LEEV

PMO-80-2672  
RWL-DM



DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT  
WASHINGTON, D.C. 20410

NOV 14 1980

OFFICE OF THE ASSISTANT SECRETARY  
FOR COMMUNITY PLANNING AND DEVELOPMENT

IN REPLY REFER TO:

Mr. Robert W. Laza  
Department of Energy  
Project Management Division  
9800 South Cass Avenue  
Argonne, Illinois 60439

Dear Mr. Laza:

Subject: Draft Environmental Impact Statement  
Memphis Light, Gas and Water Division  
Industrial Fuel Gas, Demonstration Project  
Memphis, Shelby County, Tennessee

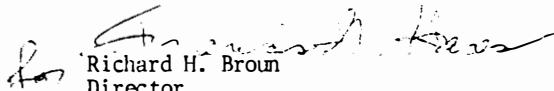
Thank you for providing us the opportunity to review the above draft Environmental Impact Statement (EIS). In accordance with 24 CFR Part 50 Protection and Enhancement of Environmental Quality, Department of Housing and Urban Development procedures, particularly Section 50.61 of our Regulations, we are forwarding the EIS to the responsible HUD Regional Environmental Officer. He will review and comment as appropriate, directly to you by your due date.

If non-HUD EIS's are sent directly to the Office with review responsibility, it would assure more prompt and thorough review. You should send copies of all future EIS's as follows:

1. All EIS's on legislative proposals, regulations, or policy documents of national or multi-state programmatic significance are reviewed by HUD Headquarters and should be sent to Mr. Richard H. Broun, Director, Office of Environmental Quality, HUD, Washington, D. C. 20410; and
2. All other site specific activities or project EIS's should be forwarded to the appropriate HUD Regional Office for comment. We have enclosed a list of our Regional Environmental Officers and their addresses.

If you have any questions in this regard, please feel free to contact me at (202) 755-6300.

Sincerely,

  
Richard H. Broun  
Director  
Office of Environmental Quality

Enclosure

|            |                                                                                                                                                                                  |             |                                                                                                                                                                  |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Region I   | David Prescott<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>John F. Kennedy Building<br>Room 800<br>Boston, Massachusetts 02203                   | Region VIII | Walter Kelm<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>Executive Tower Building<br>1405 Curtis Street<br>Denver, Colorado 80202 |
| Region II  | Marvin Krotenberg<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>26 Federal Plaza<br>New York, New York 10007                                       | Region IX   | Dale James<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>450 Golden Gate Avenue<br>Box 36003<br>San Francisco, California<br>94102 |
| Region III | Larry Levine<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>Curtis Building<br>6th and Walnut Streets<br>Philadelphia, Pennsylvania 19106           | Region X    | Ry Tanino<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>3003 Arcade Plaza Bldg.<br>1321 Second Avenue<br>Seattle, Washington 98101 |
| Region IV  | Ivar Iverson<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>Richard B. Russell Federal Building<br>75 Spring Street, S.W.<br>Atlanta, Georgia 30303 |             |                                                                                                                                                                  |
| Region V   | Harry Blus<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>300 South Wacker Drive<br>Chicago, Illinois 60606                                         |             |                                                                                                                                                                  |
| Region VI  | Otis Trimble<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>221 W. Lancaster Avenue<br>P.O. Box 2905<br>Fort Worth, Texas 76113                     |             |                                                                                                                                                                  |
| Region VII | Gary Ultican<br>Environmental Officer<br>Department of Housing<br>& Urban Development<br>Federal Office Building<br>911 Walnut Street, Room 300<br>Kansas City, Missouri 64106   |             |                                                                                                                                                                  |



United States  
Department of  
Agriculture

Soil  
Conservation  
Service

675 U. S. Courthouse  
Nashville, Tennessee 37203

*JMS 81062  
Rec'd 1/2/81  
RUL, TM*

January 5, 1981

Mr. Robert W. Laza  
Department of Energy  
Project Management Division  
MLGW Public Hearing  
9800 South Cass Avenue  
Argonne, Illinois 60439

Dear Mr. Laza:

We have reviewed the Draft Environmental Impact Statement - Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Project, Memphis, Shelby County, Tennessee, October 1980.

The Pidgeon site has been classified as prime farmland according to interpretations based on the Shelby County Soil Survey information and the National criteria. The site is presently being used for soybean production.

The Allen site and the Rivergate site do not have the characteristics to be classified as prime farmland.

We appreciate the opportunity to review the Draft Environmental Impact Statement. Please let us know if we can furnish any other information.

Sincerely,

*Donald C. Bivens*

Donald C. Bivens  
State Conservationist



The Soil Conservation Service  
is an agency of the  
Department of Agriculture

SCS-AS-1  
10-79



OFFICE OF THE SECRETARY OF THE TREASURY  
WASHINGTON, D.C. 20220

PMO-80-2584  
Rwh-OM

November 4, 1980

Dear Dr. Laza:

Thank you for forwarding a copy of the draft Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Project. This Department has no comment on the statement.

Sincerely,

A handwritten signature in dark ink, appearing to read "Anthony V. DiSilvestre".

Anthony V. DiSilvestre  
Assistant Director (Environmental Programs)  
Office of Administrative Programs

Dr. Robert Laza  
U.S. Department of Energy  
Chicago Operations and  
Regional Office  
9700 South Cass Avenue  
Argonne, Illinois 60439

STATEMENT ON ECONOMIC IMPACT  
BY  
AARON F. TATUM  
BUREAU OF ECONOMIC DEVELOPMENT/  
OFFICE OF PLANNING AND DEVELOPMENT  
OF  
MEMPHIS AND SHELBY COUNTY

MEMPHIS LIGHT, GAS AND WATER DIVISION  
INDUSTRIAL FUEL GAS DEMONSTRATION  
PROJECT'S DRAFT  
ENVIRONMENTAL IMPACT STATEMENT

DECEMBER 3, 1980

It is a pleasure to testify on behalf of the Bureau of Economic Development/Memphis and Shelby County Office of Planning and Development for such a worthy project.

It is particularly noteworthy that the E.I.S. preparation and release phases have been made more expedient by an Environmental Task Force which assures an administrative follow-up capability in the field offices of the Department of Energy.

It is also significant that as a result of memoranda in September of this year the E.P.A. and D.O.E. are working together more closely. We at the local level hope this favorable trend continues.

According to the Bureau of Business Research, M.S.U. study the number of potential gas-intensive industries which could locate in Memphis, given adequate space and support facilities, total to over 50 industries in the next 20 years.

This gives some basic indication as to a desiderata for new industry and jobs.

The Greater Memphis Community Governor's Economic and Jobs Conference mentioned specifically under the goal entitled: "Take steps to insure reasonable energy costs, adequate energy supplies, and energy conservation the following priority", and I quote:

Priority 2 - Gain public support for new energy facilities.

Lead responsibility: Memphis Light, Gas & Water Division. Time frame: Immediate. Gain support from all sectors for M.L.G.&W's efforts to build a coal gasification plant and take steps to find



-2-

other new sources of energy including co-generation plants, synthetic fuel innovations and solar installations."

An integral part of the overall thrust of this conference, held in November 1979, and of the 1980 Memphis Jobs Conference is the creation of more jobs and a general economic improvement for the Memphis area. Energy has played no small role in the formulation of an economic development strategy for Memphis. The Energy Task Force underlined this vital role for energy as it relates to jobs, by offering the above recommendation.

This testimony should help emphasize the support for the recommendation and for coal-gasification.

Virtually all energy consumed in Memphis is imported according to research compiled by the Energy Task Force Committee. This deficit in production creates a serious energy "balance of payments" problem for Memphis, thus resulting in a serious outflow of capital.

While the coal-gasification plant will not locally reduce the balance of payments problem because of the coal being "imported from Western Kentucky" it will go far to provide a medium BTU gas capability which will supplement existing gas supplies which are currently imported from overseas in the form of number two and number six fuel oil.

-3-

The goal of the Jobs Conference to Improve the Memphis Area's Industrial Mix has as its number one priority the provision of more high-wage, high-productivity industry. "Memphis should seek industry and business at all skill levels, but this effort should be guided by achieving an industrial mix that concentrates more on high-wage, high-productivity industry." The coal-gasification plant will undoubtedly aid in attracting gas-intensive industries to Memphis.

According to the Survey of Current Business - April, 1980 the per capita income is \$7,231 for the Memphis SMSA. This compares to a 1977 Figure of \$6,495 which is an increase of over 10%. However, as everyone knows, this does not keep up with the inflation rate. Despite current intensive efforts, this problem is far from being solved.

Nevertheless, there is hope. Memphis possesses a willing, able and diversified labor supply, a capability of providing goods and services to a 105-county primary market area and a solid leadership in Memphis and Shelby County which actively supports economic development. These factors can contribute to a greater industrial mix and a greater per capita income i.e. an enhanced quality of living for Memphis citizenry.

15,000 industrial jobs have been forecast as a result of the projected capital cost of \$400 million (in 1979 dollars). 700-plus construction jobs will be provided over the for-year construction period. 250 jobs will comprise the operations staff.

-4-

Furthermore, \$106 million in taxes will be returned during construction and \$26 million upon the operation of the plant.

So, it is easy to recognize that the Memphis energy balance of payments (over-coming the deficit) and the economic benefits (accentuating the positive) will contribute greatly to Memphis' economic climate as well as the overall energy picture in the United States.

There was certainly no mandate in the recent election returns to disembowel the clean-air and clean-water laws of America. The public still wants the basic programs to continue.

But, the main priority is and will be jobs and an improved economic climate.

Certainly, the Memphis coal-gasification plant will be a demonstration project that will exceed the requirements of any future lower air-quality restrictions because it more than adequately meets the current requirements as the project is planned.

Coal gasification utilizes a high-sulphur coal which is non-renewable but abundant and readily available. It produces, through the perfected U-Gas process, a gas that is clean, competitive and useful for industry in Memphis. We hope that the project moves ahead as scheduled.

*PMB 800.2  
Original RWL  
cc'd MRC-JK.OM,  
PL*



## Memphis and Shelby County Office of Planning and Development

CITY HALL 125 NORTH MAIN ST. MEMPHIS, TENNESSEE 38103 (901) 528-2601

November 21, 1980

Dr. Robert W. Laza  
Department of Energy  
Project Management Division  
9800 South Cass Avenue  
Argonne, Illinois 60439

RE: MLGW Public Meeting - December 3, 1980

Dear Dr. Laza:

The purpose of this letter is to transmit comments concerning information presented in the draft environmental impact statement (DEIS) "Memphis Light, Gas and Water (MLGW) Industrial Fuel Gas Demonstration Project", Memphis, Shelby County, Tennessee, October 1980 (DOE EIS-0071-D). We request that this letter be included in the record for the public meeting on the DEIS scheduled for December 3, 1980 at Christian Brothers College in Memphis.

The Memphis-Shelby County Office of Planning and Development has closely reviewed the technical, economic and environmental aspects of the proposed MLGW Industrial Fuel Gas Demonstration Project. This cooperative cost-sharing project offers a valuable opportunity to provide a timely demonstration of the technical feasibility of large scale production of industrial fuel gas from high-sulfur coal and should advance the state of the art in coal gasification. Demonstration of this improved gasification technology will build private sector confidence, which is of primary importance to the rapid expansion of the domestic fuels industry and attainment of synthetic fuel production capacity goals established by the Energy Security Act.

The DEIS demonstrates that the proposed gasification project will be economically viable as well, and it is certain that the economics of the project will become even more attractive as the costs of conventional energy sources continue to rise. Especially notable from an economic point of view is the proposed location of the gasification facility. Besides possessing excellent rail and water

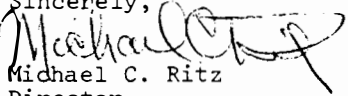
Dr. Robert W. Laza  
Page 2  
November 21, 1980

transportation access for bringing in coal, the proposed site is situated within an area of existing and planned industrial growth. Local government has placed a high priority on the continued development of this industrial area, and the coal gasification facility will be able to provide a competitive, clean and convenient energy supply to a growing number of industrial customers located well within the economic transport limits for medium-BTU gas.

As for environmental concerns, information presented in the DEIS provides adequate assurance that the proposed gasification facility design will incorporate appropriate control features to ensure operation in an environmentally sound manner. The project offers an opportunity to demonstrate that development of domestic coal resources to decrease the national reliance on volatile foreign sources of energy supplies can be achieved without compromising efforts to maintain an improved environment.

Based on the information contained in the DEIS and our familiarity with the developmental history of the project, this office supports the approval of the MLGW Industrial Fuel Gas Demonstration Project as proposed. We encourage the responsible government agencies to advance the project toward implementation as expeditiously as is practicable.

Sincerely,

  
Michael C. Ritz  
Director

MCR/lh



MEMPHIS LIGHT, GAS AND WATER DIVISION

DAVID F. HANSEN  
PRESIDENT

December 2, 1980

Dr. Robert Laza  
Memphis Project Public Hearing  
Chicago Operations and Regional Office  
9700 South Cass Avenue  
Argonne, Illinois 60439

Dear Dr. Laza:

Subject: Proposed Comments By Memphis Light, Gas and Water  
Division DEIS Public Hearing December 3, 1980

Memphis Light, Gas and Water Division, as owner of the proposed Coal Gasification Plant, and partner with the Department of Energy, welcomes all public input to the Environmental Impact Statement process. For this reason, we are pleased that concerned citizens and groups have the opportunity to provide comments on the Draft Environmental Impact Statement currently under review.

Memphis Light, Gas and Water Division is, of course, supportive of the project and eager to proceed with its construction. The plant will provide Memphis with reliable, clean, efficient and economical energy for both new and existing industries. Jobs will be created and the Memphis economy will receive benefits for years to come. We are especially pleased to offer a project that will decrease our nation's dependence on foreign oil in an urban environment, where current economic problems are most severe.

While we heartily back the project, we are also wholly committed to protecting the environment in Memphis for ourselves and our children. The Draft Environmental Impact Statement under review here is an independent Department of Energy document. However, it is based, in part, on environmental work done during the past three years by Memphis Light, Gas and Water and its project team. I would like to assure the citizens of Memphis, and all concerned citizens and groups, that Memphis Light, Gas and Water Division has consistently striven to undertake this project in an environmentally acceptable manner. All of our actions have been and will be guided by that policy.

P.O. BOX 430 MEMPHIS, TENNESSEE 38101 TELEPHONE (901) 528-4011

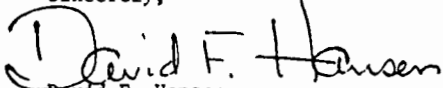
-2-

Dr. Robert Laza

December 2, 1980

These proceedings are an excellent means to further assure Memphis Light, Gas and Water Division, The Department of Energy, the people of Memphis, and all citizens concerned with Synthetic Fuels Development, that all major environmental issues have been considered. We are listening intently to your comments. We are committed to manage the project in an environmentally sound manner.

Sincerely,

  
David F. Hansen

DFH/na



901-454-2171

INSTITUTE FOR ENGINEERING RESEARCH  
*Herff College of Engineering*  
 MEMPHIS STATE UNIVERSITY  
 MEMPHIS, TENNESSEE 38152



901-454-2747

December 8, 1980

Robert W. Laza  
 Department of Energy  
 Project Management Division  
 MLGW Public Hearing  
 9800 South Cass Avenue  
 Argonne, Illinois 60439

Dear Mr. Laza:

I was indeed disappointed to miss the opportunity of speaking at the public hearing held on Wednesday, December 3 for the coal gasification project in Memphis. As I explained, time commitments did not permit me to be present before 4:30 in the afternoon and I had to leave town that evening. It was thus unavoidable that I could not make either the afternoon session before 4:30 or the evening session at all. I would like to place the following comments in the public record.

With any large project such as the one envisioned by Memphis Light, Gas and Water and the Department of Energy, the impact upon the environment is certainly an issue which must be looked at. The impact of a 3,000 ton per day plus coal processing center on the water supply in the region is certainly one issue which would exist in some minds. I would like to make the Department aware of a water research project which has been conducted at Memphis State University which is germane to this issue. Perhaps the summary of our research in the following paragraphs may lend some insight as to the presence or absence of a problem with the Memphis aquifer.

For the past eighteen months, Memphis State University has been investigating the impact and feasibility of water reuse in a water surplus area. This project was funded and under the control of the Department of Energy, Office of Water Research and Technology. One of the areas which was investigated was the impact of a planned industrial park and the compatibility of water reuse within the planned park atmosphere. With the proposal for the coal gasification project appearing at about the same time as the MSU water reuse project, the compatibility of wastewater treatment plant effluent upgraded to be reused by the gasification facility was intriguing. As part of our overall study, the economic viability as well as technical viability of utilizing effluent from the Thomas E. Maxson Sewage Treatment Plant as feedwater to the coal gasification project was explored. As a sidelight, it should be mentioned that drawdown curves for the well fields within the area from which the coal gasification plant would derive its water were evaluated and projections as to the impact of the coal gas plant on those water resources were made.



Robert W. Laza  
Page 2  
December 8, 1980

The proposed coal gasification project will utilize over two million gallons per day of water. The major uses of this water will be for cooling and for steam generation in the process. Upgraded wastewater treatment plant effluent could be introduced into the process as boiler feed water make-up and/or as cooling water with no additional treatment required other than what is presently being envisioned for Memphis groundwater. The use of Memphis groundwater at the cost of drawing it out of the ground and upgrading it is the most economically attractive alternative to all the water sources which are available. If the concern is, however, that this water use would be in some way a negative effect on the Memphis aquifer, other alternate sources of water are available, i.e. wastewater reused from the Maxson Treatment Plant or Mississippi River water.

Studies at Memphis State University have shown that if a large facility or a large water user such as a coal gasification facility were forced to abandon the use of wells and treat either Mississippi River water or secondary wastewater effluent, it is economically attractive to reuse the wastewater treatment plant effluent over the Mississippi River water and it also provides an environmental advantage of reducing the discharge of wastewater to the Mississippi River.

The MSU study was directed towards the competitive nature of reused water within an urban water rich area such as Memphis. Although regions within the City were evaluated with respect to water use and reuse potential, the presence of the coal gasification plant will probably spur industrialization within the close proximity which could provide the ideal location for a separate water system using upgraded wastewater treatment plant effluent or subpotable water for process use with Memphis Light, Gas and Water Division supplying water for sanitary purposes. Thus, under planned conditions, even large water users (of which the coal gasification plant is really not) could have their major water demands satisfied without impacting the water bearing stratas within the Memphis Area.

Also as a part of the MSU studies, the actual impact which would be felt by the withdrawal of the additional two million gallons per day from this region for the Light, Gas and Water project was studied. The impact of increased withdrawals from the Allen Well Field for this facility would not be that significant in terms of overall water strata drawdown. The existing drawdown curve around the Allen Well Field is not as critical as it is in other parts of the City which are more heavily industrialized.

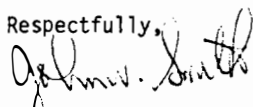
A related item was also addressed in our study which may be of interest to the Department of Energy. As part of our investigation of reuse and recycling of waters within an industrial complex, the potential pollutants which might be found in the wastewater from the coal gasification facility were explored. While it is true that many synthetic fuel plants do produce

Robert W. Laza  
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December 8, 1980

A condensate from the gasification project process which may contain carcinogenic materials or materials which are resistant to biological wastewater treatment, the technology being utilized in the MLGW project is such that the production of these types of compounds would be minimal if at all. By the use of gasification as opposed to liquifaction, the severity of destruction of the coal is such that by-products are minimized. A higher percentage of the coal is converted to usable off-gases as opposed to cyclic compounds which would end up in the condensate water. If the wastewater emitting from the process were to be found a problem with the T. E. Maxson Wastewater Treatment Plant, the state of the art is such that an on-site treatment process could be utilized to handle the wastewater before it leaves the coal gasification plant and alleviate any problems which might occur at the T. E. Maxson Plant. The studies being performed at the Oak Ridge National Laboratories also confirm our findings.

I trust that the above comments will be of assistance to you in your evaluation of the draft environmental impact statement for the Memphis Light, Gas and Water Coal Gasification Project. Again, let me say that I was sorry I was not able to deliver these comments in person; however, due to my academic and research activities I was not able to be in town during the hours in which your hearings were held. If you would like to explore my comments in greater detail or would like additional information, please do not hesitate to contact me.

Respectfully,



John W. Smith, Ph.D., P.E.  
Professor

Copy: Charles Brown, Memphis Press-Scimitar  
Dave Hansen, MLG&W  
Robert Gray  
Dean O. E. Wheeler, Herff College of Engineering

JWS:nw

UNITED STATES OF AMERICA  
DEPARTMENT OF ENERGY*CMS 8054  
A WL, DM*Draft Environmental Impact Statement)  
Memphis Light Gas and Water Division)  
Industrial Fuel Gas Demonstration )  
Plant Project )

Docket No. DOE/EIS-0071-D

## WRITTEN COMMENTS OF THE AMERICAN GAS ASSOCIATION

The American Gas Association (A.G.A.), a national trade association which represents nearly 300 natural gas transmission and distribution companies serving over 160 million customers in all 50 states, welcomes this opportunity to provide its comments on the Draft Environmental Impact Statement prepared by the Department of Energy (DOE) for the Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Project (IFGDP).

Natural gas currently provides househeating energy to 55% of all residential single- and multi-family dwellings in the U.S., and provides over 28% of the energy consumed by U.S. industry. Collectively, A.G.A. member companies account for nearly 85% of the nation's total gas utility sales.

The gas industry has been in the forefront of synthetic fuels development and has actively promoted the development of a coal gasification industry. Since 1971 the gas industry has invested over \$70 million in a joint coal gasification program with the Department of Energy and has cumulatively invested over \$150 million in equity capital on coal gasification projects. The gas industry has a very firm commitment to coal gasification and, in this regard, the Draft EIS prepared by DOE for the IFGDP is a welcome step.

The Memphis IFGDP will be the first commercial scale medium-Btu coal gasification plant to be constructed and operated. It is

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therefore important that the Draft EIS be approved and finalized as quickly as possible so that the IFGDP can demonstrate the economic and environmental feasibility of medium-Btu coal gasification. Such a demonstration will spur development of a domestic synthetic fuels industry.

#### Economic Benefits for Memphis

The construction stage of the IFGDP alone will provide a strong immediate boost to the Memphis economy. Some forecasts indicate that up to 15,000 industrial jobs would be created as a direct and indirect result of the projected capital expenditure of \$400 million (1979 dollars).<sup>1</sup> Construction alone would provide jobs at a peak level of some 700 workers over a three-year period, representing a payroll of more than \$6 million.<sup>2</sup>

It is estimated that the \$400 million (1979 dollars) medium-Btu plant in Memphis would return \$106 million in taxes during the construction phase and \$26 million in taxes per year when the plant becomes operational.<sup>3</sup> These are direct payroll and business taxes. In addition, there would be substantial benefits to the economy from enhanced employment, increased sales of goods and services, and development of the state's coal reserves.

The future of urban areas such as Memphis depends on the community's ability to provide jobs for its people. The supply of energy is a crucial problem facing urban areas, not only in terms of assuring a reliable continuity of performance by existing industries but particularly in attracting new ones. Thus, the development of more secure energy supplies for industry -- through measures which include projects such as the Memphis IFGDP -- must necessarily play a key role in any national efforts to promote revitalization of urban areas.

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Several market studies have been performed by various organizations to determine the potential market for synthetic medium-Btu gas from coal nationwide. These studies show there is a substantial market in both single-user and multi-user types of applications. Thus, the results and information made available from the construction and operation of the demonstration plant will be directly applicable to other parts of the country for increasing the use of coal in an environmentally acceptable manner.

A new source of energy, such as the Memphis IFGDP, which is available and reliable provides a strong incentive for corporations to move to or expand in the Memphis area. In Memphis, the market of existing customers which would utilize the gas produced includes 25 to 45 industrial firms. Three large industrial parks are being planned within the proposed distribution system, and the coal gasification plant will be an enormous asset in developing these sites.

The main selling point of the Memphis IFGDP is its reliability and the assurance of supply. In order to enhance the attractiveness of this fuel gas to industrial customers, the reliability of supply must be ensured, even during periods of plant shutdown or repair and maintenance. The IFGDP is designed to enhance reliability by the use of modular gasifier trains and several backup systems. Reliability is further ensured by using the existing natural gas system as a backup and by establishing a gas credit system. During fuel gas operation, up to 10 percent of the product gas can be methanated to pipeline quality gas and introduced into the existing Memphis natural gas system, thereby accruing "credit" against periods when the plant is not operating. During these periods, the "credit natural gas" will be withdrawn, diluted with air to the

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proper medium-Btu heating value, and distributed to industrial customers.

#### National Economic Benefits

Memphis is one of the few sites selected for a coal gasification project within an urban area. According to marketing studies by Stanford Research Institute (SRI), the technology and design of the Memphis plant could be used in at least 79 other U.S. cities.<sup>4</sup> Therefore, the plant, if carried through to completion, will in essence serve as a "pilot" or test project for the country as a whole and could have a significant impact on solving localized energy supply problems. The Draft EIS indicates a potential market penetration for medium-Btu coal gas of between 0.6 quad and 2.0 quads by 1992. Other studies are even more favorable.

Among the studies on the national market for industrial fuel gas is one by SRI International for Memphis Light, Gas & Water Division (MLGW) titled "Industrial Market Potential for Intermediate-Btu Gas from Coal in the United States." This study was completed in September, 1979. The objective of the study was to assess the U.S. market potential of medium-Btu gas using the marketing system concepts developed by MLGW. The study, conducted with the Memphis marketing system assumptions, concluded that the potential available market may be as much as 7.0 quads in the year 2000.

Another study, completed in July, 1979, by Booz, Allen & Hamilton, Inc.<sup>5</sup> for DOE's Office of Resource Applications, did not use the Memphis marketing concepts but focused only on manufacturing markets in the 1985 time frame. Although this assumption limited the potential market, the study found that U.S. manufacturing

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industries could support 300 medium-Btu coal gasification plants with total output of 2.9 quads. The study concluded that the development of medium-Btu coal gasification has the potential to provide substantial benefits to the nation and recommended that the first priority for DOE action in this area should be the demonstration of a commercially feasible medium-Btu multiple-user plant. The construction and operation of the Memphis IFGDP will satisfy this recommendation.

Regardless of whether potential national demand for medium-Btu coal gasification is about 0.6 quads by 1992, the low estimate as reported in the draft EIS<sup>6</sup>, or 7 quads by the year 2000 as estimated by SRI, the benefits of medium-Btu coal gas could be great. For example, at a world oil price of \$35, medium-Btu coal gas of 0.6 to 7.0 quads could displace oil imports worth about \$3.5 to \$42 billion -- a sizable impact on the U.S. balance-of-payments deficit.

The Memphis IFGDP is a crucial first step in the development of a medium-Btu coal gasification industry because financing will continue to be difficult to obtain until the technical, economic and environmental feasibility of producing medium-Btu gas is demonstrated. In addition, the Memphis IFGDP will increase the current level of knowledge relating to operating and environmental parameters. By demonstrating the ability to operate economically with a wide variety of coals with adequate control of air, water and solid waste emissions, the Memphis IFGDP will encourage the growth of a new industry.

Because the Memphis IFGDP is such an important first step in the development of a medium-Btu coal gasification industry, A.G.A. is deeply concerned about reports from Congressional sources that the draft fiscal 1982 budget which was prepared by the Office of

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Management and Budget, proposes to cut the energy research budget, including funds for the Memphis IFGDP. We urge DOE to use the means at its disposal to ensure that the Memphis IFGDP is completed.

The Role of Medium-Btu Coal Gasification in the Future Supply of Energy in the U.S.

Medium-Btu coal gas (MBG) can begin to make a modest contribution to U.S. gas supplies during the 1980s. Following successful demonstration of the Memphis IFGDP, additional coal gasification plants throughout the U.S., using a variety of coals and technologies, can combine to produce far greater quantities.

The A.G.A. Gas Supply Committee, made up of a broad spectrum of gas industry leaders, recently completed a comprehensive two-year assessment of the outlook for conventional and supplemental sources of gas energy to the year 2000.<sup>7</sup> The two major conclusions of the study regarding the long-range potential of gas were as follows:

- 1) Sufficient gas energy will be available in the year 2000 to continue to supply at least 25% of our nation's total energy requirements, and up to the 33% supply level provided by gas during the late 1960s and early 1970s.
- 2) Although projected volumes of gas supply in the year 2000 vary with one's assumptions about future technical, social, economic and political conditions, it is reasonable to expect that a range of between 23 and 33 Tcf of annual gas production can be available in the year 2000.

The Committee estimated that medium-Btu coal gasification can provide .14-.45 quads in 1990 and .5 - .99 quads in the year 2000. These estimates are comparable in size to the 0.6 quads estimate of 1992 production made in the Draft EIS.<sup>8</sup>

The enactment of phased new gas deregulation (under the Natural Gas Policy Act of 1978) has significantly improved the supply outlook for lower 43 conventional gas. Nevertheless, the active development of supplemental gas sources will be necessary



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if gas is to fulfill its potential for the displacement of imported oil. The technology required is well understood and it will be economically competitive with other sources of gas by the time most coal gasification facilities are completed.

#### Environmental Effects of the IFGDP

The Allen site is ideal for demonstrating the environmental and economic feasibility of gasifying high-sulfur caking coals. Although any of the three sites analyzed could support an environmentally-sound coal gasification plant, the Draft EIS demonstrates the superiority of the Allen site.

The gas industry agrees with DOE's conclusions that air quality and noise impact will be minimal or controllable. A comparison (see Table I) of the Memphis IFGDP with the unit plants defined in the Final Environmental Impact Statement for the Alternative Fuels Demonstration Program, shows that the Memphis IFGDP, on a per Btu basis, would have less air emissions than either coal liquefaction or direct combustion of coal for electricity.<sup>9</sup>

TABLE 1  
Daily Air Emissions

|                 | Memphis<br>IFGDP<br>(lb/d/BBtu) | Fischer-Tropsch<br>Coal<br>Liquefaction<br>(lb/d/BBtu) | Coal-to-<br>Electric<br>(lb/d/BBtu) |
|-----------------|---------------------------------|--------------------------------------------------------|-------------------------------------|
| Particulates    | 16                              | 51                                                     | 230                                 |
| SO <sub>x</sub> | 138                             | 708                                                    | 2,722                               |
| NO <sub>x</sub> | 221                             | 356                                                    | 1,696                               |
| CO              | 22                              | 26                                                     | 142                                 |
| CO <sub>2</sub> | 3                               | 8                                                      | 45                                  |

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The Draft EIS addresses the potential environmental hazards to the nearby rivers and lakes and their wildlife. A.G.A. fully agrees with DOE in its conclusion of minimal or no harm in these areas. Similar conclusions reached in the Draft EIS regarding the impact of the IFGDP on geology and soils, terrestrial ecology, and land use are also strongly supported by A.G.A.<sup>10</sup>

A.G.A. is particularly pleased to support the findings of the Draft EIS related to economic, social, and cultural impacts. These findings indicate that employment in Shelby County will increase by nearly 1,800 workers as a result of plant construction, construction of other public-sector projects that will be using the industrial fuel gas produced by the Memphis IFGDP, and secondary jobs providing goods and services.<sup>11</sup> These jobs provide a strengthened economic base for Shelby County. Other studies show an even greater benefit for the Memphis area. (See footnote 1; which references a study projecting creation of as many as 15,000 jobs.)

The increased wages, attributed only to the construction phase without regard to wages paid as a result of other construction projects and secondary jobs, are estimated at about \$50 million (1973 dollars). This \$50 million will result in an increased tax base, improving the ability of the city of Memphis and Shelby County to provide services.<sup>12</sup>

The operational phase of the IFGDP requires less workers than the construction phase, but DOE estimates that \$16.8 million (1978 dollars) of annual income to the Memphis and Shelby County economy will be generated by the Memphis IFGDP.<sup>13</sup>

A.G.A. commends DOE for examining the environmental risks of a medium Btu coal gasification industry in conjunction with the

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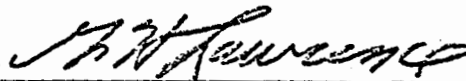
economic benefits to the public. Since the environmental risks are minimal and can be controlled by proper management, and the economic benefits are great, A.G.A. urges DOE to approve and finalize the Draft EIS without delay.

It is especially gratifying that DOE has analyzed the Program-matic Environmental Impacts with the assumption that 36 different medium-Btu plants could be sited (and producing 0.6 quads) by 1992. By using the IFDGP as a Baseline Unit Plant and analyzing the cumulative environmental effects of the program to promote a medium-Btu coal gasification industry, the Draft EIS provides a springboard from which additional medium-Btu coal gasification plants can start.

#### Conclusion

In summary, A.G.A. strongly supports the Memphis IFGDP and the Draft EIS. We believe that speedy review and finalization of the Draft EIS will be a great step toward the development of a commercial synthetic fuel industry in the United States.

Respectfully submitted,

By   
George H. Lawrence, President

Randall Griffin, Counsel,  
Legislative & Regulatory Affairs

Donald J. Schellhardt  
Assistant General Counsel and Director,  
Legislative & Regulatory Affairs

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Communications with regard to these comments should be addressed to:

Randall Griffin, Counsel,  
Legislative & Regulatory Affairs

or

James R. Watson,  
Legislative & Regulatory Affairs

The American Gas Association  
1515 Wilson Boulevard  
Arlington, VA 22209  
(703)841-8481

December 5, 1980

Footnotes

1. Coal Gasification for Memphis: Energy Hope for the Future, Memphis Light, Gas and Water Division, October 1979 Note: Total cost through 1984 is estimated at \$541 million.
2. Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Project: Draft Environmental Impact Statement, U.S. Department of Energy, October 1980. Ch. 4.1.8.
3. Coal Gasification for Memphis, supra. Note: Includes personal income tax of employees and construction crews as well as corporate and sales taxes.
4. SRI International, Industrial Market Potential for Intermediate - Btu Gas from Coal in the United States, Report prepared for Memphis Light, Gas & Water Division (Project No. ECC8313), September, 1979.
5. Booz, Allen & Hamilton, Inc., Analysis of Industrial Markets for Low- and Medium-Btu Coal Gasification, Report prepared for the Department of Energy, Office of Resource Applications (Contract No. ET-73-C-01-2625), July 30, 1979.
6. Draft EIS, supra at 1.4.3.
7. The Gas Energy Supply Outlook: 1980-2000, A Report of the A.G.A. Gas Supply Committee, American Gas Association, October 1980. Table VII-4.
8. Draft EIS, supra at 1.4.3.
9. Sources: Draft EIS, supra at 4.1.1 and Alternate Fuels Demonstration Program: Final Environmental Impact Statement, U.S. Energy Research & Development Administration, September 1977; Vol. 1, Ch. IV and XII.
10. Draft EIS, supra at 4.1.
11. Id. at 4.1.8.1.
12. Id. at 4.1.8.1.
13. Id. at 4.1.8.2.

A.2 LETTERS REQUIRING RESPONSES





## UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

## REGION IV

345 COURTLAND STREET  
ATLANTA, GEORGIA 30365

DEC 15 1980

4SA-EIS

Dr. Robert W. Laza  
Director, Project Management Division  
U. S. Department of Energy  
Chicago Operations and Regional Office  
9700 South Cass Avenue  
Argonne, Illinois 60439

Dear Dr. Laza:

We have reviewed the Draft Environmental Impact Statement (DEIS) on the Memphis Light, Gas and Water's Coal Industrial Fuel Gas Demonstration Project (IFGDP) in Shelby County, Tennessee.

In general, DOE has adequately addressed most of our environmental concerns. However, some of the discussions in the Final EIS could be improved. In our attached detailed comments we offer observations and suggestions which define these improvements.

**EPA-1** As a matter of NEPA policy, we are concerned about DOE's site selection process. A project solicitation process which requires a site specific proposal significantly limits DOE's ability to factor environmental considerations into the siting decision(s) and solve environmentally-related problems. Specifically, we have reservations about the Allen site because of its apparent inconsistency with Executive Orders 11988 and 11900, the high cost of site preparation, and the potential risk of extensive flood damage during construction.

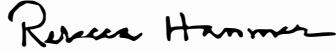
**EPA-2** EPA is committed to working with DOE to demonstrate whether synthetic fuel technology can be made environmentally acceptable. To that end we are involved in a wide range of environmental impact evaluations and technology assessments for the industry. We understand and appreciate that only through full scale demonstration can these assessments be made. Nevertheless, for DOE and EPA to discharge this responsibility, a comprehensive monitoring program during demonstration and subsequent evaluation in a NEPA-related public forum prior to a final decision on future operation is essential. The Final EIS should discuss how this evaluation will be conducted.



2

Based on the above and our enclosed technical comments, a rating of ER-2 was assigned, i.e., we have environmental reservations about the proposal and are requesting additional specified information be included in the Final EIS.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "Rebecca Hanmer".

Rebecca W. Hanmer  
Regional Administrator

Enclosure

cc: Dr. Robert Stern  
NEPA Affairs Division, DOE

AIR

## EPA-3 Page 1-28, Section 1.4.6.2, Table 1.7

The carbon monoxide 1-hour standard noted in Table 1.7 has been proposed for revision to 25 ppm (see 8/18/80 Federal Register). Same comments apply to Table 3.1 (Page 3-3) and Table 4.4 (Page 4-5).

## EPA-4 Page 3-3, Section 3.1.12, Table 3.1

No units for the pollutants listed in Table 3.1 are given.

## EPA-5 Page 2-20, Section 2.2.2.2

This section needs to be revised to include a discussion of the TSP nonattainment area on President's Island, adjacent to the Allen site.

## EPA-6 Page 2-20, Section 2.2.1.19, second paragraph

The DEIS says that during a major accident or upset the IFGDP gasifier can be shut down within several minutes of the discovery of the emergency situation. Conversations with DOE personnel suggest that the decision to take the gasifier off-line will not be made until a three-hour incident evaluation period is complete. The FEIS should reflect the steps and time frame required to take the gasifier off line in case of a major accident or upset.

## EPA-7 Page 4-1, Section 4.1.1, General Comment

We are concerned about the impacts of the coal handling and storage facilities on the TSP nonattainment areas adjacent to the plant. In a meeting with DOE on 10/23/80, EPA requested additional modeling studies be furnished in respect to TSP impact. Specifically, from the information in the DEIS and the ER it does not appear that the fugitive coal dust emissions have been included in the significant impact determination for the TSP nonattainment area adjacent to the Allen site. If this is true and the results of such a demonstration show a significant impact, further TSP mitigating measures will be required. Also in this regard the FEIS should include more information (Page 2-8, Section 2.2.1.6) on the barge unloading facility and the process by which coal is transferred to and from the storage pile. This discussion should describe the pollution control equipment or procedures to be employed to limit emission from these areas.

## EPA-8 Page 4-1, Section 4.1.1.1, second paragraph

The emission estimates for construction equipment in this section are not consistent with Page 2-13 of the DEIS or with Page 4-10 of the Environmental Report (ER).

## EPA-9 Page 4-5, Section 4.1.1.2, sixth paragraph

The FEIS should identify by name the Class I area that might be impacted.

## EPA-10 Page 2-8, Section 2.2.1.7

Depending on the temperatures reached in the coal dryer, two potential concerns arise. First, if the temperature is high enough, some hydrocarbon emissions may occur. Second, if temperatures are too low, condensation may lead to plugging of the baghouse filters. The FEIS should address both of these concerns and outline operational safeguards which will insure that the dust control system operates within an acceptable temperature range.

## EPA-11 Page 2-10, Section 2.2.1.9

The DEIS proposes the use of Selexol acid gas removal, followed by one thermal and three catalytic stages of Claus sulfur recovery, with Beavon/Stretford tail gas cleanup. Selexol acid gas removal would appear to be a reasonable control selection. Were other acid gas removal processes considered and if so, why was Selexol chosen? The Claus sulfur recovery process seems to be a reasonable selection over the alternatives considered in the DEIS (Sulfuric acid recovery with Wellman-Lord tail gas emission control). It should be mentioned that the ability of the Selexol process to minimize carbon dioxide removal from the gas stream is critical to the dependable operation of the Claus unit. The Beavon/Stretford tail gas cleanup system offers guaranteed sulfur removal probably equal to or better than any other tail gas system which might be considered in this application (less than 10 ppm H<sub>2</sub>S and 200 ppm total sulfur). It should be recognized that sulfur compound removal with any process in these new uses areas is not documented. Thus, reliability and long-term operability of the above units need to be discussed in the FEIS. In this regard, any redundancy requirement built into these units should be discussed.

## EPA-12 Page 2-11, Section 2.2.1.10, first paragraph

The acid gas removal system planned for the credit generation portion of the Memphis plant is the Benfield process, which removes carbon dioxide and the sulfur-containing gases which were not removed by the Selexol and Claus units. Based on other information a zinc oxide sulfur guard is also to be incorporated in this unit. Alternative methods of carbon dioxide removal are not discussed in the DEIS but include an amine-based scrubbing process such as MEA, DEA, etc. These alternative carbon-dioxide removal methods should be discussed in the Plant Design Alternative Section (2.3.2.1).

## EPA-13 Page 2-11, Section 2.2.1.11, third paragraph

This appears to be a typographical error where 100 ppm of hydrogen sulfide is cited as being emitted from the Stretford sulfur recovery process.

**EPA-14** Page 2-11, Section 2.2.1.11, General Comment

The DEIS does not show hydrogen cyanide as a predicted component of any of the gaseous streams. We believe this is erroneous and the FEIS should discuss this apparent inconsistency.

**EPA-15** Page 2-12, Section 2.2.1.11, third paragraph

The pulverized coal/char-fired boilers used could be a major source of NO<sub>x</sub>, particulates, and SO<sub>2</sub> emissions in the plant. No controls are mentioned in the DEIS for NO<sub>x</sub> emissions. Controls which might be considered involve modifications to burner design and firing techniques. It may be necessary to implement such controls (or others) depending on EPA's new source performance standards for industrial boilers or site specific factors.

**EPA-16** Page 2-10, Section 2.2.1.10

The incinerator will normally receive combustible vapors and gases containing sulfur compounds, carbon monoxide, polycyclic aromatic hydrocarbons (PAH), and ammonia, among others. Apparently, it will be made self-sustaining by burning a portion of the fuel gas product from the plant (or natural gas during start-up or emergency operations). However, the last paragraph on Page 2-11 of the DEIS states that coal will be burned in the incinerator if combustible vapors are not sufficient. This statement needs to be corrected or explained in the FEIS.

**EPA-17** Page 2-12, Section 2.2.1.11, fourth paragraph

According to the DEIS a methanical draft evaporative cooling tower will be used to dissipate waste heat. Due to the large quantities of water uses, evaporation losses will amount to nearly a half-million pounds per hour. Drift losses (having the same composition as the treated cooling water) will be about 9,000 lb/hr. Chromium (VI), zinc, and sulfuric acid will be emitted from the cooling tower. If makeup water from the process will be employed, it should be stream stripped and biologically treated prior to use to remove volatile components and the bulk of the organics which might otherwise be emitted from the cooling tower.

**EPA-18** Page 2-12, Section 2.2.1.11, second paragraph

Conditions during start-up and shut-down may lead to emissions whose composition is somewhat different than those during steady state operation. For example, although not spelled out in the DEIS, the formation of organometallics (such as iron carbonyl in the gasifier and nickel carbonyl in the methanation reactor) is more likely to pose an emission hazard when reactors are relatively cool. Emissions of PAH are more likely to occur at start-up before the gasifiers reach their final operating temperature. The DEIS indicates that

gas cleaning and sulfur removal units will be partially or fully operational during these temporary operating conditions. The FEIS should give an estimate of the start-up and shut-down emissions and discuss ways these emissions will be reduced.

**EPA-19 General Comment**

Equipment leaks around seals and valves may result in potentially harmful quantities of gaseous emissions such as hydrogen sulfide, carbon monoxide and fugitive organics. Area monitors should be considered to detect and warn of such leaks. In addition, a structured program of periodic leak detection should be considered. This is especially important in enclosed areas where natural ventilation may not be sufficient to dilute potentially hazardous emissions. The FEIS should outline a maintenance protocol for control of the above emissions.

**EPA-20 General Comment**

Periodically, catalyst beds used in Claus, shift reactors, Beavon and methanation units, and zinc oxide catalyst guard beds will need to be decommissioned prior to disposal of the catalyst or regenerated due to loss of catalytic activity. This is not addressed in the DEIS. The emitted gases may contain such species as organometallics, carbon monoxide, sulfur species and particulates. Although such off-gases are somewhat infrequent streams, the contribution to the temporary emissions level could be significant. For example, SO<sub>2</sub> from the decommissioning of shift or Beavon catalyst may cause an increase of a factor of two or more in the overall plant emissions of SO<sub>2</sub>. These potential emission sources and strategies for controlling them should be discussed in the FEIS.

SOLID AND HAZARDOUS WASTE**EPA-21** Page 2-8, Section 2.2.1.8, second paragraph

The "criteria" for determining whether a waste is to be classified as hazardous or non-hazardous is Subpart "C", not "D" in the Resource Conservation and Recovery Act (RCRA).

**EPA-22** Page 2-8, Section 2.2.1.8

The discussion in the DEIS on handling and disposal of hazardous waste, such as sludges from the clarifier and the chromate destruct system, needs to be expanded to include the onsite storage precautions and segregation procedures. If these wastes are to be disposed of "off site", the FEIS should identify this site.

**EPA-23** Page 2-8, Section 2.2.1.8, General Comment

The DEIS states leachates from the on site landfill will be monitored and treated if necessary. The FEIS should include more specific information as to "trigger level" of leachate pollutant concentration above which wastewater treatment will be necessary.

**EPA-24** Page 2-8, Section 2.2.1.8, General Comment

Fly ash waste, bottom ash waste, slag waste and FGD waste have been generally classified as not hazardous by criteria in Part 261.4(b) of the RCRA. However, this part, as presently written, applies only to waste generated from industrial boilers and not from coal gasification processes. EPA will clarify this situation in a Regulatory Interpretative Memorandum (RIM). The FEIS should contain this document.

**EPA-25** Page 2-8, Section 2.2.1.8, General Comment

The DEIS does not discuss a contingency plan for handling of cooling tower blowdown if the chromate destruction system malfunctions. Since the cooling tower blowdown would under this circumstance be classified as a hazardous waste stream, the FEIS should address this scenerio.

**EPA-26** Page 2-8, Section 2.2.1.8, General Comment

DOE should evaluate the proposed synthetic fuel products generated by the plant for conformity with the pre-manufacturer review requirements of the Toxic Substances Control Act.

**EPA-27** General Comment

The DEIS mentions that the nickel methanation catalyst will be reclaimed. Such a course of action is strongly recommended. EPA encourages the reclamation of spent catalyst whenever possible.

WATER**EPA-28** Page 2-3, Section 2.2.1.4

We are concerned about the potential of organics and heavy metal loading in the final effluent during gasifier upsets or accidents. In a meeting with DOE on 10/8/80 the possibility of issuing an NPDES permit for the gasifier discharge alone was discussed. To evaluate the soundness of this approach the FEIS should give the chemical composition and the physical characteristics of the gasifier waste stream. (Raw gas scrubber clarifier over flow process condensate and sour water stripping streams.)

**EPA-29** Page 2-3, Section 2.2.1.2 and Figure 2.3

The various wastewater treatment steps appear to be a logical combination of established methods applied to the various wastewater streams anticipated in the plant. Since the plant will be the first of its kind, complete characterization of the waste streams will not be possible until the plant actually begins operation, and as such, no data is presently available on the effects of trace amounts of organic contaminants on the functioning of various wastewater treatment processes. Therefore, we suggest that provisions be made for addition of redundant processes for the removal of organics should that be deemed necessary at a later date.

**EPA-30** Page 2.6, Figure 2-4

Figure 2-4 indicates that domestic waste is to be discharged for treatment in the T. E. Maxson Wastewater Treatment Plant (WWTP). The Maxson WWTP is currently under an EPA forced moratorium for accepting new customers. The FEIS should either definitively resolve this issue or evaluate alternative wastewater treatment technologies.

WETLANDS/FLOODPLAINS

EPA-31 Page 4-20, Section 4.1.7.1

The preferred site (Allen Site) also lies within the 100 year floodplain of the Mississippi River. Construction will permanently alter 106 acres of successional bottomland forest, of which some 69 acres are wetlands. The DEIS acknowledges that the clearing of floodplains and riparian forests is a significant national problem. Executive Order 11988, Floodplain Management, states that "Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare and to restore and preserve the natural and beneficial values served by floodplains..." The proposed project will increase the risk of flood loss by raising the flood level 0.7 feet in Lake McKeller and will thereby increase the impact of flooding on human safety, health and welfare. The proposed project will destroy rather than protect the natural beneficial values of the floodplain.

Executive Order 11990, Protection of Wetlands, states that "Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial value of wetlands..." The proposed project will destroy rather than preserve wetlands. We do not believe that the proposed action reflects the leadership and actions required by Executive Orders 11988 and 11990.

It is estimated that filling the proposed site with approximately 4.6 million cubic meters of material will cost \$15 million (\$96,154 per acre). The DEIS states that a major flood during the filling operation could "wash away the fill and destroy the work completed before the flood."

EPA questions whether this cost for site preparation, coupled with the risk of flooding during construction and the destruction of the natural environment contrary to Executive Orders 11988 and 11990 represents a prudent course of action. A full discussion of the costs and risks associated with the Allen Site should be included in the Final EIS.

The Pidgeon Site appears to have some environmental advantage over the Allen Site based on information presented in the EIS. It is assumed that the protected Pidgeon Site would require much less site preparation and would involve less manipulation of the adjacent floodplain or wetlands. Present zoning of the Pidgeon Site for heavy industry clearly indicates a decision to convert the present agricultural usage and such conversion can be expected whether this or some other development occupies the site. The DEIS states that there are high quality wetlands lying between the levee and the river and that if the barge facility were located on the river this area would be impacted. We agree that such adverse impacts might rule out the barge terminal but would not necessarily rule out the Pidgeon Site. The Final EIS should fully explore alternatives for transporting coal from existing Port(s) to the Pidgeon Site.





UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

10 DEC 1980

Dr. Robert Laza  
U.S. Department of Energy  
Chicago Operations and Regional Office  
9700 South Cass Avenue  
Argonne, Illinois 60439

Dear Dr. Laza:

Enclosed you will find comments on the DEIS for the Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Project. The Effluent Guidelines Division (EGD), within the Office of Water Regulations and Standards at the Environmental Protection Agency, is responsible for the development of national wastewater discharge regulations for a variety of industries. Work is currently underway which will eventually lead to the promulgation of discharge regulations for the gasification industry. It is, therefore, quite appropriate that EGD be given the opportunity to comment on the proposed MLGW facility and, in particular, on the proposed wastewater treatment system.

Due to time limitations, review and comments have concentrated on the wastewater treatment system, although a few comments on other aspects of the facility are made. An overall summary of EGD's comments is presented first, followed by a discussion of ten specific comments.

If you have any questions please feel free to call me or the EGD Gasification Project Officer, Allison Phillips, at (202) 426-4617.

Sincerely,

A handwritten signature in cursive script, appearing to read "W. A. Telliard".

William A. Telliard, Chief  
Energy and Mining Branch  
Effluent Guidelines Division

SUMMARY OF COMMENTS

The document is well organized, and obviously the product of the combined effort of a qualified project team. It forms an excellent basis for acquiring additional input to the project. EGD does feel some additional input is needed. The Allen site has some serious drawbacks due to its flooding potential. Alternative sites given serious consideration also had flooding problems. Is no site available without zoning and flooding problems? The solution to the flooding problem appears to be well thought out but independent review by qualified experts should be sought.

Several questions arise about the wastewater treatment system design: Haven't some wastestreams been left out of the design? The basis for the decision not to design for zero discharge is not clearly presented. What are the costs associated with each wastewater discharge option? Has the potential for failure of the biox filter and discharge of toxic organics been examined? Information in the DEIS concerning the discharge of chlorine, zinc, and chromium from cooling tower blowdown at steam electric plants is wrong. (EPA has recently proposed new regulations for the steam electric point source category.) Information provided on the biox filter design is inadequate. The assumption that ash pile runoff needs no wastewater treatment lacks a sound basis. Reevaluation of the treatment of this stream is needed. Other comments are given in the following section.

No significant advantage concerning wastewater treatment appears to exist at any of the three sites chosen. The same treatment system will be installed at each site. Flooding problems and other concerns seem to dominate site selection.

Overall, if the wastewater treatment system performs as expected and issues raised in this submittal can be resolved, it does not appear that the project will bring about any significant deterioration of the Mississippi River or Lake McKellar. However, some serious questions requiring careful evaluation are not adequately addressed in the current DEIS.

DISCUSSION OF SPECIFIC COMMENTS

(1) Plant Location

EPA-32

The subject of plant location was addressed in great detail in the Draft Environmental Impact Statement (DEIS). The proposed Allen site is currently in the 100-year floodplain and as was properly recognized by the DEIS authors, this hardly makes the Allen site ideal. Of particular concern to EGD is the potential for a flood that could bring about serious environmental hazards:

- Damage to the wastewater treatment system and possible release of partially treated or untreated wastewaters;
- Damage to the on-site landfills, both short-term and long-term and potential release of solid waste; and
- Damage to plant process equipment, defeating the purpose of the project and potentially resulting in the release of process materials to the environment.

EPA-33 Having recognized the flooding problem with the Allen site, MLGW has proposed to dredge material from the Mississippi River and landfill the site to slightly above the 100-year flood level. EGD lacks proper expertise to provide a detailed review of the proposed solution to the flooding problem. It is clear that this solution has received serious study by MLGW. It is noted that two alternative sites were evaluated, but both these sites had potential flooding problems as well. Are no sites available

where flooding would not be a problem? Has the proposed solution to the problem, the dredge-fill operation, received outside independent technical review?

EPA-34

(2) Wastewater Sources

Sources of wastewater mentioned on page 2-3

include:

- Process wastewater
  - gas-scrubbing blowdown
  - sour water
  - stripping condensate
  - methanator condensate
- Cooling tower blowdown
- Coal pile runoff
- Ash pile runoff
- Process area storm drainage
- Boiler-feedwater preparation wastes
- Sanitary sewer waste

Based on EGD's familiarity with coal-fired utility boilers, there are several other wastestreams for which no discussion has been given including:

- Fly ash sluice water (wet fly ash handling?)
- Bottom ash sluice water
- Metal cleaning wastes
  - air preheater wash water
  - boiler fireside wash water
  - boiler tube wash water
  - cleaning rinses (both steam boiler and gasification unit)
- Low volume wastes
  - laboratory drains

- floor drains
- miscellaneous equipment (pumps, compressors, etc.)  
closed cycle cooling system discharge
- FGD system blowdown from the utility boiler, if used

Have these wastestreams been considered in the wastewater treatment system design? If not, revision of the design to account for these wastes is needed.

EPA-35

(3) Zero Discharge Option

On page 2-28, the DEIS states: "The capital and energy requirements of a zero discharge system would be a significant burden on the economics of the demonstration plant." No cost estimates are presented in the DEIS to support this conclusion. The DEIS does a good job of discussing alternative wastewater treatment design configurations. However, the lack of cost estimates associated with each option makes it difficult to judge the proper level of treatment.

Of particular concern in the selected direct discharge option is the process wastewater stream. This stream is to be subjected to lime flocculation, clarification, recarbonation, filtration, ozonation, biological oxidation, oxygenation, and carbon adsorption before discharge to the Mississippi River. Of concern is the potential release of partially treated wastewater should the biox filter (Fig. 2.3) fail. Although some information is available indicating that coal gasification wastewaters should be bio-treatable, the MLGW facility is a demonstration plant and, as such, may have a process wastewater with different characteristics than wastewaters from U-gas pilot units.

Also, considerable operational problems and process upsets can be expected in a demonstration unit. This may lead to sudden shock loadings of toxic materials which could bring about the failure of the biox filter.

The use of ozonation before the biox filter appears to be a good idea as substantial oxidation of toxic components of the wastewater may be achieved, thus making the biox filter more stable. EGD was not able to acquire a copy of the wastewater treatment detailed mechanical design<sup>1</sup> in the time available for comment, so the exact role of ozonation and the biox filter remains unclear. Following the biox filter with carbon adsorption is a good idea since those organics not biodegradable may be adsorbed on the carbon. However, were the biox filter to fail, it is unclear whether acceptable effluent quality could be achieved with ozonation and carbon adsorption alone. For this reason, the zero discharge option may merit additional consideration.

Other questions on the wastewater treatment system include:

EPA-36

- What is the detention time of the process wastewater mixing basin? Is this to be used for equalization of process wastewater shock loadings as well as lime addition? If not, why is no equalization basin provided? This could minimize the impact of shock loads on the biox filter.

EPA-37

- Inadequate detail is provided on the recarbonation chamber. What vent gas

is used for CO<sub>2</sub> supply? Is a calcium carbonate floc expected to be formed? Will this be settled out or removed by the following filter? What kind of filter follows recarbonation? Why add nutrient in the recarbonation chamber? What nutrients are being added? Won't subsequent ozonation affect nutrients (NH<sub>3</sub> + NO<sub>3</sub>?)?

- EPA-38 ● Very inadequate detail is provided on the biox filter. What exactly is this? (See comment #5).
- EPA-39 ● What is meant by oxygenation before carbon adsorption? What is the purpose of this process?
- EPA-40 ● What is the design basis for carbon adsorption columns? Will carbon be regenerated on-site? If so, how? If not, where does waste carbon go?
- EPA-41 ● Is dissolved air flotation of the storm water and spent service water to be conducted using nitrogen? Why?
- EPA-42 ● Is utilities neutralization water the same thing as boiler feedwater wastes?

EGD recognizes that some of these questions are probably addressed in the wastewater treatment mechanical design report<sup>1</sup>



which could not be obtained in the time available for comment on the DEIS. However, many of these questions are of such a fundamental nature that more detail in the DEIS is warranted.

EPA-43

(4) Utility Boiler

Several questions arise concerning the presence of a utility boiler on-site. First, as was already discussed in comment #2, it appears several wastestreams from the steam boilers have been ignored. Will the steam boilers employ wet fly ash handling or dry fly ash handling? New source performance standards (NSPS) for the steam electric point source category are currently proposed (Federal Register; October 14, 1980; p. 68328) and require dry fly ash handling. The steam boilers on-site at the MLGW facility would constitute a captive steam plant and, as such, are not affected by the steam electric regulations. However, dry fly ash handling offers a reduction of water use and an elimination of the potential discharge of toxic metals with the fly ash handling sluice, all at no significant increase in cost over wet fly ash handling systems. In addition, the marketability of the fly ash will be improved by handling it in a dry form. Thus, EGD feels there are many reasons for which dry fly ash handling is superior and would recommend its use.

EPA-44

How will bottom ash sluice water from the boilers be handled? Use of dewatering bins in the steam electric industry has met with success. Where will discharge water from the bottom ash handling system be sent?

EPA-45

With regard to cooling water, two errors exist on page 2-27. First, in the third column of Table 2.4, it is stated that NSPS rules for chlorine (assumed steam electric) are:

- 0.2 ppm average free available chlorine
- 0.5 ppm maximum free available chlorine

These were the old NSPS standards. They have been revised (Federal Register; October 14, 1980, p. 68328) and are currently in the proposal stage. The new NSPS requirement is:

- The concentration of total residual chlorine (not free available chlorine) may not exceed 0.14 ppm at any time.

Thus, the conclusion of MLGW that the proposed cooling system will meet NSPS rules may be in error. Consideration should be given to alternative biofouling control technologies including mechanical condenser cleaning, bromine chloride, chlorine dioxide, and chlorination with dechlorination of the cooling tower blow-down.

EPA-46

A second error on page 2-27 is the statement that an "uncertain regulatory picture discourages development of alternative corrosion inhibitors". MLGW proposes to use chromium and zinc as corrosion inhibitors, yet EPA has currently proposed a ban on the use of all priority pollutants containing corrosion inhibitors, including chromium and zinc, for NSPS in the steam electric category. Non-priority pollutant containing chemical mixtures are currently available from several vendors for corrosion and scaling control. EGD suggests that more serious consideration be given to designing the cooling system with corrosion resistant materials and to the use of non-priority pollutant corrosion inhibitors.

Further information on all aspects of the proposed steam electric New Source Performance Standards is available in the Development Document.<sup>2</sup>

EPA-47

(5) Biox Filter

The DEIS lacks adequate detail to determine the feasibility of using a "biOX filter" for organics removal. First, not enough information is provided to determine exactly what this unit is (some kind of biological packed bed?). Second, no data is provided to demonstrate it will effectively degrade the diverse organics expected to be present in coal gasification waste-waters. How is the unit to be designed? Where do the kinetic constants come from? This unit process is central to the waste-water treatment system and should be addressed in more detail in the DEIS.

EPA-48

(6) Ash Pile Leachate

A great deal of discussion is given to the gasifier ash pile runoff. Studies of leaching characteristics of the gasifier ash (Appendix C.2.2) are useful for preliminary estimation of whether or not this waste will be considered hazardous under RCRA. It must be recognized however, that these tests are preliminary and that the gasifier ash generated at the MLGW facility may have substantially different leaching characteristics. Thus, proper planning for the disposal of a hazardous waste as required by RCRA should be carried out.

The conclusion that ash pile runoff is therefore "suitable for river discharge without treatment" as stated on page 2-28 is in error. Simply because the gasifier ash leachate allows the waste to be considered non-hazardous under RCRA, it does not follow that ash pile runoff does not need treatment before discharge. Treatment requirements for industrial point sources

originate in the Clean Water Act, not RCRA, and the ash pile runoff stream will need to be included in the NPDES permit.

EGD is currently working on the development of effluent guidelines for gasification plants. It can be expected that NSPS standards for gasifier ash pile runoff will be developed that represent the best available demonstrated control technology. It is thus suggested that the decision to direct discharge the gasifier ash pile runoff be reevaluated. Serious consideration should be given to ash pile runoff options 2 and 3, as identified in Table 2.4 (page 2-27). At the very least, option 2 represents some assurance of meeting pH, TSS, and oil and grease limitations and should thus seem worthy of careful evaluation.

EPA-49

#### (7) Decommissioning

On page 2-25, mention is made of options for wastewater discharge if the MLGW plant is decommissioned. Although decommissioning is unlikely, it should be recognized that it may be necessary to keep some portion of the plant's wastewater treatment system operational in the event of decommissioning. Ash pile, coal pile, coke pile runoff and process area storm water runoff may continue to require treatment even after plant decommissioning. This needs to be recognized as a potential cost associated with decommissioning.

Additionally, a second option might be sending wastewater to the Maxson wastewater treatment plant. What waste streams could be sent to Maxson? Has Maxson been asked to comment on this?

EPA-50

#### (8) Cooling System

The discussion of waste heat rejection options which begins on page 2-32 is very good. MLGW's basis for the

selection of a recirculating cooling system using mechanical draft cooling towers is clearly stated. For the Allen site, the decision seems quite reasonable.

One advantage of an alternative site where more land was available, (besides avoiding the potential flooding problem) would be the possible use of cooling ponds or spray canals which might prove more energy efficient and may have some environmental advantages as well (lower TDS in blowdown, less of a chlorine discharge problem).

EPA-51

(9) List of Preparers

Upon review of the list of preparers, it was noted that no wastewater treatment expert was listed. The wastewater treatment work was obviously done by someone with significant expertise in the area. Who did the work?

(10) Potential for Sale of Ash

Exploring the potential market for plant solid wastes, as suggested on page 9, is an excellent idea. If a market develops, some thought should be given to potential routes through which contaminants in the ash (or FGD sludge) might be released to the environment before large scale sale of any solid waste is undertaken.

REFERENCES

1. Industrial Fuel Gas Demonstration Plant Program, Phase I, Mechanical Design, Vol. 10, Waste Water Treatment, prepared for the Department of Energy Under Contract ET-77-C-01-2582.
2. Development Document for Effluent Limitations Guidelines and Standards for the Steam Electric Point Source Category, U.S. Environmental Protection Agency, EPA 440/1-80/029-6, September 1980.

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## COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED INDUSTRIAL FUEL GAS DEMONSTRATION PROJECT MEMPHIS LIGHT, GAS AND WATER DIVISION MEMPHIS, TENNESSEE (DOE/EIS-007-D)

December 3, 1980

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The Natural Resources Defense Council, a citizen environmental organization with more than 45,000 members nationwide, submits these comments on the Proposed Industrial Fuel Gas Demonstration Project of the Memphis Light, Gas and Water Division, with costs shared by the U.S. Department of Energy.\*/

Let us first briefly outline the perspective we bring to the review of this project. Like all Americans, NRDC advocates an energy policy that reduces our dependence on foreign sources of oil. We believe the fastest, safest, cheapest way to reduce this dependence is to emphasize energy conservation and efficiency, and the rapid expansion of renewable energy sources. As the much-acclaimed Harvard Business School study of our energy future concluded:

If the United States were to make a serious commitment to conservation, it might well consume 30 to 40 percent less energy than it now does, and still enjoy the same or an even higher standard of living. That saving would not hinge on a major technological breakthrough, and it would require only modest adjustments in the way people live. Moreover, the cost of conservation energy is very competitive with other energy sources. The possible energy savings would be the equivalent of the elimination of all imported oil -- and then some.\*\*/

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\*/ NRDC reserves the right to supplement these comments with additional material by December 20, 1980.

\*\*/ "Energy Future," the Report of the Energy Project at the Harvard Business School, R. Stobaugh & D. Yergin, eds., p. 167 (Ballantine Books, 1980).



Synfuels plants may play a role in reducing our dependence on foreign oil, although one less rapid, more expensive, and more fraught with health and environmental hazards than the Department of Energy acknowledges. It is absolutely critical to squarely confront the problems with synthetic fuel technologies - and the problems with this particular plant - now, in order to minimize the dangers at the onset, and the delay, retrofitting cost, and possibly of total failure later on.

The stated justification for the federal government's financial support of synfuels projects is that they are too risky for the private market alone. The public, through its taxes, is taking the financial risk off the shoulders of private industry. The residents of the Memphis area are being subjected to health, safety, and environmental risks as well. In return for bearing these financial, health, and other risks, the public has a right to demand that DOE elevate health and safety concerns to the same priority as the goal of demonstrating that coal can be converted to gas.

Above all, this means that as much attention must be paid to uncovering potential hazards to health, safety, and the environment and to researching, demonstrating, and improving pollution control techniques and means for mitigating other adverse impacts as is given to demonstrating the basic process for turning coal into gas.

## iii

The environmental impact statement (EIS) is the public's and the governmental decision-makers' window on the planning of the project. The scope and depth of the EIS must be sufficient not for its own sake, but in order to assure that health, safety, and environmental concerns actually receive the priority they are due as the project is developed.

This draft EIS (DEIS) in some ways successfully carries out its mission of revealing for public scrutiny major hazards and choices the project developers and DOE must make. In some areas however, there are major shortcomings, where the DEIS reveals that the developers and the Department of Energy have failed to address major problems which threaten the health and safety of the residents of the Memphis area, and which in turn threaten the viability of the project, at least as currently envisioned. While this DEIS represents in some respects an improvement over past DEIS efforts, the Department has a great deal of work ahead of it before the requirements of the National Environmental Policy Act and the Department's duties to the public are met.

I. Scope of The Environmental Impact Statement

NRDC-1

A. The Draft Statement Lacks An Adequate Analysis Of Programmatic Concerns

Chapter 1 of the DEIS attempts to meet the requirement for a thorough analysis of the programmatic concerns related to this project. The Memphis project is part of a program for developing medium-Btu coal gasification facilities across the country. This, in turn, is part of a larger program for developing coal gasification. Broader still, coal gasification is one of the three key elements of the Nation's synthetic fuels program. And the synfuels program fits, or ought to fit, into a coherent national program for meeting our energy needs. The National Environmental Policy Act requires DOE to consider the health, safety, and environmental consequences of the program which a particular project fits into, and to consider alternatives for mitigating those problems, including alternatives to part or all of the basic program itself.

Basically, two purposes can be served by programmatic impact statements. First, the statement can describe and assess the environmental and socioeconomic impacts and benefits of a particular program and the alternatives to that program. Second, the statement can provide a logical framework for making individual decisions within the program, and can develop overall guidelines for making programmatic decisions. The programmatic materials at the beginning of the Memphis DEIS do not serve

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either function. These programmatic materials are fundamentally a cut-and-paste job from other EISs, DOE forecasts, reports of consultants, but they do not provide the basis for decisions. Nor do they set up any heirarchy of values or methodology for choosing among potential negative impacts or for assessing the relative importance of negative impacts and benefits.

The DEIS does not assess the costs and benefits of the syn-fuels program as a whole vis-a-vis other alternatives, in terms of meeting the nation's energy demands and reducing oil imports through conservation or alternative forms of energy production. Chapter 1 summarizes benefits that we are expected to get from the synfuels program. It does not tell how we are expected to get those benefits, how we will evaluate whether we have indeed received the benefits, or how great those benefits are relative to what we might achieve by spending the money elsewhere. In particular, it is assumed that the new technologies that will be developed and commercialized are indeed all valuable. There is no consideration of whether some may be white elephants, or how we will decide when to pull out support from those that are revealed to be white elephants later. It is simply assumed that we must proceed on all fronts with all energy alternatives without any consideration of whether this program forecloses other possibilities. It is simply assumed that we will obtain and use relevant environmental data. Yet

## I-3

no specifics are given in any of those areas, not is any basis given for comparing this alternative with others.

Although it presents some valuable data, the DEIS is of no use for guiding policymakers within DOE in determining which technologies to support, when to support them, in what form and to what degree. It provides no basis for deciding when some of the risks should be left with project sponsors. It is of no use in deciding where plants should be built or how many should be built. There is no assessment of alternative means of handling the cumulative impacts of the medium-Btu gas program, let alone the potential cumulative impacts of the entire synfuels program. There is no assessment of how this DOE program -- a program which fundamentally removes all risk for project sponsors and places DOE in the role of close and detailed management of project development -- fits with the Synthetic Fuels Corporation's anticipated program, which seems to be premised on the different assumptions. When it begins to address specific cumulative environmental impacts arising from the medium Btu gasification program, Chapter 1 simply makes a set of assumptions about where gasification projects may be built on a state-by-state basis and then projects some potential impacts. While that does provide some useful data, what is needed is assessment of where the impacts of the maximum possible development may be significant and how they can be mitigated. This analysis

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should not necessarily be on a state-by-state basis, but often on a regional basis.

It does not make sense in this context to separate out the medium-Btu gasification program. The question is where synfuels development as a whole is going to have unacceptable cumulative impacts. And there is substantial evidence that the combination of liquefaction and gasification plants in certain areas of Appalachia and possibly the west will have significant impacts. That may be particularly important in certain two- or three-country areas that will bear the brunt of development.

The criteria that supposedly govern the selection of plants for support are so undemanding that they would be met by almost any energy project representing a technology not in wide commercial application in the U.S. The question is how should DOE determine which projects would yield the most new environmental data of significance to the public, which will yield new technological data, which are most likely to provide the crucial leap to a technology whose commercialization is desirable. How did DOE choose Memphis? Why should the Memphis plant be one of the first developed? Is this the most useful way to use the coal in the area? To what extent will the product of the Memphis plant be displacing oil, to what extent natural gas, and to what extent direct use of coal? How does DOE determine that

I-5

federal funds are needed most for research, development, and commercialization of gasification technologies when the DEIS acknowledges that coal gasification is an old technology, that it is in commercial use in various areas of the world, and that low-3tu coal gasification has been developed on a limited basis by American industry without federal help? What is the program for assuring experimentation with new pollution control technologies, and how do the various projects fit together to assure that in 1983 and 1984 DOE will have developed full data on the alternative control technologies available for gasification plants?

NRDC-2      B.    The EIS Process Cannot Be Completed Until The  
Plant Has Been Designed

The DEIS has been issued before the Memphis plant has been designed in detail. As a result, many concerns have not been, and cannot be, adequately addressed in this document. For example, there is no meaningful analysis in the DEIS about the problem of fugitive hydrocarbon and other process emissions -- leaks from process points such as valves, seals, and pumps subjected to high temperatures and pressures -- into the workplace or the general community air. Fugitive emissions will contain many of the most chemically and biologically active compounds associated with the process. They can be expected during both normal and upset conditions. The problem cannot be addressed

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thoroughly until detailed design is underway, and the configuration of these emission points and selection of materials, etc., is under consideration. Other examples of problems that have not been fully addressed because of the absence of design detail are covered below. It is premature to close the public's only review of the planning of the project before meaningful analysis or such issues is possible.

The absence of detailed discussion of design alternatives reflects a major difficulty with the conventional process of preparing EISs for extremely complex facilities demonstrating new technologies, such as synthetic fuels demonstration plants. On the one hand, a DEIS must be issued at this early design phase, when the choice whether to build the facility, and the basic siting and technology choices, must be made. On the other hand, the full extent of the risks to public health and the environment and the opportunities for mitigating them cannot be explored in meaningful detail until process configurations are fully determined, materials specified, pollution controls designed in detail, monitoring plans complete, and numerous other technical decisions affecting public health reached.

The National Environmental Policy Act requires the preparation of a document that reflects the major project choices and exposes them for public scrutiny before decisions are made. The



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EIS process thus necessarily must track the design process. At least two levels of review are needed. The first, reflected by the DEIS here under review, concerns the basic decision whether to undertake the project as opposed to major alternatives, and decisions pertaining to siting and basic technology choices. The second level of review must reflect the detailed design.

This is a challenge to DOE's creativity in fulfilling its NEPA obligations. A draft supplement to the DEIS must be prepared which lays open to public scrutiny the major choices of detailed design. The public must have opportunity to comment on the detailed design choices before a final EIS can be issued and before DOE's NEPA obligations can be considered fulfilled.

This DEIS is not as short of design information as, for example, the statement prepared several months ago for the Solvent Refined Coal II project in West Virginia. Yet, as indicated in the analysis that follows, there are substantial questions that can be answered only at the design stage, and the EIS cannot be finalized now.

II. The Allen Site, and Other Sites On The Mississippi River Flood Plain, Have Serious Drawbacks

The proposed site, and the alternatives, are all in the floodplain of the Mississippi River. The site would have to be elevated with fill by some 33 feet, in order to protect the plant against the anticipated 100-year flood water height. The proposed site is directly above the aquifers that supply drinking water for the Memphis area, and it is within an area classified for earthquake safety in Zone 3, a relatively high hazard level. The siting plan poses several serious problems.

NRDC-3 First, even barring unusual events such as high floods or earthquakes, locating the coal piles and waste piles on top of fill above the aquifer is unwise. Such fill is potentially unstable, even without major stresses. It can subside or settle differentially, making breaks and tears in the clay and plastic film linings more likely. At the very least the fill, and the ground below, must be thoroughly compacted. The coal piles and the waste piles will leach substances that may endanger the aquifer. As is discussed more in Section III the wastes should be treated as hazardous wastes and secured accordingly.

NRDC-4 Second, the 33 foot elevation does not assure sufficient protection against high flood waters. Recent experience has

## II-2

drawn into question the accuracy of flood water heights projected for the 100-year flood and other floods. Development upstream tends to increase runoff from a given rainfall, and channeling of the river reduces the flow it can handle. As a result, some recent floods, such as in St. Louis in 1973 have been much higher than predicted.<sup>\*/</sup> In addition, the limited data available on flood heights and the probabilistic method involved in predicting heights for future rainfalls make the calculation used here of doubtful reliability. As a result, the 33 foot elevation does not assure that the plant will not be placed underwater by a flood of unexpected magnitude.

The U.S. Water Resources Council recommends that for critical actions, the planned facility be protected from the 500-year flood. The hazardous nature of the materials that will be used in the process, plus the dangerous waste materials which will be stored there perpetually, argue strongly against reliance on 100-year flood projections. See the Council's Floodplain Management Guidelines, Part II. I.C., Federal Register Vol. 43, Feb. 10, 1978.

<sup>\*/</sup> Belt, "The 1973 Flood and Man's Constriction of the Mississippi River," Science vol. 189, pp. 681-84 (Aug. 29, 1975).

## II-3

Even if the dikes above the site are not breached, floodwaters could infiltrate the plant foundations and seep up from the bottom of the waste piles. Water pressure from below could rupture liners and perhaps undermine the stability of the fill and of the plant structures.

NRDC-5      A third concern is that the fill itself, taken from heavily polluted sediment at the bottom of the Mississippi River, may itself pose a hazard to the drinking water aquifers. The DEIS should analyze the potential for these substances to leach into the Memphis water supply.

NRDC-6      Fourth, the central Mississippi Valley, of which the Memphis area is a part, is an area that is subject to severe earthquakes. The Memphis area is classified for earthquake hazard in Zone 3. This is a relatively high risk. In 1811 and 1812, massive earthquakes hit the region, centered near New Madrid, Missouri. The severity of these quakes was summarized by Charles Richter, who devised the fundamental system for measuring quakes' strength, and was a pioneer in the science of understanding earth movements:

Great earthquakes are commonest where the general level of seismicity is high, but occasionally they occur in other regions. Such were those of 1811-1812 under the central Mississippi Valley, near New Madrid (Missouri). There were three great shocks on December 16, January 23, and February 7. One of these must have been the largest known earthquake in the present territory of the forty-eight states. All of them, judging by their effects, exceeded magnitude 8 [on the Richter scale]; evidence for comparing them is in part conflicting but suggests the epicenters differed. The first great earthquake, on December 16, 1811, was perceptible over an area of at least a million square miles, extending from the headwaters of the Missouri River to the Atlantic seaboard (as far as Boston) and from Canada to New Orleans.

## II-4

In the heavily alluviated meizoseismal area, fissuring, lurching, slumping, emergence of ground-water, and associated effects took place on a large scale. The investigators of the Indian earthquake of 1934 have compared these effects closely with those in the "slump belt" on that occasion. The numerous long, narrow areas of subsidence suggested dropping of crustal blocks rather than slumping or warping. Such subsidence amounted in places to 15 feet and formed large new lakes, such as Lake St. Francis west of the Mississippi and Reelfoot Lake (Tennessee) to the east. There were also large uplifts; their exact extent is not known, since investigation many years later showed that the relief had changed; however, evidence of old trees indicated elevations of at least 10 feet at the time of the earthquake. Small scarps were formed which produced temporary waterfalls; since these were not in rock, it is impossible to tell whether they were the result of slumping and fissuring, or whether they related to displacement in the basement rock.\*/

The Federal Energy Management Agency considers another serious quake in this region sufficiently likely that the Agency is taking preliminary steps for disaster readiness planning.

The earthquake hazard cannot be avoided in the Memphis area, but it does counsel against locating the plant on the banks of the Mississippi River and directly over the Memphis water supply. There is a significant danger of the alluvial bed's or the fill's liquefying, literally taking the bottom out from under the plant. Even if the footing under the plant were to remain secure, a 1.33 safety factor for the plant foundation would not protect it against such a quake; a 1.33 factor is intended to protect against a quake measuring no more than 7-7.2 on the Richter scale.

Even a small quake could result in substantial damage to the liners under the coal pile, and under the waste pile if

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\*/ C. Richter, Elementary Seismology, pp. 593-94 (W.H. Freeman & Co., 1958).

## II-5

installed there. The permanent location of the wastes at the site causes the hazard to extend indefinitely into the future, well after the plant closes. A major quake while the plant is operating could result in a serious spill of raw coal or process material directly into the Mississippi.

Thus serious consideration should be given to locating the plant off the floodplain and off the aquifer. At the least, serious consideration should be given to locating the waste disposal site in a more secure place. (If the plant or the waste site is located off-river, the energy used and pollution caused by transporting the coal and/or wastes must be fully considered.) If the plant is left in the floodplain, serious consideration must be given to building a much greater safety factor into the plant foundation and into the coal and waste piles' liners.

## III-1

III. The DEIS Does Not Contain An Adequate Discussion of  
of the Known and Potential Health and Environmental  
Hazards of Toxic Chemicals Associated with the U-Gas  
Process, and the Opportunity to Mitigate these Dangers

NRDC-7 In order to accurately determine the environmental impact of proposed industrial facilities, a minimum of four steps is required.

1. Identification and if possible quantification of amounts of hazardous materials that might be released from the facility;
2. Identification of toxic effects associated with exposure to such materials;
3. Estimation of the possible dispersion of these materials in the occupational and ambient environments;
4. Identification of populations who might be exposed to such materials, and where possible, estimation of the magnitude of such exposures.

It is only by studying the constituents of various emission and effluent streams and estimating levels of workplace and ambient exposures that a responsible framework for considering alternative mitigation measures can be developed.

In general, DOE failed to address adequately the problem of exposure to toxic pollutants. Although the presence of polycyclic aromatic hydrocarbons and various trace elements at various points in the process and waste streams is frequently mentioned, the DEIS contains no description of

## III-2

potential health effects. No consideration of other pollutants is evident in the DEIS. The DEIS presents only a cursory analysis of possible points of release of individual substances. Likewise, evaluation of the potential for dispersion in the occupational and ambient environment and the identification of populations at risk is generally inadequate. Thus, DOE has failed on all four counts to estimate hazards associated with toxic pollutants.

The absence of adequate health effects data may well be due to the fact that, according to Chapter 5, the Department of Energy employed no health scientists in the preparation of this document. This is a very significant shortcoming. Unfortunately, it is not peculiar to this project, but instead appears to be a systematic problem in DOE's preparation of environmental impact statements for synthetic fuels project. There were no health scientists involved in the preparation of the DEIS for the Solvent Refined Coal II project in Morgantown, W. Va., either. It is high time DOE faced the need to have top-flight health hazard evaluation as an integral part of its synfuels environmental impact statements. If health scientists are left out of the EIS process, the public can have little confidence the issue will receive meaningful attention at any stage in the project development process, either by DOE or the industrial partners.



## III-3

NRDC-8 A. Insufficient Analysis of the Health Hazards From  
Compounds in the U-Gas Process Known or Suspected To  
Be Toxic, and Potentially Available for Human and  
Environmental Exposure

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The DEIS does not give a thorough and informative analysis of the health hazards that may be posed by human exposure to be chemicals produced and releases which are known or suspected to be toxic. The document does mention at many points the need for concern over exposure to cancer-causing polycyclic aromatic hydrocarbons (PAH), trace metals, and other trace elements, and such acute hazards as carbon monoxide and certain sulfur compounds. Appendix B.0.1 contains some data on concentrations of specific PAH's at a point in the process, and Appendix C.2 offers some information on the constituents of wastes. But the DEIS lacks a discussion of the health effects information available regarding such compounds sufficient to inform decision-makers and the interested public of the potential hazards involved.

An adequate environmental impact statement for a synthetic fuels plant must contain such information. In conjunction with reasonably specific data on releases and exposure to be expected--much of which is lacking as well--data on health effects permits decision-makers and the public to understand the importance of controlling occupational and general public exposure to the greatest possible extent.

When one considers the structure and composition of coal (the system's major input), the potential for the

## III-4

formation and release of a wide range of toxic materials is readily apparent. In general terms, coal is composed of clusters of aromatic rings linked into huge molecules by carbon bridges, saturated rings, and heteroatomic groups like OH, CO, COOH, NH<sub>2</sub>, CN, S and SH (Figure 4-1). From 50 to 95 percent of the total carbon in coal is present in the form of aromatic rings. The aromatic and saturated rings are highly substituted by methyl and ethyl groups. On a moisture and ash-free basis, a typical organic matter composition would be 70 to 90 percent carbon, 2 to 6 percent hydrogen, 1 to 2 percent nitrogen, 0.5 to 6 percent sulfur and 2 to 20 percent oxygen by weight. Most of the oxygen is present in phenolic compounds. The aromatic character of coal structure facilitates the formation of polycyclic organic matter during conversion or combustion processes. Moisture content of freshly mined coal depends on ground water and varies with transport and storage conditions. Inorganic matter is measured as ash, which normally ranges from 3 to 30 percent.

Given such a structure one would predict that a large number of toxic Organic materials would be formed in coal conversion processes. On the following pages a representative sample of those chemicals and the health effects associated with human exposure are described.

## III-5

Polycyclic Aromatic Hydrocarbons (PAH)

At several points in the DEIS the potential for release of PAH's was noted. A wide variety of PAH s, all of which are carcinogens, have been found in coal conversion products. These compounds include benzo(a)pyrene, dibenz(a,h)-anthracene, benz(a)anthracene, dibenzo(a,i)pyrene to name just a few. Their presence, as well as the presence of other carcinogenic materials list below, raises an important issue. Many of the potential human exposures to such materials will result from short-term high level exposures, as well as chronic episodes, and would arise from occasional accidental emissions or spills. The PAH benzo(a)pyrene is known to be carcinogenic in single dose experiments; <sup>\*</sup>/and other polycyclic aromatic hydrocarbons present in coal, such as chrysene, methylchrysenes, benzanthracenes, benzacridines, aminoanthracenes, aminofluorenes, and naphthylamines are also among the most potent carcinogens known. <sup>\*\*</sup>/ This raises the very real possibility of significant carcinogenic risk arising even from short-term leaks and spills, and this should be addressed in the DEIS.

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<sup>\*</sup>/ Pierce, "Tumor-Promotion by Lime Oil in the Mouse Forestomach," Nature vol. 189, p. 164 (1961); Huggins & Yang, "Induction and Extinction of Mammary Cancer," Science, vol. 137 p. 257 (1962); Lombard & Vesselinovitch, "Renal Carcinogenesis by Benzo(a)pyrene," Proc. Amer. Assoc. Cancer Research, vol. 13, p. 49 (March 1972).

<sup>\*\*</sup>/ International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man:

Vol. 3, "Certain Polycyclic Aromatic Hydrocarbons and Heterocyclic Compounds" (1973),

Vol. 4, "Some Aromatic Amines, Hydrazine and Related Substances and Miscellaneous Alkylating Agents" (1974), World Health Organization, Lyon, France

## III-6

Aromatic Amines

A number of tertiary aromatic amines (N, N-dimethylaniline and triphenyl amine), secondary aromatic amines (N-methylaniline, N-phenylaniline and N-phenyl-h-naphthylamine), and primary aromatic amines (aniline, -naphthylamine) have been found in coal conversion products. All have been shown to be carcinogenic in one or more test species and/or humans. For example, aniline was carcinogenic in rats in a bioassay conducted by the National Cancer Institute. \*/

Other chemicals of concern include:

Benzene. Benzene is a known human carcinogen. It has been identified as a cause of leukemia in humans \*\*/ although it does not cause skin tumors in animal skinpainting experiments.

Thiophene. Daily injections of thiophene have been found to cause degeneration of the cerebellum and other brain areas of dogs.\*\*\*/

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\*/National Cancer Institute, "Bioassay of Aniline Hydrochloride for Possible Carcinogenicity," National Cancer Inst. Carcinogenesis Technical Report Series No. 130, Washington, D.C., DHEW Publication No. (NIH) 78-1385 (1978).

\*\*/Infante et al, "Leukemia in Benzene Workers," Lancet, July 9, 1977, pp. 76-78 (1977).

Ott et al, "Mortality Among Individuals Occupationally Exposed to Benzene," Exhibit 154, OSHA Benzene Hearings, July 19-August 10, 1977.

\*\*\*/Clinton, "Thiophene and Derivatives," APA Toxicological Reviews, American Petroleum Institute, Washington, D.C., (1948)

## III-7

Other investigators have found the same type of brain degeneration when they administered thiophene to rats. \*/ Another study has reported that inhalation of thiophene effects the flexor reflexes in rabbits, \*\*/ and one investigator stated that inhalation of only 0.8 mg/m<sup>3</sup> of thiophene caused changes in human electroencephalograms. \*\*\*/

\*/ Bradley & Berry, "Effects of Thiophene on the Purkinje Cell Dendritic Tree: A Quantitative Golgi Study," Neuropathology and Applied Neurobiology, vol. 5; pp.9-16.

\*\*/ Mikhaillets, et al., "Toxicology of Thiophene," Gig. Tr. Prof. Zabol. vol. 10 pp. 57058. (Biological Abstracts, vol. 48, p. 23256.)

\*\*\*/ Khikmatullaeva, "Data to Substantiate the Maximum Permissible Concentration of Thiophene in Atmosphere," Gig. Sanit. vol. 32, pp. 3-6 (1977) (Biological Abstracts, vol. 49, p. 63743).

## III-8

Phenols and Cresols. Mixed phenols from shale oils, although not carcinogenic themselves, promoted the carcinogenic activity of benzo(a)pyrene in skin painting experiments in mice.<sup>\*/</sup> A recent literature review noted that all phenols and cresols tested caused chromosome damage in a variety of in vitro test systems,<sup>\*\*/</sup> even though at least some were not mutagenic in the specific tests used in the Battelle studies.

Quinoline. Quinoline induces liver tumors in rats and in mice.<sup>\*\*\*/</sup> It is mutagenic in the Ames test,<sup>\*\*\*\*/</sup> and causes chromosomal aberrations in Chinese hamster cells.<sup>\*\*\*\*/</sup>

<sup>\*/</sup> Bogovski, & Mirme, "Co-carcinogenicity of Phenols from Estonian Shale Tars (Oils)," Environmental Health Perspectives, vol. 30, pp. 177-178 (1979).

<sup>\*\*</sup> Dean, "Genetic Toxicology of Benzene Toluene, Xylenes, and Phenols" Mutation Research vol. 47, pp. 75-97 (1978)

<sup>\*\*/</sup> Hiroaro et al., "Carcinogenic Activity of Quinoline on Rat Liver," Cancer Research, vol. 36, pp. 329-335 (1976); Shinohara, et al., "Effects of Various Factors on the Induction of Liver Tumors in Animals by Quinoline," Gann, vol. 68, pp. 785-796 (1977).

<sup>\*\*\*/</sup> Hollstein, et al., "Quinoline: Conversion to a Mutagen by Human and Rodent Liver," Journal of the National Cancer Institute, vol. 60, pp. 405-410 (1978).

<sup>\*\*\*\*/</sup> Matsuoka, et al., "Chromosomal Aberration Tests on 29 Chemicals Combined with S9 Mix in Vitro," Mutation Research, vol. 66, pp. 277-290 (1979).

## III-9

Hydrogen Sulfide and carbon disulfide.  $H_2S$  and  $CS_2$  will be present in the gases generated by the coal liquefaction process.  $H_2S$  is partially dangerous, because a single exposure to more than  $300 \text{ mg/m}^3$  can cause unconsciousness and death, and those who survive exposure at such levels often experience long-lasting damage to the nervous system.<sup>\*/</sup> Even currently accepted occupational exposure limits may not provide an adequate margin of safety for the neurotoxic effects of  $H_2S$ . The threshold limit value-time weighted average (TLV-TWA) standard adopted by the American Conference of Government Industrial Hygienists is  $15 \text{ mg/m}^3$ .<sup>\*\*/</sup> One investigator reported that exposure to only  $10 \text{ mg/m}^3$  for 12 hours per day over 90 days caused brain damage and abnormal nerve conditions in rats.<sup>\*\*\*/</sup> Carbon disulfide is also a human neurotoxin. Several human epidemiologic studies reviewed by NIOSH indicate that occupational exposure to carbon disulfide is associated with both psychological disturbances and severe polyneuropathies.

<sup>\*/</sup> National Institute for Occupational Safety & Health, "Criteria for a Recommended Standard . . . Occupational Exposure to Hydrogen Sulfide," Washington, DC., DHEW Publication No. (NIOSH) 77-158 (1977).

<sup>\*\*/</sup> American Conference on Governmental Industrial Hygienists, "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1973." ACGIH, Cincinnati, (1978).

<sup>\*\*\*/</sup> Duan, F.Z., 1959, "Data for Determining the Maximum Permissible Concentration of Hydrogen Sulfide in the Atmospheric Air," Gig. Sanit. 10:12-17 (as reported in NIOSH 1977).

## III-10

Pregnance complications and various ovarian and menstrual cycle disorders were also noted in women exposed to carbon disulfide.<sup>\*/</sup> Mixtures of hydrogen sulfide and carbon disulfide<sup>\*\*/</sup> are teratogenic in rats.

In addition to the compounds described above, coal contains a number of potentially toxic trace elements. These include:

Arsenic. Arsenic is a known human carcinogen.<sup>\*\*\*/</sup> Studies have shown that certain smelter workers who inhaled high levels of arsenic trioxide were at 4 to 12 times greater risk of developing lung cancer than unexposed workers.<sup>\*\*\*\*/</sup> Arsenic pollution in the general environment also appears to be associated with increased risk of lung cancer.<sup>\*\*\*\*\*/</sup> Skin cancer in humans is<sup>\*\*\*\*\*/</sup> also causally associated with exposure to arsenic.

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<sup>\*/</sup> See NIOSH, above.

<sup>\*\*/</sup> Barilyak, et al., "Effects of Small Concentrations of Carbon Disulfide and Hydrogen Sulfide on Intrauterine Development in Rats," Arkh. Anat. Histol. Embriol., vol. 68, pp 77-81 (Russian with English summary) (1975).

<sup>\*\*\*/</sup> Althouse, et al., "An Evaluation of Chemicals and Industrial Processes Associated with Cancer in Humans Based on Human and Animal Data: IARC Monographs 1 to 20," Cancer Research, vol. 40, pp. 1-12 (1980).

<sup>\*\*\*\*/</sup> International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man, Vol. 2, pp. 48-73, World Health Organization, Lyon, France (1973); Kuratsune, et al., "Occupational Lung Cancer, vol 13, pp. 552-558 (1974); Tokome & Kuratsune, "A Cohort Study on Mortality from Cancer and Other Causes Among Workers at a Metal Refinery," International Journal of Cancer, vol. 17, pp 310-317 (1976).

<sup>\*\*\*\*\*/</sup> Blot & Fraumeni, "Arsenical Air Pollution and Lung Cancer," Lancet (1975) vol. ii, p. 142.

<sup>\*\*\*\*\*/</sup> Althouse, et al., above.



## III-11

Mercury. A discussion of the toxic potential of mercury must be based on considerations of the toxicity of mercury and inorganic mercury compounds, as well as that of the alkyl mercury compounds (especially methylmercury). Mercury and inorganic mercury compounds are central nervous system toxins, producing signs of irritability, excitability, etc. They also accumulate in the kidney, leading to proteinuria, renal failure, etc. Several alkyl mercury compounds are also known to induce central nervous system disorders and renal effects. In addition, methyl mercury is known to be a human teratogen.<sup>\*/</sup>

Nickel. Several forms of nickel are carcinogenic in animals.<sup>\*\*/</sup> Nickel subsulfide produces lung cancer when inhaled by rats. Nickel carbonyl increased the incidence of lung tumors when inhaled by rats. Intra-muscular injection of several other nickel compounds (nickel powder, oxide, carbonate, subsulfide, and nickelocene) has produced local sarcomas in rats, mice and hamsters.<sup>\*\*\*</sup> Increased incidences of cancer of the nasal cavity,

<sup>\*/</sup> National Academy of Sciences, Assessment of Mercury in the Environment, Washington, DC (1978).

<sup>\*\*/</sup> Althouse et al., above.

<sup>\*\*\*/</sup> International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man, vol. 11, pp. 75-112, World Health Organization, Lyon, France (1976).

## III-12

lung, and probably larynx, have been observed in nickel refinery workers. Exposure to nickel also produced dermatitis.

Chromium. Chromium is a human and animal carcinogen<sup>\*/</sup> An increased incidence of lung cancer has been observed among<sup>\*\*/</sup> chromate workers, chromium plater, and chromium alloy workers. Several forms of chromium have also been found to produce local<sup>\*\*\*</sup> sarcomas in rats.<sup>\*\*\*\*</sup> Chromic acid and the chromates are also skin irritants, and, at lower exposure levels, the chromates are sensitizers.

<sup>\*/</sup> Althouse, et al., above.

<sup>\*\*/</sup> IARC, vol. 2, above.

Taylor, "The Relationship of Mortality and Duration of Employment as Reflected by a Cohort of Chromate Workers," American Journal of Public Health, vol. 56, pp. 218-229 (1975);

Davies, "Lung Cancer Mortality of Workers Making Chrome Pigments," Lancet, (1978) vol. 1, p. 384;

Waterhouse, "Cancer Among Chromium Platers," British Journal of Cancer, vol. 32, p. 262 (1975);

Royle, "Toxicity of Chromic Acid in the Chromium Plating Industry," Environmental Research, vol. 10, p. 39-53 (1975)

Pokrovskaya & Shabynina, "Carcinogenous Hazardous in Production of Chromium Ferroalloys," Gig. Tr. Prof. Zabol., vol. 10, pp. 23-26 (1973).

<sup>\*\*\*/</sup> IARC, vol. 2, above.

<sup>\*\*\*\*/</sup> National Academy of Sciences, Chromium: Medical and Biological Effects of Environmental Pollutants, Wash., D.C. (1974).

## III-13

Lead. Lead is a general metabolic poison, documented in both humans and laboratory animals, that affects the central and peripheral nervous system, the kidneys, the reproductive system, and behavior.<sup>\*/</sup> Furthermore, lead acetate induces kidney tumors in mice and rats upon oral administration. Lead acetate, lead subacetate, and lead phosphate are carcinogenic in rats when administered by various routes.<sup>\*\*/</sup> Limited epidemiological evidence of lead exposure in smelter and lead workers showed increased cancer mortality. The excess of tumors was seen in the respiratory, urinary, and digestive systems, although tumors at no site alone were significantly increased.<sup>\*\*\*/</sup>

Cadmium. Exposure to cadmium and/or certain cadmium compounds may result in a wide range of toxic effects. A number of investigators have found that workers exposed to some form of cadmium are at increased risk of developing cancer of the prostate, respiratory system, and kidney.<sup>\*\*\*\*/</sup> Several forms of

<sup>\*/</sup> National Academy of Sciences, Lead in the Environment, Washington, DC (1980).

<sup>\*\*/</sup> International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man, vol. 1, pp. 40-50 (1972).

<sup>\*\*\*/</sup> Althouse, et al., above.

<sup>\*\*\*\*/</sup> IARC, vol. 11, above.

Khellstrom, et al., "Morality and Cancer Morbidity Among Cadmium-Exposed Workers: A Preliminary Report," Environmental Health Perspectives, vol. 28, pp. 199-204 (1979).

## III-14

cadmium are also carcinogenic in rats and mice following subcutaneous and intramuscular administration.<sup>\*/</sup> Cadmium is also a mutagen, capable of causing point (gene) mutations and chromosomal damage.<sup>\*\*</sup> Numerous investigators have found cadmium to be a potent teratogen and fetotoxic agent. In a recent review of these studies, the Battelle Memorial Laboratory concluded that a no-observable-effect-level could not be established.<sup>\*\*\*</sup>

All of the trace elements listed above are toxic and volatile. All can be expected to volatilize during the conversion of coal to synthesis gas. In addition with the reducing atmosphere of the conversion process each of these trace elements may form compounds such as hydrides, carbonyls, or sulfides, which may be more volatile than the oxidized forms.

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<sup>\*/</sup> Althouse, et al., "An Evaluation of Chemicals and Industrial Processes Associated with Cancer in Humans Based on Human and Animal Data: IARC Monographs 1-20," Cancer Research, vol. 40, pp. 1-13 (1980).

<sup>\*\*</sup>/ Environmental Protection Agency, "Rebuttable Presumption Against Registration and Continued Registration of Pesticide Products Containing Cadmium," 42 Fed. Reg. 56574 (1977).

<sup>\*\*\*</sup>/ Ibid.

Table III-1 Summary of Toxic Chemicals and Effects

| <u>Chemical</u>                  | <u>Carcinogenic</u> | <u>Causes</u>     |                    | <u>Other--</u>          |                      | <u>Neurotoxic</u> | <u>Toxic to Other</u>                              |
|----------------------------------|---------------------|-------------------|--------------------|-------------------------|----------------------|-------------------|----------------------------------------------------|
|                                  |                     | <u>Chromosome</u> | <u>Damage</u>      | <u>Reproductive and</u> | <u>Developmental</u> |                   |                                                    |
|                                  |                     |                   | <u>Teratogenic</u> | <u>Toxicity</u>         |                      |                   | <u>Organ Systems</u>                               |
| Polycyclic aromatic hydrocarbons | +                   | +                 |                    |                         |                      |                   |                                                    |
| Benzene                          | +                   |                   |                    |                         |                      |                   |                                                    |
| Aromatic Amines                  | +                   |                   |                    |                         |                      |                   | +(interferes with blood's ability to carry oxygen) |
| Indole                           | +                   |                   |                    |                         |                      |                   |                                                    |
| Quinoline                        | +                   |                   |                    |                         |                      |                   | +(skin, eye)                                       |
| Phenols (promoters)              |                     | +                 |                    |                         |                      |                   |                                                    |
| Cresols                          |                     | +                 |                    |                         |                      |                   |                                                    |
| Thiophene                        |                     |                   |                    |                         |                      | +                 | +(liver, kidneys, heart, blood)                    |
| Hydrogen sulfide                 |                     |                   | +                  |                         |                      | +                 |                                                    |
| Carbon disulfide                 |                     |                   | +                  | +                       |                      | +                 |                                                    |
| Arsenic                          | +                   |                   |                    |                         |                      |                   |                                                    |
| Mercury                          |                     |                   | +                  |                         |                      | +                 | +(kidneys)                                         |
| Nickel                           | +                   |                   |                    |                         |                      |                   | +(skin)                                            |
| Chromium                         | +                   |                   |                    |                         |                      |                   | +(skin)                                            |
| Lead                             | +                   |                   |                    | +                       |                      | +                 | +(kidneys, blood-forming system)                   |
| Cadmium                          | +                   | +                 | +                  | +                       |                      |                   |                                                    |

## III-15

B. Incomplete Assessment of Potential Emission Points  
and Opportunities For Mitigation

The DEIS's evaluation of the potential for release of toxic chemicals and of means to mitigate such releases is uneven at best. In some cases, the site of releases and the pollutants involved are identified, but potential health and environmental consequences and means of preventing or remedying the releases are left unexplored. Discussion of some possible emission points is seriously incomplete, and certain other important problems are virtually ignored.

NRDC-9 1. Fugitive Hydrocarbon and Other Toxic Emissions

The DEIS pays virtually no attention to the potential for fugitive emissions of hydrocarbons and other toxic chemicals from process valves, seals, pumps, and other points. The expectation of such emissions is acknowledged in only the most cursory way, at p. 2-10, where the flare system is described as taking care of emissions from "[v]ents and safety valves in the various process units." No mention of such fugitive emissions is to be found in the summaries of air pollution concerns at p. 1-21, or p. 2-11.

How many such emission points will there be? What will they release? What will be their individual and total rates of release? What is controllable by use of the best available

## III-16

materials and equipment for controlling often high-pressure, corrosive gases? How will emissions be detected, collected, and conveyed to the flare? What efficiency will this system have?

Experience with EPA's attempts to set new source performance standards and hazardous air pollutant standards for fugitive emissions raises an especially important issue that needs to be addressed in the DEIS. Typically, industries have sought to have exempted from control relatively large leaks -- sometimes up to 10,000 parts per million of chemicals such as benzene -- except when caught by maintenance scheduled at intervals of as long as six months. Will all such fugitive emissions be sent to the flare? Does DOE intend to allow exemptions, and if so, for what size leaks?

More attention must be paid to the potential for large fugitive emissions during upsets and emergencies. Upsets will be a frequent occurrence at a demonstration plant, and major process equipment failures leading to enormous releases of chemicals are likely to occur as well. Many of the likely equipment upsets and failures have to do with conditions of runaway temperature and pressure, which may cause ruptures in pipes, seals, vents, and valves.

These questions can hardly be answered except at a stage of more detailed design than this DEIS represents. It is

## III-17

essential that the matter be covered in a draft document and that the public be allowed the opportunity to comment on the adequacy of a meaningfully detailed design, perhaps through the two-tiered process described in Section I. The degree to which such emissions can be captured and routed to the flare is impossible to appraise without significant design information.

NRDC-10

2. Occupational Health

Closely related to the fugitive emissions problem is the issue of occupational health. Here the DEIS has significant shortcomings. Largely because toxic chemical hazards in the process have not been adequately addressed yet, and because of the absence of design detail, the information in the DEIS is inadequate to identify the character, location, and severity of occupational health risks, and to determine engineering and work practice measures to prevent or reduce them.

The occupational health section of the DEIS, more than any other portion, is written in obfuscatory jargon. When much of the "systems-talk" is peeled away, significant deficiencies are revealed.

The workers in the plant will be at the greatest risk of chemically-related illness, more so than persons in the general community. Given this greater risk, a much more detailed investigation of the industrial health hazards and available control measures is needed.



## III-18

One especially unjustified assertion must be corrected. The DEIS generally acknowledges that toxic organic compounds such as PAH's will be found in the process (see e.g. p. 1-42). But at several places the document inconsistently purports to deny their formation. At p. 1-15, it claims:

The U-gas process will operate at a 1800-1900<sup>o</sup> F range that is high enough to avoid tar and oil production. . . . Material hazardous to the workers will therefore be eliminated by this higher temperature operation of the gasifier.

See also p. 1-18, where it is claimed that all hydrocarbons except methane will be converted to synthesis gas. These statements must be retracted and the risks unambiguously acknowledged.

The DEIS makes the flat statement (at 2-18) that the Memphis plant presents health hazards "similar to those found in petrochemical and chemical plants." At many such plants, risks of cancer and other serious diseases are extraordinarily high. Thus, this comparison should underline the urgency of the maximum possible protection of workers' health, the investigation in advance of the dangerous chemicals in the process and the possible points of release, and the development of effective controls.

In fact, there is data from a coal gasification facility itself which suggests significant potential danger. A study was performed of skin cancer incidence among workers employed at

## III-19

the coal hydrogenation plant at Institute, West Virginia, in the 1950's. Among the 359 workers examined over a period of five years, 10 developed skin cancer. This was 16-37 times the expected incidence.<sup>\*/</sup> Although the processes are quite different, DOE has failed to demonstrate that similar compounds would not be released into the workplace.

It must also be noted that industrial health discussion places an unreasonable reliance on the use of respirators. This is unacceptable. The use of respirators should be limited to emergencies and not used on a routine basis. In addition, the DEIS reveals that planning for occupational health is vague and incomplete. Contingency plans appear not to have been developed for the protection of worker safety in the event of major emergencies.

<sup>\*/</sup> Sexton, "The Hazards to Health in the Hydrogenation of Coal: IV. The Control Program and the Clinic Effects," Archives of Environmental Health, Vol. 1, pp. 208-31 (1960). Follow-up studies have not found a demonstrably high rate of systemic cancer among the 10 workers, but this is too small a sample on which to base any negative conclusions; the possibility of a significantly elevated risk's escaping notice in so small a sample are very high.

## III-20

NRDC-11

3. The Flare System

The DEIS states that leaks of hydrocarbons and, presumably, other chemicals in process pipes, etc., will be collected and disposed of through a flare. P. 2-10. Little information is given which would allow evaluation of how completely the flare would destroy complex, toxic chemicals likely to be routed to it along with simple, readily combustible hydrocarbons. This stands in contrast with the somewhat greater detail offered for the incinerator, which apparently collects and combusts a different waste stream. It is essential to determine whether the flare, when operating, has the temperature and residence time necessary to destroy these toxic compounds, or whether it will simply volatilize them, enhance their dispersion, and increase the risk of human exposure.

The plans for the Solvent Refined Coal II plant in West Virginia call for primary reliance on a "controlled combustor," with a flare relied upon only as a back-up. This was deemed necessary there because the flare was judged incapable of destroying the toxic hydrocarbons and other chemicals routed through it. Why has a controlled combustor not been planned for this plant? What differences in the waste streams in question justify reliance solely on a flare for the Memphis plant?

## III-21

The DEIS acknowledges that a total failure of the flare would result in release of "significant" quantities of toxic hydrocarbons and other chemicals. The DEIS, however, gives no indication of what "significant" means, what types of hydrocarbons might be emitted, nor how long it might take to correct the situation. Indeed, as noted above, there are many known and potential carcinogens which might be emitted in such an incident.

The statement that ambient concentrations of toxic hydrocarbons and other substances -- whether from fugitive emissions or flare failures -- will be "relatively low" is not a sufficient justification for a failure to address these problems adequately. Such releases will be added to an already badly polluted atmosphere. The county is a non-attainment area for ozone, and an alarming array of toxic chemicals is emitted to the air by the many chemical plants heavily concentrated in the Memphis area. Potential synergistic interactions between the pollutants from the gasification plant and the emissions from other industrial facilities should be considered. Memphis currently suffers an unusually high cancer rate, and high rates of other chemically-related disease. The community exposure due to the Memphis U-Gas plant must be reduced to the absolute minimum.

## III-22

NRDC-12 4. The Cooling Tower

The DEIS states that during the lifetime of the plant the heat exchangers in the cooling tower may fail, allowing gases to enter the cooling tower water. Carbon monoxide, hydrogen sulfide, and (most likely) carbon disulfide, would be released from the cooling tower until repair of the system. The latter two of these compounds are quite toxic and one might anticipate extremely serious effects. The magnitude of such effects would depend at least in part of the rate of release of each substance as well as the length of time needed for repair or shut-down.

What materials could be used to minimize the risk of failure of the heat exchangers? What inspection schedule could be devised to catch damage to the exchangers before a total failure? How long will it take to shut down the plant and how much of each toxic gas would escape in such an event? What would the effects be? How can response time be improved?

The discussion of chromate deposition from the cooling towers "drift" at p. 4-5 does not explore the consequences of exposure to these compounds. Chromium compounds, as discussed above, have serious known and potential toxic effects. Some consideration of possible adverse effects, and of alternatives to the use of chromates, is essential.

## III-23

NRDC-13      5. Other Air Pollution Issues

As mentioned, the air in Shelby County violates the health-based standard for ozone. The hydrocarbons and NO<sub>x</sub> emissions from the proposed plant would exacerbate current ozone violations and make attainment more difficult. The DEIS does not examine in meaningful detail the degree to which the plant would worsen air quality. This may be impossible until enough detailed design is accomplished that hydrocarbon and NO<sub>x</sub> emissions can be estimated with some reliability, and alternatives for reducing them can be considered.

The DEIS contains no discussion of what offsetting emission reductions may be found elsewhere in the Memphis area to compensate for the hydrocarbon and NO<sub>x</sub> emissions increases due to this plant. Such offsets are required by the Clean Air Act as a condition of industrial expansion in a polluted area.

Table 3.1, at p. 3-3, which summarizes air quality in the area, reveals several problems. According to the table, SO<sub>2</sub> measurements were made between February and May, 1978. Sampling for this portion of the year may not be sufficient to determine attainment, since the period of highest energy use and most stagnant air in the Memphis area may be late summer and early fall. What does data from this time of year show?

## III-24

No information is given on the time of year of particulate sampling.

The DEIS claims that the project will contribute only insignificantly to acid rain, a long-distance pollution problem of high importance. This discussion is not adequate. The project's contribution to the total emissions of sulfur and nitrogen precursors to acid rain may be small, but that total is made up of contributions from many smaller sources. The problem can be controlled only through emission reductions at all these sources. How do the project's emissions compare with those of other sources contributing to the acid rain problem? Is further emission reduction at this project preferable to some alternative reductions elsewhere?

NRDC-14      6. Wastewater Treatment

The DEIS discusses the presence of PAH's and trace elements in the treated wastewater effluent to be released to the river. (Appendix B.0.1). This discussion was somewhat more complete than those summarized above, although many important details were missing. For example, one input to the wastewater stream will be the process condensate. The composition of this material is not described. Similarly, no mention is made of the composition of slop oils.

We can tell already, however, that the planned treatment process will not be sufficient for all constituents of the waste

## III-25

stream. For example, the DEIS states (at p. C-57) that significant quantities of Cd, As, Cr, Fe, and Se are present in the wastewater. The use of neutralization as an effluent control will not significantly reduce the levels of As and Se.

Similar problems exist with respect to PAH's in wastewater (Appendix B.0.1). The DEIS proposes to make use of a combination of biological oxidation and activated carbon to reduce levels of PAH's. The document correctly notes the variability in biodegradation of various PAH's. It then puts an upper limit on the reduction of PAH levels via this process at 80%. This is extremely optimistic. The DEIS continues by stating that dilution by river water even under 10 year low-flow conditions will lead to very small concentrations, in the 0.1 ug/liter range for "many" species. No further information is given. One must wonder which PAH species DOE is referring. The implication is that some compounds may be found at higher concentrations, perhaps in the parts-per-billion range, which considering the potential for bioaccumulation up the food chain, represents a significant hazard.

NRDC-15(a) Table 4.6 at p. 4-12 purports to indicate the concentrations of various pollutants that would be released to the Mississippi River. This table is misleading, however, for it makes no



## III-26

acknowledgement of the dependence of effluents on the composition of the coal feedstock. One goal of the project is to demonstrate the flexibility to use a wide variety of coals. The concentration of trace metals and elements, such as selenium, in different coals can vary by an order of magnitude or more.

At the very least, the table should indicate ranges to be expected depending on the coal used.

NRDC-15(b) A more useful methodology would be to develop data on what proportion of each constituent of coal will end up in water effluents, air emissions, wastes, the product gas itself, etc. Then, the results of the use of coals with particular compositions could be more readily analyzed.<sup>\*/</sup>

NRDC-15(c) In light of these uncertainties and shortcomings, the DEIS's characterization of the waste water treatment system as adequate is premature.

NRDC-15(d) The DEIS's repeatedly states (sometimes explicitly, and sometimes implicitly) that the addition of more toxic pollutants into this stretch of the Mississippi River is a matter of no concern because the river is already badly polluted. But the goal of the Clean Water Act and of state water pollution control programs is to improve the water quality in this stretch of the river as well as elsewhere. These programs will be definitely hindered by any additional toxic effluent from the plant.

<sup>\*/</sup> See Klein, et al., "Pathways of 37 Trace Elements Through a Coal-fired Power Plant," Environmental Science & Technology, Vol. 9, no. 10, p. 273 (October 1975).

## III-27

Moreover, far from being toxicologically unimportant, the additional pollution in polluted waters can have disproportionately severe effects on fish, other aquatic life, and the higher life that depends on it. The current condition of the Mississippi River at Memphis magnifies, rather than reduces, the need for the most effective effluent controls possible, approaching as close to zero discharge as is feasible.

NRDC-15(e) Water quality criteria which are already approached or exceeded are likely to become more protective in coming years, as EPA and the state revise them to account for more recent information on toxic effects. The DEIS should acknowledge that many current criteria are seriously out-of-date, and it should discuss the range of new criteria that are likely to be set.

NRDC-16 7. Hazardous Wastes, Coal Piles and Threats To Groundwater

Perhaps the most serious threat to health and the environment posed by the proposed project is the possibility of contaminating groundwater relied on for the Memphis water supply. The plant will generate huge quantities of solid waste:

- . Gasifier ash (25 tons/hr);
- . Boiler fly ash and bottom ash (4 tons/hr);
- . Gypsum from flue gas desulfurization (4 tons/hr);
- . Miscellaneous sludges (wastewater treatment and chromate destruct); and
- . Spent catalysts.

## III-28

Associated with these wastes are a large number of trace elements known to be toxic. If these compounds were released to the groundwater, significant risks would be posed to public health. The Memphis water supply might be rendered unusable.

Whether a particular element is able to reach the groundwater depends on a variety of factors. One factor is addressed in Appendix B.5.3, which considers which metals are most likely to leach under different soil conditions. However, the DEIS nowhere evaluates the toxic materials to be found at this site in relation to the soil conditions at this site.

**NRDC-17** The draft states that "preliminary" leaching studies indicate gasifier ash agglomerates (74% of the waste) are not "hazardous" wastes as defined by EPA. This understates the true toxicity problem, however, because the extraction procedure used in those tests is designed for municipal waste sites. The procedure does not expose the gasifier waste to real-world industrial landfill conditions, or the conditions to be experienced here.

It is not adequate in preparing an EIS to simply rely on existing official tests and standards, for those may be seriously inadequate to protect health and the environment. The purpose of an EIS is to investigate all significant threats to health and the environment, and to examine means to mitigate them, re-

## III-29

gardless of whether the practice in question is not forbidden by an existing government regulation.

In addition it must be noted that given the enormous quantities of waste to be disposed of on the site, significant contamination would result from even a small amount of leachate's reaching groundwater. Therefore, greater concern for potential low rates of leaching of toxic materials is warranted here than perhaps at other waste sites. In this situation, with a massive waste pile sitting atop crucial water supplies, the EPA criteria for hazardous waste (leaching at 100 times the primary drinking water standards) may not be sufficiently protective.

**NRDC-18** To reduce potential risks of groundwater contamination, DOE plans to use a 30 mil Hypalon liner in the short-term (first four years) storage area. There are several problems with this choice. First the wastes must be sealed off perpetually, but the life of synthetic liners is limited due to aging and degradation. Second, such liners are extremely susceptible to ripping or tearing. As mentioned in Section II, settlement of soils may result in failure of the system. These problems are addressed in the DEIS's plans for monitoring and repair, but the plan does not contain any indication how often repair might be needed, how expensive they may be, or who will undertake them after the life of the plant.

## III-30

Assuming the site is adequately constructed to begin with, little of the leachate probably will reach the groundwater under normal circumstances. However, the DEIS presents no contingency plan describing how to deal with waste problems arising from a seismic event or floods of a magnitude greater than the anticipated 100-year level.

**NRDC-19** In addition, the DEIS states that commitment to even this degree of leachate control for the long-term (4-20 years) waste storage would be deferred until experience with this short-term area is evaluated. It is unclear how four years' experience with the short-term waste's liner can be used for designing the long-term storage area.

**NRDC-20** No consideration was given to the possibility that on-site storage may prove to be infeasible. The technological problems and economic costs associated with moving huge quantities of waste to other sites were not addressed. Indeed, DOE should be particularly interested in the amount of energy that would be needed to accomplish such a task.

Questions regarding the availability of disposal sites in Tennessee must also be raised. Table 1-14 on p. 1-37 indicates that this plant, in conjunction with four other similar ones planned for Tennessee will add 15.2 percent to the State's solid waste disposal burden.

## III-31

These are all problems which must be addressed now. Memphis is only one of a handful of major cities which obtains all of its drinking water from groundwater.

**NRDC-21** Indeed, continuous pumping from the bedrock aquifer underlying the area is expected to result in increased leakage of alluvial water through the Jackson clay in areas either where faults have produced secondary porosity or where the lithology is permeable. Thus, it is possible that leaching into the alluvial aquifer underlying the Allen site would eventually result in contamination of even the deeper bedrock aquifer.

In other areas of Memphis such contamination is no longer just a possibility. Toxic pollutants emanating from the numerous other hazardous waste sites in the area have already contaminated the drinking water supply. Further deterioration of the quality of underground water would be unacceptable.

**NRDC-22** Leaching from the coal piles presents many similar problems. The liner proposed for use will be subject to the same risks of failure as that under the wastes. The DEIS states that five coal types were tested for leaching. Yet results on only two are given in Appendix C.3.2, at pp. C-57 and C-58. What were the results from all five coals? Are these five coals representative of the range to be used at the facility?

For these reasons, as indicated in Section II, serious consideration should be given to locating the plant off the river and off the aquifer.

CONCLUSION

While this DEIS represents a start towards a complete assessment of the health, safety, and environmental risks of the coal gasification project, more detailed assessment is needed. A meaningful programmatic evaluation is essential. More information and a broader assessment of alternatives are needed in the areas we have discussed above: toxic chemicals and effects, fugitive emissions, occupational health, the plant flare, the cooling tower, other air emissions, wastewater treatment, and threats to groundwater from hazardous wastes. Thorough considerations of these matters will reveal the need for better control of dangerous chemicals than apparently is currently planned.

To a great extent, these information gaps can be filled only at a later, more detailed design stage. As we have stated, we believe the NEPA process requires the issuance of a supplemental draft document at that stage, with the opportunity informed public comment before the final design decisions are made. A final EIS cannot be completed at this preliminary design stage.

Special consideration should be given to relocating the plant site, or at least the waste disposal site, off the Mississippi flood plain and off the aquifer on which Memphis depends for its water supply.

## Natural Resources Defense Council, Inc.

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December 15, 1980

Mr. Robert W. Laza  
Department of Energy  
Project Management Division  
MLGW Coal Gasification Project  
9800 S. Cass Avenue  
Argonne, IL 60439

RE: Draft Environmental Impact Statement  
MLGW Coal Gasification Project DOE/EIS-0071-D

Dear Mr. Laza:

In our initial comments of December 3, we indicated that we would have some additional comments to make by December 15. This letter conveys our additional comments on the draft EIS for the Memphis coal gasification project.

NRDC-23 First, we believe the EIS must give more attention to possible toxic contaminants of the product gas. As noted in our earlier comments, very little information was provided on the composition of the product gas. Indeed, DOE appears to assume that the product gas will contain only hydrogen, carbon monoxide, methane, and no more sulfur than natural gas, and no other compounds of toxicological concern. However, coal contains a number volatile trace elements which might be expected to appear in the product gas. Indeed results from a study performed for EPA by the Institute for Gas Technology indicate the need for considering such a possibility. <sup>1/</sup> In that study IGT measured the levels of various trace elements

<sup>1/</sup> Attari, A. 1973. Fate of Trace Constituents of Coal During Gasification. Environmental Protection Technology Series EPA-650/2-73-004; Attari, A., Pau, J. and Mensinger, M. 1976. Fate of Trace and Minor Constituents of Coal During Gasification. Environmental Protection Agency Report EPA-600/2-76-258



Robert W. Laza  
December 15, 1980  
Page Two

in coal residues throughout the gasification process. Their results indicate that up to 96% of certain trace elements did not appear in any of the residues and were unaccounted for during the gasification process.

Such losses may be associated with leaks or other losses to the environment or they indicate the presence of such materials in the product gas.

In our earlier comments, we provided DOE with a list of toxic materials that might appear in the process or waste stream. They might also end up in the product gas. For example, arsenic is a known human carcinogen. In the IGT study 65% (by weight) of the arsenic present in coal was "lost" during the gasification process and not found in any of the residues. This material might be in the product gas, possibly in the form of arsine (as a result of the reducing atmosphere of the methanation process). Arsine, a gas with a slight garlic-like smell detectable only at toxic levels, produces massive hemolysis and renal failure.

NRDC-24      Second, the Department should be aware of, and the EIS should thoroughly consider, the available health and environmental monitoring information from foreign plants. Specifically, we know of two papers evaluating the Kosovo gasification plant in Yugoslavia:

R. Patterson, "Ambient Air Downwind of the Kosovo Gasification Complex: A Compendium," presented at the Symposium on Aspects of Fuel Conversion-V, St. Louis, Mo., September 16-19, 1980. (Patterson is at the Environmental Sciences Research Laboratory of the EPA.)

K. Bombaugh, W. Corbett, K. Lee, W. Seames, "An Environmentally Based Evaluation of the Multimedia Discharges from the Liurgi Coal Gasification System at Kosovo," undated. (The authors are at Radian Corp.)

Other studies of this complex may be available, and if so, should be considered. In addition, NIOSH has accumulated some limited data on the synfuels plants in South Africa. Along with the information on health hazards in the coal gasification

Robert W. Laza  
December 15, 1980  
Page Three

operation at Institute, West Va. (discussed in our earlier comments), this evidence bears on the risks that may be experienced at the Memphis project. Although the processes are different, DOE has an obligation to explain why such discharges of toxic materials should not be expected here.

A copy of these comments is being delivered today to the Department of Energy headquarters in Washington, DC.

As I indicated at the Memphis public hearing, we are available to discuss any matter raised in our comments.

Sincerely,

A handwritten signature in cursive script, reading "David D. Doniger".

David D. Doniger  
Senior Project Attorney



## MEMPHIS AUDUBON SOCIETY

December 3, 1980

Mr. Robert Laza  
Department of Energy  
Chicago Operations and Regional Office  
Project Management Division  
9800 South Cass Avenue  
Argonne, Illinois 60439

RE: Public Comments on Draft Environmental Impact Statement for  
Memphis Light, Gas, & Water IFG Demonstration Plant Project

Dear Mr. Laza:

For the record, the following is a written statement of my comments  
at the public hearing in Memphis:

One of the goals of the National Audubon Society is to ". . . to promote rational strategies for energy development and use, stressing conservation and the use of renewable energy sources." While the proposed demonstration plant project does not meet all of the aims of the National goal, we recognize the project as an important step toward the development of alternative energy supplies for future generations. However, in preparing for the future, we can not afford to over-look the present-day environmental needs of our community.

It is essential that we recognize the fact that the proposed project is a demonstration project and the technology it utilizes is experimental in nature. While this is truly an opportunity for the city of Memphis to assume a role in leading the country down the road of energy independence, our enthusiasm to help must be tempered by the reality that the data obtained from this project will be used in planning similar facilities throughout the country and, therefore, must be well-documented and beyond reproach.

In striving to reach these goals, we have found that there are several areas that have not been adequately addressed for the draft Environmental Impact Statement (DEIS):

- A. Groundwater Usage
- B. Air and Water Emissions
- C. Adequate Monitoring of all Environmental Impacts
- D. Mitigation

- 1 -

Post Office Box 17452 Memphis, Tennessee 38117

Mr. Robert Laza  
 Department of Energy (continued)  
 December 3, 1980

MAS-1

## A. Groundwater Usage

The proposed plant site is subject not only to seismic activity, but also to the rise and fall of the Mississippi River water levels. While located within the floodplain, water will be taken from the aquifer which is the sole source of drinking water for the City for the plant's processes. While it is true that the City wells are pumping more water per day than is actually used, the Draft E.I.S. offers no information regarding future water needs over the twenty-year life of the project. The City of Memphis withdraws water from the ground faster than it can be replenished and this trend is expected to continue.

Memphis is the largest city in the United States that depends entirely upon groundwater for its drinking water supply. It seems more practical, therefore, to utilize river water or waste water from the nearby sewage treatment plant in order to obtain data that would be beneficial to planners of other coal/gas conversion projects. Most other proposed plant sites in the country will not have the plentiful groundwater to use and, while additional funds would be necessary to alter the design, it seems a small price to pay for conservation of these valuable resources. As the attached newspaper editorial illustrates, the citizenry of Memphis is concerned about the use of drinking water for such an industrial purpose.

MAS-2

## B. Air and Water Emissions and Monitoring

Since this is an experimental project, certain "de-bugging" of the process systems will be required before commercial production of gas can begin. The draft E.I.S. states that air and water emissions will fall within the limits of Federal regulations, except during " . . . non-routine emissions (such as during plant start-up and emergency venting). . . which would be higher. . . " than those regulations. The draft E.I.S. does not define what "higher" emissions are or how long they will last. The draft E.I.S. also has not dealt with the provisions being made for thorough plant monitoring, especially during start-up and emergency venting.

As you are aware, the proposed plant site will cause the prevailing, southwesterly wind currents to carry stack emissions over most of the city. To our knowledge, only three (3) air pollution monitors are in operation by the Health Department down-wind from the plant and these monitors are not fully-equipped to monitor the elements contained in the air discharge. We propose that funds be specifically set-aside for the acquisition of additional air-pollution monitors to be placed throughout the City. Funds should also be appropriated for personnel necessary to provide complete monitoring of those stations.

Mr. Robert Laza  
Department of Energy (continued)  
December 3, 1980

The National Audubon Society has acquired forty acres of land in the northeast part of Shelby County and, in the spirit of co-operation and in the interest of mutual community benefit, we propose that one of the air pollution monitors be located on this property, free of charge. This will aid in placing the monitors where they are needed, at the lowest possible cost.

MAS-3

C. Mitigation

The Draft E.I.S. also does not address the mitigation of habitat taken to complete this project. We are aware that certain parcels of land are available adjacent to the nearby T. O. Fuller State Park. We propose that the 134 acres to be used by the plant be mitigated by placing additional acreage in the Fuller State Park. Because of its proximity to the proposed plant, this Park can assist in minimizing the impact of this construction on the Mississippi Kite, the six-lined racerunner, and the swamp rabbit. These species were identified in the Draft E.I.S. as suffering significant loss of habitat and breeding grounds. The Memphis Audubon Society would be pleased to assist in the acquisition of this land on behalf of the State.

D. Conclusion

As stated in the Draft Environmental Impact Statement, "This program is designed to obtain operating experience, to confirm design criteria, and to provide technology, performance, reliability, and maintenance data that will permit the design of environmentally sound and economically viable commercial-scale production facilities." We must make certain that the design of this program is followed with community interests in mind. By implementing certain design changes, the citizens of Memphis and throughout the country can be assured of not having to fund an unsuccessful, 800 million dollar, experiment.

Sincerely,  
MEMPHIS AUDUBON SOCIETY

*Maury Radin*  
Maury Radin  
President

# THE COMMERCIAL APPEAL

## Jabs At Mother Nature

12/11/70

A RECENT STUDY financed by the Interior Department's office of water research and technology once again punctures the theory that the Memphis water supply is blissfully and inviolably bottomless.

The study is one for the good-news-bad-news archives. It says the water, which we might now drink untreated, faces no "immediate threat" of contamination from places like the Hollywood Dump or Hardeman County's pesticide-laden landfill near Toone, Tenn.

But "immediate" is relative, because at our water usage rate — now roughly 187 million gallons a day — we could begin to see traces of pesticides or other manmade

low or groundwater sources — 30 to 80 feet deep — which seep through sandy "windows" or faults in clay layers once thought to form a tight cork-like seal between the surface and the aquifer. Groundwater near the Hollywood Dump already shows traces of manmade chemicals, although in "infinite" amounts, according to the Memphis Light, Gas & Water Division. The Groundwater Newsletter, an Interior Department publication, recently reported findings of chlordane in the billionths range.

Employees of the city's planning and development office, LG&W and the county health department scoffed at potential contamination of the aquifer as "theoretical" or outright erroneous. It will be 2,900 years or "never" before that happens, they said.

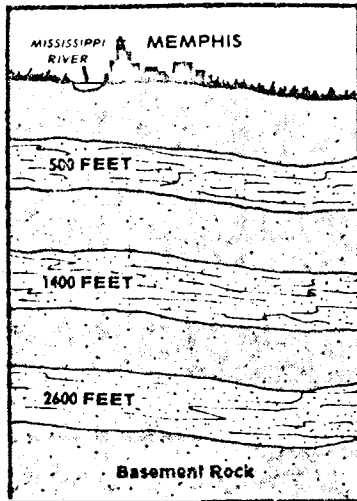
Now comes an experimental coal gasification plant to help focus on the aquifer. Cooling water for the project would be tapped from the aquifer although the plant would be built alongside the Mississippi River. The muddy mineral-laden river water might corrode the machinery, according to Robert Gray, LG&W's vice president in charge of the project. Taking water from the city's South Wastewater Treatment Plant, as LG&W president David Hansen has suggested, would mean building a three-fourths mile pipeline from the coal plant to the treatment plant.

**BUT, SAYS GRAY, THE aquifer still beckons as the "cheapest, cleanest water available."**

According to the estimates, the new plant would use roughly 2.5 million gallons of cooling water a day, and, if it works, attract new, spinoff industries to our Kuwait on the Mississippi. Each industry will, no doubt, also want its share of our cheap, plentiful water and, like the coal gasification plant, increase the potential for further groundwater contamination. Then, the faster we deplete the aquifer the faster it will have to recharge itself — from sources such as the groundwater above and from the vast recharge area stretching out to places like Hardeman County.

Smith says Hansen has asked for a one-page synopsis of the Interior Department study when it is complete. It is not quite ready yet. But the message is clear. We have already fooled with Mother Nature.

Hansen's suggestion of a pipeline to the South Wastewater Treatment Plant sounds like the best alternative, because it does consider the economics of having a product we can continue to drink at a competitive price.



chemicals in the Memphis aquifer within, at worst, 20 to 30 years, says Dr. John Smith, a Memphis State University civil engineer coordinating the Interior Department study.

"I'm an engineer, so I don't get worried too easily. But if tendencies continue the way they are we may have problems," he says.

SMITH'S STUDY borrows from computer findings by the U.S. Geological Survey, which concluded earlier this year that the Memphis Sand, our 500-foot deep aquifer, is filling up "too fast." To explain, USGS hydrologists said that pumping pressure causes water levels in the aquifer to drop most noticeably in the immediate vicinity of pumping stations.

The conclusion? As much as 20 per cent of the city's tapwater is coming from shal-



## Memphis City Beautiful Commission

November 6, 1980

Mr. Robert W. Laza  
DOE Project Management Division  
MLGW Public Hearing  
9800 South Cass Avenue  
Argonne, Illinois 60439

Dear Mr. Laza:

In regard to the Draft Environmental Impact Statement for the Memphis Light, Gas & Water Industrial Fuel Gas Demonstration Project, the Memphis City Beautiful Commission recommends the following actions:

MCBC-1

1. Construction debris is the third biggest source of litter in Memphis; therefore, we recommend fencing of the construction area, placement of litter barrels throughout the work site, and controlling fugitive dust, dirt, etc.
2. Improper handling of solid waste during hauling is the fifth major source of litter in Memphis; therefore, we recommend tarping of trucks with loose debris during construction phase and when plant is in operation.
3. Permanent litter receptacles be placed in proper locations after the plant is completed to handle litter generated by motorists and pedestrians.

Thank you for your support of these actions to help maintain the beauty of Memphis and Shelby County. This letter is in lieu of a personal appearance at the December 3rd public hearing.

Sincerely,

Peter R. Pettit  
Chairman

PRP:ak



CITY HALL, MEMPHIS, TENNESSEE 38103

4679 Cassann Avenue  
Memphis, Tennessee 38128

December 5, 1980

Certified Mail

Dr. Robert W. Laza, Director  
Project Management Division  
Department of Energy  
Bldg. No. 207  
Chicago Operations Office  
9300 South Cass Avenue  
Argonne, Illinois 60439

Re: Memphis Coal-Gasification Demonstration Plant

Dear Dr. Laza:

The purpose of this letter is to make an additional written statement to be incorporated into the record of the public hearing held here in Memphis on December 3rd, 1980 regarding the Draft Environmental Impact Statement of the above- referenced facility.

CBF-1 I. While I recognize that the Allen site is favored over the Pidgeon site because the barge-turning basin already in use by the Allen steam plant eliminates the problem of coal-transportation inherent in the Pidgeon site, I must express a deep concern since land change use at the Allen site would eliminate breeding habitat of several species listed by Tennessee as needing special management due to scarcity of their habitat and since it would also eliminate a foraging, though not apparently breeding, area for the endangered Mississippi Kite.

While I am not familiar with the lizard or swamp rabbit in question, I recognize - and hope you will - their right to exist along with us as co-inhabitants of the earth. I am familiar, however, with the Mississippi Kite and have become a great admirer of this magnificent and graceful bird of prey which is already endangered. I cannot imagine anyone familiar with the Mississippi Kite who would not feel a deep and abiding sadness, or an inestimable sense of loss if it were to perish.

There are those, I know, who would argue that the acreage involved is relatively small, but each year millions of acres of precious wildlife habitat are lost - many of them in just such a piecemeal fashion, in what appears at first glance to be seemingly small amounts. Speaking for wildlife, I must remind you that such losses are an insidious but wholly adequate means of insuring their demise.

On this basis, I would propose either of two courses of action:

- 1) That the facility be located at the Pidgeon site - where it would not cause such a loss;

or,



Dr. Robert W. Laza  
Page Two  
December 5, 1980

- CBF-2      2) That if the Allen site is to be used, some restitution be made- perhaps by providing sufficient funds for the purchase of similar areas as additions to T. O. Fuller State Park. These areas, of course, to be restricted in their use to wildlife habitat.

CBF-3 II. Regarding plant operation, design and water usage- Dr. Berkey of Energy Impact Associates explained to me ( when I asked him why it was necessary to use our fine artesian drinking water rather than pre-treated river water in the plants operation) that there were 3 possible sources of water for the plant:

- 1) Pre-treated river water
- 2) Drilling your own well
- 3) Using Memphis water

The reasons he gave for using Memphis water were:

- 1) its consistent level of purity ( necessary for manufacture and helpful in reducing equipment maintenance costs),
- 2) seemingly adequate supply
- 3) the simple economics of Memphis water as compared to the cost of incorporating a water pre-treatment system into the plant.

In our conversation, he did state that if, at some future point, water supply was limited or otherwise threatened, or if the plant represented an inequitable burden on supply -- that the plant could be converted to using pre-treated river water by the addition of necessary equipment although it would be very costly.

I would like to see, then, in the final plant design, a definite, pre-planned capacity for such a conversion and to know it is there should the need arise. I still believe, however, that conservation is not and should not be an after-the-fact affair.

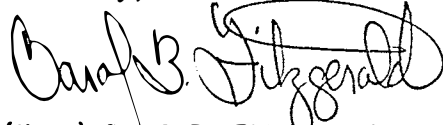
CBF-4 III. Again, addressing the proposed Allen site, I am concerned that land change use would contribute to already serious losses of U. S. floodplain forests and wetland loss, and would remind you that while wetlands are primarily thought of only in terms of providing badly needed habitat for waterfowl, fish, and wildlife, they really do much more and their importance in flood control, groundwater recharge and pollution/sediment control has been cited by the General Accounting Office.

Dr. Robert W. Laza  
Page Three  
December 5, 1980

CBF-5 IV. Regarding the actual design and operation of the facility, I must reiterate that I am deeply concerned, as a resident of Memphis, with the potential health hazards involved with such a facility. Speaking for myself and other residents, let me emphasize that not only do I want continuous, thorough monitoring of this facility with regard to possible air and water pollutants and toxic or hazardous wastes and not only do I want this information made available to the proper local authorities for audit on at least a monthly basis; I want the very best controls available built into the plant; the very best technology available at work protecting myself, my family, friends and neighbors.

After all, along with racerunner, rabbit and kite, we have to live here.

Sincerely,

A handwritten signature in cursive script, reading "Carol B. Fitzgerald". The signature is written in dark ink and is positioned above the typed name.

(Mrs.) Carol B. Fitzgerald



DEPARTMENT OF THE ARMY  
MEMPHIS DISTRICT, CORPS OF ENGINEERS  
668 CLIFFORD DAVIS FEDERAL BUILDING  
MEMPHIS, TENNESSEE 38103

Reply to  
Attention of:

LMMOD-GP

8 December 1980

Dr. Robert W. Laza  
Department of Energy  
Project Management Division  
MLGW Public Hearing  
9800 South Cass Avenue  
Argonne, Illinois 60439

Dear Dr. Laza:

Reference is made to the Draft Environmental Impact Statement for the Memphis Light, Gas and Water Division's proposed industrial fuel gas demonstration project at Memphis, Shelby County, Tennessee. After review of the referenced document, the following comments are offered subsequent to the Public Hearing for inclusion within the official record:

1. As a whole, the Memphis District Corps of Engineers supports the project for the important potential benefits which may be provided nationally, as well as locally, on the economy.

2. Environmental issues which should be clarified relative to site selection and wetland values in the Final Environmental Impact Statement should address the following:

COE-1 a. Summary, Section 8.2, entitled Sites, page XI. Supporting data does not appear to document the statement that selection of the alternative sites would not appreciably result in lower environmental impacts. Documented environmental consequences at the proposed site include 1) greater hydrologic impacts, 2) greater terrestrial ecology impacts, 3) greater potential for future floodplain development, and 4) greater wetland impacts pending barge facility location than the alternative sites.

COE-2 b. Section 3.1.7.1., entitled Vegetation, page 3-23. Wetlands on the site proper were apparently classified as low to moderate due to low food availability for wildlife. Other important wetland values such as flood water storage, overbank fish spawning and feeding areas, sedimentation and silt entrainment of pollutants during overbank flooding, and groundwater recharge were apparently not considered within the classification system. Also, the utilization of the site as a dredged material disposal area by the Corps does not necessarily preclude the continuation

LMMOD-GP  
Dr. Robert W. Laza

8 December 1980

of such values. Annual deposition of dredged material may affect seedlings and understory to some extent, but re-establishment may soon occur in support of wildlife populations.

The opportunity to provide comments for consideration in the Final Environmental Impact Statement is appreciated.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Will H. Reno', is positioned above the printed name.

WILLIAM H. RENO  
Colonel, Corps of Engineers  
District Engineer



## United States Department of the Interior

OFFICE OF THE SECRETARY  
WASHINGTON, D.C. 20240

ER 80/1332

DEC 16 1980

Dr. Robert Laza  
Department of Energy  
Chicago Operations and  
Regional Office  
9800 South Cass Avenue  
Argonne, Illinois 60439

Dear Dr. Laza:

Thank you for your letter of November 6, 1980, transmitting copies of the draft environmental impact statement for the Industrial Fuel Gas Demonstration Project, Memphis, Shelby County, Tennessee. Our comments are presented according to the format of the statement or by subject.

### DOI-1 Description of the Proposed Site

The proposed Federal support for filling a floodway site outside the Mississippi River levees is likely to affect other decisions on floodway land use in the area. However, we found no discussion of these indirect effects. Since it is the cumulative effects of floodway encroachment that lead to rising flood damages, the indirect effects of Federal support for floodway development should be carefully considered.

### DOI-2 Environmental Consequences, Proposed and Alternate Sites

Site selection is the single most critical item of concern in the assessment of environmental effects about the proposed project. We believe the site may have been selected prior to institution of the scoping process because this project has been under consideration since 1976. Further consultation should be initiated with interested Federal and State agencies to re-evaluate the various alternative sites. The Final Environmental Impact Statement should reflect this additional evaluation.

- DOI-3** The environmental consequences of locating the project at the Pidgeon alternative site appear to be substantially less than those that would occur at the proposed Allen site. The Pidgeon site, although located in the Mississippi River floodplain, is protected from flooding by a levee; thus, construction in this area would not increase flood levels in other areas of the floodplain by excluding flood waters from traditional overflow

lands. Construction at the Allen site would utilize 134 acres of flood storage area. In addition, approximately one-half as much fill material would be required to raise the elevation of the Pidgeon site to the level necessary to avoid under-levee water seepage problems, as would be required to raise the Allen site above the designated flood level. The environmental damages caused by dredging to obtain fill material from the Mississippi River would likewise be reduced. No terrestrial or wetland habitat would be destroyed by project construction on the Pidgeon site, as opposed to 134 acres destroyed by construction on the Allen site. The use of an over-the-levee unloading facility for barges would substantially reduce the adverse impacts of barge facility construction on the wetlands lying between the Pidgeon Industrial Park levee and the Mississippi River. The statement describes the Pidgeon site as unacceptable due to the high environmental impacts which would be experienced by high quality wetlands due to construction of a barge terminal, Section 4.5.4.1, Alternative Sites. After reviewing the statement and studying other available data, our Fish and Wildlife Service believes that the Pidgeon site was inadequately studied as an alternative prior to site selection, and that the environmental impacts may be substantially less severe at this site than at the Allen site. The two sites appear to compare favorably as regards other considerations of site selection. The Pidgeon site should be studied further prior to publication of the final statement in order to better determine at which site plant construction would entail the least environmental degradation.

DOI-4 Monitoring Plan and Mitigative Measures

In a letter to you dated December 28, 1979, the U.S. Fish and Wildlife Service recommended that the project include complete compensation for the adverse impacts to fish and wildlife expected to accrue as a result of the project. Compensation was discussed with Energy Impact Associates, who conducted the environmental assessment for the project, during evaluation of the Allen site. The protection and enhancement of a nearby wetland area which might otherwise be lost to agricultural or industrial degradation was considered to be an acceptable form of mitigation for the adverse impacts of project construction. However, this recommendation was not included in the draft statement. This concept should be fully explored in the final statement.

We hope these comments will be helpful to you in the preparation of a final statement.

Sincerely,  
  
Special Assistant to  
~~Assistant~~ SECRETARY

CIVIC RESEARCH CENTER / 116-A S. FRONT  
ST. / MEMPHIS, TN. 38103 / (901) 522-9931 :::

December 3, 1980

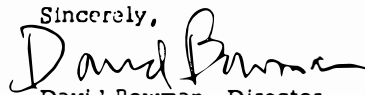
Robert W. Laza, Project Manager  
MLGW Coal Gasification Plant  
U.S. Department of Energy

Dear Mr. Laza:

Attached are comments from Dr. Robert Ginsburg, Ph.D., the staff chemist and toxicologist for the Citizens for a Better Environment, Inc., Chicago, Illinois. The Civic Research Center concurs with his comments on the draft EIS.

We are a Memphis-based not-for-profit corporation dedicated to raising public policy issues when we feel they are not adequately represented by other units of government, civic groups, or other organizations.

Sincerely,

A handwritten signature in cursive script that reads "David Bowman".

David Bowman, Director  
Civic Research Center

**a CBE COMMENT**

Citizens for a Better Environment (CBE) is a not-for-profit organization involved in environmental research, advocacy and litigation over national, regional and/or local pollution and health problems. On behalf of CBE I would like to comment on The Draft Environmental Impact Statement (EIS) which the Department of Energy (DOE) has prepared for the proposed experimental coal gasification plant in Memphis. In that regard I would like to discuss DOE's general attitude toward potential health and environmental problems from such plants and then address some specific points from the Draft EIS.

Before going further I would like to emphasize that CBE does not have a principled position against the development of all types of coal gasification. We do have severe reservations based on both health and economic considerations about any type of coal liquefaction or any large scale gasification project. Nevertheless, we do think there is great merit in the idea of small-scale, decentralized production of an environmentally clean fuel (such as is intended in the Memphis experimental project) especially when such a fuel would only be used by facilities close to the generating plant.

**CRC-1** However it is our scientific and legal opinion that no evidence has yet been produced which clearly shows that any gasification or liquefaction process can operate without significantly affecting the health of the surrounding community or without producing serious environmental pollution. In fact there is strong evidence to support such concerns. It



~~DOE COMMENT~~

is unfortunate that no proposed or existing gasification project in the United States except possibly the TVA project in Muscle Shoals, Alabama, has seriously attempted to gather or plans to gather the necessary information to confirm or disprove such contentions. We can only assume either the DOE is not overly concerned about the potential health effects or does not think it needs to describe how it will prevent those health effects. Such an attitude makes the construction of the Memphis plant and all future plants a foregone conclusion, in essence a "bureaucratic fait accompli" and also converts them from experimental gasification plants into long-term experiments in human health hazards.

CRC-2 The Draft EIS perpetuates an attitude that minimizes potential health problems. Such an attitude is contrary to the interests of public health and disregards the limited facts which are available today. For example the U.S. EPA conducted a detailed environmental analysis of a medium BTU coal gasification plant in Kosovn, Yugoslavia which showed that the plant produced and emitted very high levels of particulates and organic materials including carcinogens such as benzene and possibly benzo(a)pyrene. Furthermore these materials were detected more than a mile downwind from that plant. There are heavily populated areas within several miles of the proposed Memphis plant. Even though the Yugoslavian plant used a different process than proposed in this project and lacked many of the environmental controls that would be present in American facilities, the EPA study clearly shows the potential for the

~~ACBE CONFIDENTIAL~~

emission of very hazardous materials and therefore the existence of what could become a major public health hazard.

**CRC-3** The Draft EIS also contains information that contradicts DOE's attitude. In particular the Draft EIS admits that gasification processes will produce significant fugitive emissions and will emit carcinogenic air and water pollutants (p. 1-42). Perhaps most disturbing was the section discussing "Unavoidable Adverse Impacts" (section 1.4.9, p. 1-51) which concluded that the air quality (1.4.9.1) and water quality (1.4.9.2) around the plant would deteriorate. Furthermore the Draft EIS allowed that adverse human health effects could result from exposure to the "unavoidably emitted" polycyclic aromatic hydrocarbons (PAHs) present in the plant emissions. We are shocked that DOE would consider such health effects and such emissions "unavoidable." If such emissions are "unavoidable" (and according to the Draft EIS unquantifiable) then DOE is negligent in its failure to evaluate the potential risks posed by these emissions and by not specifying, in detail, what will be done to monitor and evaluate those emissions. Unfortunately, the public cannot adequately evaluate the risks from the project or the entire project without such information.

**CRC-4** In the past we have waited 20 or 30 or more years before seeing and proving the risks from certain industries and certain types of technologies. For example, a recent study has shown that people living near coke ovens may have higher rates of cancer than people living further away (see attached paper.). It has long been known that coke oven workers suffer

## aCBEComment

increased rates of cancer because of their exposure to coke oven emissions. Coal gasification plants probably will produce emissions similar to those from coke ovens. We fear that DOE wants to wait 20 or 30 years before beginning to collect the information necessary to show the presence of adverse health effects and may never take strong measures to prevent those effects. We hope that the government and our society can learn from past mistakes. We urge DOE to seriously examine this and other projects to determine (1) what pollutants will be emitted and (2) publicly describe - before construction begins - the proposed air and water monitoring in and around the plant and medical monitoring of the surrounding communities. Since this project is truly an experiment, it is only proper that enough data be collected to properly evaluate the experiment. It is the very least that can be done for the residents near the plant and the workers inside the plant who will bear all the risks. Their fear that they will pay for this plant with their lives as well as their pocket books is not unfounded.

In addition to our concerns over the lack of details and plans for monitoring plant emissions, we have some questions regarding several specific areas of the Draft EIS. It should be added that this is not an exhaustive list but one which covers our areas of expertise. Other areas such as occupational, siting and economic problems will be addressed by other commenters.

In the interests of time and simplicity we will list the specific problems and follow them with a brief explanation.

## **2. CBE COMMENT**

**CRC-5 1. Fugitive Emissions:** The Draft EIS has very little to say about the extent of this problem or how they will control these emissions. Fugitive emissions are a significant source of particulates, Volatile Organic Compounds (VOC's) and other hazardous air pollutants at both coke ovens and refineries. It should also be anticipated as a problem at coal gasification facilities. At coke ovens, ash and slag removal constitutes a significant source of particulates and, to a lesser extent, organic air pollutants. These could pose a health risk to both the plant workers and the surrounding community. No mention of such problems occurs in the Draft EIS.

Leaks from joints, welds, seals etc. make a large contribution to the emission of particulates and VOC's from refineries. Coal gasification plants will also have large numbers of joints, welds, seals etc. which could leak.

Finally, the Kosovo coal gasification plant study showed that leaks and venting emissions from the coal lock hoppers and injection ports were a source of carcinogenic PAHs as well as particulates. Lid leaks have long been known to be a significant source of carcinogenic air emissions from coke ovens.

The failure of the Draft EIS to address these and related problems for a gasification plant is a serious omission and should be corrected.

~~ACBE COMMENT~~

**CRC-6 2. The Use of Flares:** The Draft EIS places some emphasis on the use of flares to control hydrocarbon emissions and to vent process materials in case of plant upset (i.e., if something goes wrong in the plant). We are very concerned that flares will be a major (if irregular) source of particulates and will increase emissions of PAHs due to incomplete combustion of organic materials. The Draft EIS does not address this problem.

We do not consider flares to be an example of best available pollution control technology for these plants. In our experience it is difficult to monitor and regulate the emissions from flares. Other techniques and control methods would provide much better protection of the public health and minimize emissions of particulates and PAHs.

**CRC-7 3. Condensate from the Scrubbed Raw Gas (p. B-11):** The Draft EIS emphasizes that no tars or oils will be produced by this gasification process. However this condensate could contain some of the hazardous materials that would have been present in tars and oils. The Draft EIS makes no mention of plans to analyze this and similar process stream.

**CRC-8 4. Credit Generation (Methanation):** The Draft EIS makes no mention of the details involved in this process. There are no plans to analyze the product to check for impurities. This product, which may contain hazardous materials, will be put in the general gas pipelines thereby potentially exposing many Memphis residents to hazardous impurities. There is also no mention of any waste streams from this process. How can the project be properly evaluated if a significant portion of the project is omitted from the public review?

~~at CBE Confidential~~

**CRC-9** 5. PAH Levels in the Wastewater (p. 2-7; Appendix B.O.1): The Draft EIS admits that low levels of PAHs will be contained in the plant effluent but then goes on to "assure" the public that they will not pose a hazard. We strongly disagree with the assumption that there is a safe level of exposure to carcinogenic PAHs. Any level of exposure carries a significant long-term health risk. Many scientists would maintain that low-levels of PAHs in the drinking water would be a chronic health hazard. DOE's dismissal of the cumulative loading effect of PAHs and other organic materials on the ground and drinking water in Memphis is another example of their inadequate treatment of potential public health hazards.

**CRC-10** 6. Air Impacts (p. 2-13): The Draft EIS implies that the emissions from the plant will not "significantly deteriorate" the surrounding air quality. In support of this position total air emissions are listed (though PAHs are not included). Unfortunately there is no information given as to how those emission figures were calculated. No pilot plant data or loading factors are included in the Draft EIS. Furthermore there is little mention of VOC's in this section, which is surprising given the processes involved. Without this information the public cannot evaluate the claims in the Draft EIS that there will be no problems. They remain only unsupported claims.

The validity or contradiction of such claims will play a major role in evaluating the entire project.

-8-

**ACBECOMMENT**

In conclusion we believe that the Draft EIS as it presently stands, is inadequate. It fails to provide a reasonable basis for evaluating the Memphis gasification project. We propose that the Draft EIS be revised and another public hearing be held to assess the project. Such a revision should include, at a minimum:

1. The potential for the emission of hazardous, especially carcinogenic, air and water pollutants, such as polycyclic aromatic hydrocarbons.
2. A detailed description of a monitoring program for these hazardous pollutants that will be coordinated with a medical/epidemiological program for the surrounding population. We suggest that plans devised by the TVA for its gasification plant at Muscle Shoals, AL be viewed as a beginning model.
3. A more detailed description of the plant (and pilot plant that preceded it), so that the planned pollution control features can be more fully assessed.

Finally, NEPA requires the agency to fully describe or analyze the impact on the human environment which will result from approval and operation of the plant. As noted in the numerous deficiencies discussed above, the Draft EIS fails to describe or analyze the probable impacts on human health which can reasonably be anticipated as a result of human exposure to the kinds of pollutants that will or may be emitted during operation of the facility. This failure renders the Draft EIS deficient as a matter of law and requires further supplementation with additional data. Failure to supplement the Draft EIS prior to approval will likely invite a successful judicial challenge to the adequacy of the Final EIS.



## NATIONAL WILDLIFE FEDERATION

1412 Sixteenth Street, N.W., Washington, D.C. 20036 202-797-6800

December 24, 1980

Dr. Robert Laza  
U.S. Department of Energy  
Chicago Operations and Regional Office  
9700 South Cass Avenue  
Argonne, Illinois 60439

Re: Comments on Draft Environmental  
Impact Statement for Memphis  
Industrial Fuel Gas Project  
DOE/EIS-0071-D

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Dear Dr. Laza:

In accord with my letter of December 15, 1980, and our telephone conversation of this week, the National Wildlife Federation submits the enclosed comments on the Department of Energy's Draft Environmental Impact Statement for the Memphis Light, Gas and Water Division Industrial Fuel Gas Demonstration Project (DOE/EIS-0071-D).

The National Wildlife Federation is the world's largest non-governmental conservation organization. Founded in 1936, the Federation presently has over 4.6 million members and supporters as well as affiliate organizations in each of the 50 states, Guam, Puerto Rico, and the Virgin Islands. These comments are part of the Federation's ongoing project aimed at mitigating the environmental impacts of synthetic fuels development.

We appreciate your consideration of these comments.

Sincerely,



Norman L. Dean, Jr.  
Counsel

NLD/ceh





# NATIONAL WILDLIFE FEDERATION

1412 Sixteenth Street, N.W., Washington, D.C. 20036 202-797-6800

## COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

### FOR THE MEMPHIS INDUSTRIAL FUEL GAS PROJECT

DOE/EIS-0071-D

The National Wildlife Federation (NWF) joins in those comments submitted on the draft EIS by the Natural Resources Defense Council (NRDC) on December 3, 1980, and December 15, 1980. In these brief comments we offer a few additional criticisms and emphasize several points raised by NRDC.

#### NWF-1 A. Discussion of the Flare System is Inadequate

The DEIS contemplates that leaks of hydrocarbons and apparently other chemicals will be collected and disposed of through the use of a flare. See DEIS, p. 2-10. However, no data on flare operation characteristics exists in the DEIS to support the contention that hydrocarbon emissions will be fully consumed. In addition, the DEIS states that "large quantities" of hydrocarbons would be emitted should the flare fail. Id., p. vii. The probability of flare failure is not discussed nor is the time for flare repair addressed. In fact, there is no mention of a monitor system to detect flare failure. The importance of these issues is underlined by the fact that the hydrocarbon emissions from the plant will consist of compounds such as benz(a)anthracene, benzo(a)pyrene, 9H-carbazole, and 7H-dibenzo[c,g] carbazole.

-2-

All of these compounds have been found to cause cancer in experimental animals and the probability is high that they also do so in man (1).

NWF-2      B. The DEIS Fails to Discuss Possible Cancer Causing Synergisms

There exists evidence, which should be discussed by the DEIS, that there may be cancer promoting synergisms between the SO<sub>2</sub> and polynuclear aromatic hydrocarbons (PAH) that will be emitted by the proposed plant. Experimental evidence indicates that sulfur dioxide is a promoter of carcinogenesis (2) and that the polynuclear aromatic hydrocarbons have a marked tendency to adsorb to particulate material such as soot and dust. When respirable particles of these types are inhaled, the adsorbed carcinogenic materials are introduced into the lung tissue where elution from particles into the organism's circulatory system is probable (2,3). Since the distribution of SO<sub>2</sub> and PAH emissions is likely to be widespread according to the DEIS their control merits special effort.

NWF-3      C. The DEIS's Discussion of Possible Contamination of Cooling Water Is Incomplete

The plant's cooling tower represents a potential dangerous source of environmental contamination. The DEIS concedes that the heat exchangers in the plant may fail, allowing gases to enter the cooling tower water and that, in such event, "contaminants would be released from the cooling tower until repair of system." DEIS, p. 2-13. Given this possibility, the DEIS should

-3-

have addressed a number of important questions. What monitoring system will be employed to alert plant operators of a heat exchanger failure? If this is to be done by chemical analysis, a schedule for samplings should be provided so that an estimate of a worst case emission can be calculated. In the event of cooling tower water contamination, for how long will emissions be released? What substances would be released, and in what quantity? Would the plant be shut down in the event of heat exchanger failure? What systems are being employed to minimize the probability of cooling water contamination?

NWF-4     D. The DEIS Should Include Additional Discussion of Acid Rain Impacts

The DEIS concludes that the project will contribute only insignificantly to acid-rain. DEIS, p. 4-5. This conclusion, however, is unsupported by any data presented in the DEIS. To the extent the conclusion implies that the plant's contribution to acid rain is relatively small and should be ignored, the conclusion is highly misleading. Generally speaking, the contribution of any given source to the acid rain problem is relatively small and, consequently, control of the problem involves the control of numerous small, diverse sources.

Given the growing recognition that acid rain produces significant long-term ecological damage, some attempt should be made to quantify the acid rain impacts of this plant. In addition, an acid rain monitor should be installed in the area of plant emissions and ecological studies of the regions likely to be affected should be undertaken.

-4-

NWF-5 E. The DEIS's Discussion of Wastewater Treatment is Inadequate

The DEIS concludes that the plant wastewater treatment is adequate yet notes that effluent concentrations from the plant for several potentially dangerous pollutants will exceed effluent limitations permitted at industrial wastewater plants. DEIS, p. 4-13. The DEIS then attempts to reconcile this contradiction with the assurance that "if it can be demonstrated that treatment by practical conventional unit treatment processes cannot meet the effluent limitations, other reasonable concentration limits can be established." Id. p. 4-12. The DEIS fails to explain how discharge of effluents in quantities above government standards can possibly be reasonable especially given the toxicity of the substances involved and their tendency to bioaccumulate.

Special attention should be given in the DEIS to the discharge of PAH from the plant. Release of these materials into a turbid water system increases their longevity. Under clear water conditions these carcinogens would be quickly degraded. However, there is a strong tendency for these materials to adsorb to particulate matter. Under conditions of adsorption no significant compound degradation occurs and one is faced with a slow-release array of carcinogens in the sediments (1). Not only can this condition prove hazardous to the aquatic ecology, but some of this material could conceivably contaminate drinking water. Although it is acknowledged that effluent chemistry is not well-defined

-5-

and that effluent bioassay data are lacking, appropriate studies of effluent chemistry and its biological implications should be made in advance of the MLGW installation to establish a safe modus operandi with respect to these chemicals.

NWF-6      F.    The DEIS Fails to Discuss the Discharge of Radioactive Materials

The DEIS should have contained a discussion of the potential hazards from discharge of the radioactive components that are found in coal. Fly ash, bottom ash, and scrubber sludge all contain radioactive elements. Although the amounts of radioactivity are quite small, radionuclide releases from ash disposal sites have never been evaluated, and, depending upon ash leachate rates and the longevity of storage liners, these elements could become a significant human health consideration (4). The shallow ground-water sources near the Memphis plant may be especially susceptible to radioactive contamination.

NWF-7      G.    It is Unclear Whether DOE Consulted With the Fish and Wildlife Service Pursuant to the Fish and Wildlife Coordination Act

Although DOE consulted with the Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act (DEIS, p. B-39) there is no evidence in the DEIS that the Department engaged in the broader consultation required by the Fish and Wildlife Coordination Act. Such consultation is critical given the admission by the DEIS that there will be significant impacts on wildlife. DEIS, p. 4-20 to 4-21. Such consultation will assist DOE in developing alternatives for mitigating the impacts on wildlife and wildlife habitat. As it now stands, the DEIS contains no

-6-

discussion of alternatives for mitigating the significant impacts of the project on wildlife. The final EIS should contain a detailed discussion of such alternatives.

CONCLUSION

The draft EIS represents a good first step toward an adequate assessment of the proposed project. Considerable additional work, however, is required in those areas outlined above and in NRDC's earlier comments.

Respectfully submitted,

*Jorge Manring, Ph.D.*  
Jorge Manring, Ph.D.

*Norman L. Dean, Jr.*  
Norman L. Dean, Jr.  
Counsel

December 24, 1980

-7-

REFERENCES

1. Environmental Pathways of Selected Chemicals in Freshwater Systems: Part II, EPA -600/7-78-074.
2. Cited in Hans L. Falk and William Jurgelski, Jr., Health Effects of Coal Mining and Combustion: Carcinogens and Co-factors, Environmental Health Perspectives 33:203-226 (1979).
3. Kotin, P., and Falk, H.L., Atmospheric Factors in Pathogenesis of Lung Cancer. In: Advances in Cancer Research, A. Haddow and S. Weinhouse, Eds., Academic Press, N.Y., 1963, Vol. 7, pp. 475-513.
4. Van Hook, R.I., Potential Health and Environmental Effects of Trace Elements and Radio Nuclides from Increased Coal Utilization. Environmental Health Perspectives 33:227-247 (1979).
5. Bureau of National Affairs, "Tennessee Effluent Limitations and Standards," Environmental Reporter 916:1001-1002, Washington, D.C., April 28, 1978.
6. Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons, EPA 440/5-80-069, October 1980.



DEPARTMENT OF HEALTH &amp; HUMAN SERVICES

Public Health Service

Centers for Disease Control  
 Atlanta, Georgia 30333  
 (404) 262-6649  
 December 10, 1980

Mr. Robert W. Laza  
 Department of Energy  
 Project Management Division  
 9800 South Cass Avenue  
 Argonne, Illinois 60439

Dear Mr. Laza:

We have reviewed the Draft Environmental Impact Statement (EIS) for Memphis Light, Gas, and Water (MLGW) Industrial Fuel Gas Demonstration Project, Memphis, Shelby County, Tennessee. We are responding on behalf of the U.S. Public Health Service.

It appears the preparers of this document gave broad coverage to literature searches and a commitment for the proposed plant to function under the best available technology.

DHMS-1 Since little baseline exposure data exists on plants of this type, we have concerns about the occupational exposure of the workers and people who live near facilities of this type, especially those who would be in the heaviest drift areas. The facility will be located in a heavily populated industrialized area and, therefore, the potential for fugitive emissions and drifts will be greater on people. We recommend that a precise monitoring program be conducted once the plant is in operation to determine the extent of impacts the surrounding areas are receiving.

DHMS-2 We were impressed with the MLGW Division's commitment for a thorough industrial hygiene program. On page 2-18 it is stated that MLGW has prepared and submitted to DOE several documents that emphasize MLGW's commitment to a safe plant. We hope these documents were developed with the National Institute for Occupational Safety and Health's (NIOSH) input and recommended procedures for plants of this type.

On page 2-19 it is stated that a preliminary and final safety analysis report will be prepared by the MLGW which will identify and evaluate both health and safety hazards with this facility. We would be interested in reviewing this analysis for the occupational health perspective when it is completed.

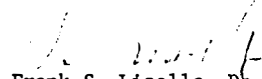
We will not address the possible runoff problems associated with the facility nor the point source discharge but will leave them to the cognizance of the Tennessee Department of Public Health and the Environmental Protection Agency since they require an NPDES permit.



Page 2 - Mr. Robert W. Laza

Thank you for the opportunity of reviewing this Draft EIS. We would appreciate receiving a copy of the final document when it is issued.

Sincerely yours,



Frank S. Lisella, Ph.D.  
Chief, Environmental Affairs Group  
Environmental Health Services Division  
Bureau of State Services

### A.3 RESPONSES TO COMMENTS

#### LIST OF COMMENTERS

U.S. Environmental Protection Agency  
Natural Resources Defense Council  
Memphis Audubon Society  
Memphis City Beautiful Commission  
Carol B. Fitzgerald  
U.S. Army Corps of Engineers  
U.S. Department of the Interior  
Civic Research Center  
National Wildlife Federation  
Department of Health and Human Services



## Appendix A.3

## RESPONSES TO COMMENTS

Response to EPA Comment No. 1

The DOE recognizes the potential conflicts with Executive Orders which might arise as a result of building a facility in a floodplain or wetlands. In response to this, DOE has investigated the practicability of locating the proposed facility outside the floodplain. A report documenting this investigation entitled "Identification and Evaluation of Alternatives to the Location of a Proposed Federal Action in the Floodplain" has been published; and, based on this report, a Preliminary Statement of Findings concluding that there is no practicable alternative to locating in the floodplains or wetlands has been published in the *Federal Register*. This report and the Preliminary Statement of Findings are reproduced in Appendix C.8 of the FEIS.

Response to EPA Comment No. 2

A Memorandum of Agreement is being prepared documenting the aspects of cooperation between DOE and EPA, including participation by the public, regarding the monitoring program for this project.

Response to EPA Comment No. 3

The carbon monoxide 1-h standard in Tables 1.7, 3.1, and 4.4 was correct at the time of the issuance of the DEIS. The revision is still in proposed form. The FEIS considers the standard applicable at the time of issuance.

Response to EPA Comment No. 4

The change has been made in Table 3.1.

Response to EPA Comment No. 5

This point has been included in the discussion in Sect. 2.2.2.2.

Response to EPA Comment No. 6

A detailed response to this comment is contained in the Analysis of Ambient Air Quality During Non-Normal Operation of the IFGDP, PSD/PTC Permit Application; January 1981.

In general, an upset condition could result from a blockage or equipment malfunction which requires the combustion of off-specification product gas or waste gas in either the controlled combustor or the flare. The most environmentally significant upset is one requiring incineration of the Sulfur Recovery Unit feed gas for one-half hour followed by flaring of "raw" (nonprocessed) product gas. This upset, coupled with incineration of acid gas, constitutes the worst-case condition. Should the Sulfur Recovery Unit not be repaired within 30 min, each operating gasifier would immediately be reduced to 75% of normal operation, and the raw gas would be flared for up to 2 1/2 h. This worst-case condition results in SO<sub>2</sub> concentrations which, when added to the ambient air, are less than half of the 3-h National Ambient Air Quality Standard (NAAQS) of 1300 µg/m<sup>3</sup> and therefore will not result in any violation of air quality standards.

A much less environmentally significant upset condition is one which requires the immediate shut-down of the gasifiers. The significance of this condition is limited by the short time required to shut down all of the gasifiers. The estimated duration of SO<sub>2</sub> emissions in this case is 5 to 15 min. This release may occur at either the flare or the incinerator.

Response to EPA Comment No. 7

Fugitive coal dust emissions were not included in the significant impact determination, because they were deemed to be insignificant. Impacts of fugitive emissions are being developed as part of the PSD permitting activities. This will include modeling studies to quantify the conclusion of insignificant impact. If impacts are predicted to be significant, mitigation measures will be incorporated in the final design. A revised description of the barge facility and its pollution reduction methods is given in Sect. 2.2.1.12 of the FEIS.

Response to EPA Comment No. 8

Emissions listed in Sect. 4.1.1.1, p. 4-1, were calculated using the U.S. EPA's *Compilation of Air Pollutant Emission Factors*, 3d ed., August 1977. Emissions listed in Sect. 2.2.1.11, p. 2-13, of the DEIS were calculated using the previous edition of the same source (i.e., 2d edition, 1975). The 3rd edition data are now shown in Sect. 2.2.1.11.

Response to EPA Comment No. 9

The change has been made in Sect. 4.1.1.2.

Response to EPA Comment No. 10

Operational safeguards are provided to ensure that the dust control system operates within an acceptable temperature range. The dryer mill temperature is limited to prevent hydrocarbon emissions. This is accomplished by a temperature sensor tied to a recorder which monitors system temperature at all times. If the mill goes beyond maximum set point, the heater will go to low fire; and if the temperature continues to rise, the heater will automatically shut down. The gas set point temperature at the dryer mill discharge is 121°C (250°F), which is considerably below the volatilization temperature for coal. The coal is only heated to 82°C (180°F).

Likewise, the baghouse filter is provided with a temperature sensor tied to a control valve which regulates the hot gas bypass flow from the heater to the filter. With this feature, the spent gas from the mill to the baghouse can be maintained to a temperature above the gas dew point temperature at all times. The dew point temperature of the gas is approximately 74°C (165°F), and the temperature at the baghouse is maintained at 121°C (250°F). A discussion of the temperature controls has been added to the text in Sect. 2.2.1.7.

Response to EPA Comment No. 11

A critical process requirement for the Sulfur Removal Unit is the choice of a process selective enough for the type of acid gases to be fed to the Claus unit.

Processes such as Stretford, Sulfinol, MEA, etc., were ruled out because of their inadequate or unproven capability for COS removal. Thus, the choice of the Selexol process for the IFGDP is based on its being the system for selectively removing H<sub>2</sub>S and COS and the lowest utility requirement for the degree of total sulfur removal required.

The Claus sulfur recovery system is a proven design with demonstrated reliability in over 250 installations. One of the major causes of downtime reported on Claus units in oil refineries has been hydrocarbon poisoning (coking) of the reactor catalyst (from excessive carryover from an amine unit). It is anticipated that because of the nature of the upstream units in the IFGDP, the quality of gas being produced, and the lack of heavy-hydrocarbon contaminants, the reliability factor will be enhanced. Additionally, the split-flow design incorporated in the Claus plant is specifically directed at the treatment of the low-H<sub>2</sub>S acid gas present here.

The Parson's Beavon-Stretford tail-gas treating system has also demonstrated proved performance in worldwide installations. The only possible problem associated with this new use is the high CO<sub>2</sub> content of the absorber vent gas. This has been anticipated and corrected by the addition of a vent-gas heater to provide the necessary plume rise required for adequate H<sub>2</sub>S dispersion.

Text has been added in Sect. 2.3.2.1 concerning the choice of acid-gas removal process and in Sect. 2.2.1.9 covering the vent-gas heater.

Response to EPA Comment No. 12

The selected process scheme for the credit generation unit includes the proprietary Benfield hot aqueous potassium carbonate process to remove  $\text{CO}_2$  and residual  $\text{H}_2\text{S}$ . This process was selected because it requires less energy (per mole of acid gas removed) than other conventional chemical solvent processes such as MEA or DEA. A comparison between the Benfield process and the Selexol process, a physical solvent system, showed the Benfield unit to be more economical and effective. Regardless of the process selected, the off-gas from this process (a  $\text{CO}_2$  stream containing small amounts of  $\text{H}_2\text{S}$ ) requires incineration. Also, the zinc oxide guard chambers are required as safeguards against possible sulfur breakthrough into the methanator regardless of the acid-gas removal process selected.

Text has been added in Sect. 2.3.2.1 concerning the choice of acid-gas removal processes. The zinc oxide guard has been explicitly called out in Sect. 2.2.1.

Response to EPA Comment No. 13

The DEIS contained a typographical error. The hydrogen sulfide concentration of treated tail-gas from the Stretford sulfur-recovery process has been revised to 10 ppm in FEIS Sect. 2.2.1.11.

Response to EPA Comment No. 14

Hydrogen cyanide (HCN) will be a component of the raw gasifier off-gas. Preliminary indications show HCN concentrations ranging from 0.3 to 60 ppm (by volume) in the raw gas. Because of the solubility of HCN in water, however, gas scrubbing will significantly reduce HCN concentrations. Finally, residual HCN will be substantially removed through physical absorption in the Selexol process. Thus, the product fuel gas is expected to contain only trace concentrations of HCN. The HCN scrubbed from the raw gas will eventually be sent to the sulfur recovery unit as a sour-water stripper gas where the HCN is destroyed in the Claus furnace.

In summary, although HCN is produced in the gasification process, it is expected that no HCN emissions will result — thus, Sect. 2.2.1.11 of the DEIS did not list HCN as a component of any of the gas streams contained in that section. Text of Sects. 2.2.1 and 2.2.1.9 has been revised.

Response to EPA Comment No. 15

EPA and Tennessee New Source Performance Standards for fossil-fuel-fired steam generating units with heat input of more than 250 million Btu per hour limit  $\text{NO}_x$  emissions to 0.70 lb per million Btu. To meet this limit, the boilers will incorporate two basic design features: two-stage combustion with off stoichiometric firing in the primary stage, and flue gas recirculation. Off stoichiometric firing reduces the amount of air introduced with the fuel into the primary combustion zone of the furnace to less than that theoretically required for complete combustion. This limits the conversion of fuel nitrogen to  $\text{NO}_x$  in the flame zone of the furnace. Flue gas recirculation mixes recirculated flue gas from the economizer section with the air supplied for combustion just before the air entering the windbox is distributed to individual burners. This feature produces lower flame temperatures and hence lower  $\text{NO}_x$  emissions. Boilers will be designed to limit emissions to no more than 0.63 lb per million Btu — well below the regulatory limit. Text of Sect. 2.2.1.11 has been modified to reflect this.

Response to EPA Comment No. 16

The DEIS was in error. The FEIS has been changed to read: "Product fuel gas is normally burned at the rate of 0.268 kg/s (2125 lb/h) (Table 2.2) to make the process self-sustaining."

Response to EPA Comment No. 17

As described in Sect. 2.2.1.5, the primary source of makeup cooling water is city water from the Davis Pumping Station. In an effort to conserve city water, 22 gpm of clean condensates from the utility and air separation areas will be used to supplement the city water makeup. Additionally, provisions have been made to recycle up to 110 gpm of treated process wastewaters of acceptable quality. These wastewaters consist of treated stormwater runoffs, which are low in organic components. Process wastewater will only be recycled to the cooling towers, if at all, after complete treatment for both inorganic and organic pollutants.

Thus, city water is the primary source of cooling tower makeup with treated wastewater effluent being used only up to 110 gpm, and only after complete treatment. Text in Sect. 2.1.1.5 has been revised accordingly.

#### Response to EPA Comment No. 18

Startup and shutdown operations are discussed in detail in the Permit Application, January 1981 — Analysis of Ambient Air Quality Impact During Non-Normal Operation of the IFGDP.

Emissions from startup operations are minimized through a phased startup sequence for each gasifier. The sequence includes a refractory heat-up period using natural gas and air, followed by low-sulfur (0.8%-S) coke heating and auto ignition. These steps entail combustion reactions on coke (with essentially no volatile material), followed by particulate removal at low temperatures [121°C (250°F)] prior to flaring. Gasification reactions do not occur until the gasifier temperature reaches 1024°C (1875°F) — well above the temperature at which organometallics and PAH formation pose serious emission hazards. Gasification with coal does not begin until the gasifier is operating at a temperature and pressure sufficient for operation of the downstream sulfur-removal equipment. Text in Sect. 2.2.1.11 has been augmented accordingly.

#### Response to EPA Comment No. 19

A continuous in-plant air monitoring program and a quarterly inspection program is planned during plant operation. This program will consist of the inspecting and subsequent maintenance of valves, pump seals, and compressor seals for leakage of H<sub>2</sub>S and CO. Leakage of fugitive organics may not be monitored based on the fact that nonmethane hydrocarbons (volatile organic compounds) represent less than 1% of the total organics in the raw gasifier product gas. A conceptual process monitoring program is given in Sect. 4.5.1 of the FEIS.

#### Response to EPA Comment No. 20

The decommissioning and replacement of catalysts will not result in any emission increase — including SO<sub>2</sub>. The Claus unit catalyst (aluminum oxide) and the Beavon unit catalyst (cobalt/molybdenum) should not require replacement more than once every five years. The decommissioning of these catalysts consists of a nitrogen purge to remove any H<sub>2</sub>S present on the catalysts. This purging does not result in combustion of sulfur with a resulting increase in SO<sub>2</sub> emissions. Additionally, the purged gas stream is incinerated at a temperature of not less than 815°C (1500°F). As specified in Sect. 2.2.1.8, spent Claus unit catalyst will be landfilled on site, and spent Beavon unit catalyst will be reclaimed by the catalyst vendor. Replacement of the methanation (nickel oxide), shift reactor (iron-chromium oxide), and guard chamber (zinc oxide) catalysts should not occur more than once every three years. Purging is also accomplished with nitrogen, although the purging of these catalysts is only designed to remove any vapors from the reactors prior to replacement of the catalyst. This purged gas stream will be flared. Shift and guard chamber catalysts will be landfilled on site, and methanation catalyst will be reclaimed by the catalyst vendor. Text of Sect. 2.2.1.11 (Temporary Operations) has been augmented accordingly.

#### Response to EPA Comment No. 21

This change has been made in text.

#### Response to EPA Comment No. 22

Onsite sludge disposal is planned only for those wastes that are not hazardous (as defined by the applicable EPA criteria). Thus, sludge from the chromate destruct system and from the process clarifiers will only be disposed of onsite if these wastes are found to be not hazardous. Appendix C.3.2 discusses the nature of chromate-destruct sludges and concludes that these wastes are not hazardous. The characteristics of the clarifier sludge are presently being evaluated as part of the overall wastewater characterization and treatability studies.

Should any solid waste meet the EPA criteria for a hazardous waste, the following storage and segregation procedures (see 45 FR 76076, November 17, 1980) will be implemented prior to offsite disposal in an approved disposal facility:

- a. All procedural requirements will be followed (i.e., applications, manifest requirements, notification, etc.).

- b. The facility will be adequately segregated.
- c. All storage tanks will be leakproof and will contain instrumentation required to ensure careful operation.
- d. An inspection plan will be implemented and carefully followed.

No specific offsite disposal areas have been identified; however a possible disposal site is identified in Sect. 2.2.1.8.

Response to EPA Comment No. 23

Leachates which accumulate in sumps adjacent to coal and waste storage areas will be either discharged directly or treated, depending on leachate quality (Sect. 2.2.1.8). The comment requests statement of the threshold concentrations, of possible leachate constituents, above which the leachate will be routed to the wastewater treatment system. A spot table in Sect. 2.2.1.8 provides parameters to be included in the monitoring program, monitoring frequency, and the threshold or "trigger" concentration, above which the leachate will be treated prior to discharge.

Response to EPA Comment No. 24

This RIM will not be available until June 1981; therefore, it cannot be included in the FEIS.

Response to EPA Comment No. 25

The chromate destruct system is an electrochemical process that operates on a continuous, once-through basis with no holdup or reaction time needed beyond that of the electrochemical cell itself. As designed, the system contains three separate electrochemical cells and electrodes, each complete with its own instrumentation, piping, and power supply. The total system is designed to produce an acceptable effluent even during backwashing of a cell (backwashing is accomplished in about 15 min, once each day). Thus, the design of the chromate destruct unit inherently contains a sizable degree of redundancy. In the unlikely event that the chromate destruct system becomes completely inoperative, the cooling tower could continue to function for periods of up to a few days without plant shutdown by allowing the cycles of concentration to build up to higher than design levels and by accepting the increased corrosion rate. Untreated blowdown will not be discharged from the plant. Should dissolved solids concentrations become excessive, portable tankage will be rented to store the blowdown. After repair of the chromate destruct system, stored blowdown will be gradually recycled back to the cooling cycle. Text in Sect. 2.2.1.2 has been augmented.

Response to EPA Comment No. 26

A premanufacture notice will be prepared.

Response to EPA Comment No. 27

No response required.

Response to EPA Comment No. 28

The composition of process wastewater streams entering the wastewater treatment facilities has been added to Sect. 2.2.1.2, based on existing characterization data.

A more comprehensive characterization and treatability study (currently in progress) may result in an adjustment of some of the parameters indicated; however, significant changes are not expected.

Response to EPA Comment No. 29

Such redundancy has been incorporated into the wastewater treatment system design described in Sect. 2.2.1.2 and Fig. 2.3 by providing ozone addition to promote biological assimilation of organics in addition to conventional adsorption of organics by activated carbon. Additionally, the carbon adsorption system consists of two trains of three adsorption columns. This will assure continued operation in the event of equipment malfunction.



Response to EPA Comment No. 30

As noted in Sect. 3.1.3.1, the sewer moratorium in force for the Maxson Wastewater Treatment Facility applies to new industrial wastewater. The Memphis and Shelby County Public Health Department has indicated that Maxson can accept wastewater from industries if their effluent has been pretreated so that concentrations of wastewater constituents are comparable with domestic waste limits. Sanitary sewage from the MLGW-IFG facility would not require pretreatment to meet this requirement.

Response to EPA Comment No. 31

Environmental impacts associated with construction and operation of the proposed facility at the proposed site and alternatives are compared in Sect. 2.3.2.2 of the FEIS. Details of the environmental analyses at each site are given in Sects. 4.1, 4.2, and 4.3 of the FEIS. The DOE has investigated the practicability of locating the proposed facility outside the floodplain, considering environmental, technical, and economic factors, and has made a preliminary finding that no practicable alternative to locating in a floodplain or wetland exists. Details of this investigation are provided in Appendix C.8 of the FEIS. Coal transportation to the Pidgeon site is discussed in Sect. 2.3.2.2.

Response to EPA Comment No. 32

Construction of a filled area as proposed will elevate the process area to 71.0 m (233 ft) above sea level. The estimated elevation of the 100-year flood is 68.55 m (224.9 ft), as is shown in Table 3.2 and Fig. 3.2 of the FEIS. The elevation of the project design flood used by the U.S. Army Corps of Engineers to design the flood control levees is 70.96 m (232.8 ft).

The project design flood is estimated to be less frequent than a once-in-500-year event. The grade elevation of the process areas will be higher than the 100-year flood and the project design flood.

Inspection of the topographic map of the area reveals that levee crest elevations are higher than 71.63 m (235 ft) adjacent to the Allen site on both the east and west banks of the river. Occurrence of a flood resulting in water levels between 70.96 m (233 ft) and 71.63 m (235 ft) would result in water covering some parts of the process area to a maximum depth of 0.61 m (2 ft) before river bank levees would be overtopped. The probability of such an event occurring is less than the probability of occurrence of the project design flood.

As is shown in Fig. 4.5 in the FEIS, the bottoms of the leachate collection sumps for coal and ash storage areas are at 68.58 m (225 ft). A flood magnitude greater than the 100-year flood would be required to cause hydraulic uplift beneath the liners. Once the storage areas are in use, hydraulic pressures would have to exceed the load pressures expected by overlying materials to affect the liner.

Response to EPA Comment No. 33

See response to comment EPA-31. On the issue of independent review, Foster-Wheeler, a subcontractor to MLGW, developed plans for the dredge/fill operation. The plans have been reviewed by DOE. The U.S. Army Corps of Engineers will also review these plans as part of the permitting procedure.

Response to EPA Comment No. 34

The wastewater streams listed in this comment (not given in Sect. 2.2.1.2 of the DEIS) will be handled as follows:

- Low-ash sluice water — as discussed in the response to comment EPA-43, fly ash will be handled dry (without water addition).
- Bottom ash sluice water — as discussed in the response to comment EPA-44, this stream will be recycled within the ash-handling system.
- Metal-cleaning wastes — all the streams listed under this heading will only be generated prior to initial startup of the boiler. A contractor will be responsible for the required chemical cleaning. The cleaning consists of running a chemical solution from the contractor's truck, through the boiler, and back to the truck for offsite treatment. Thus, no metal-cleaning wastes will be discharged to the wastewater treatment system.

- Low-volume wastes — laboratory wastes will be collected in a segregated chemical sewer, neutralized, and then drained to the oily water sewer system for treatment prior to discharge. Floor drains and equipment drains will discharge directly to the oily water sewer.
- FGD system blowdown — the FMC Double Alkali Scrubbing System produces no liquid blowdown stream. Water added to the system is clarified in a thickener and then recycled to the contractor-scrubber (along with the filtrate stream produced from dewatering the filter cake).

#### Response to EPA Comment No. 35

The cost of zero-effluent discharge was evaluated by Foster-Wheeler, a subcontractor to MLGW, in 1973. In today's dollars, the cost of an evaporation system would be equal to approximately \$5 million in capital costs and \$1.2 million in yearly operating costs. No cost estimates of alternative treatment systems were done, because the proposed scheme was based solely on its ability to produce an acceptable effluent.

A comprehensive wastewater characterization and treatability study, currently in progress, is expected to verify the capability of the wastewater treatment system to effectively treat the process wastewater system. Every effort has been made to duplicate the demonstration plant gasifiers, so that process wastewater (off-gas condensate) is truly representative. The treatability study also closely models the demonstration plant system; the one exception being the lack of biological activity in the treatability study because of a quantity of wastewater that is insufficient to allow microbial acclimatization. Because of the lack of biological activity, the pilot plant treatability study will actually serve to demonstrate the effectiveness of the demonstration plant design without the benefit of biological oxidation. Preliminary data indicate that organic removals, accomplished solely by carbon adsorption, are sufficient to meet previously predicted levels. This is in large measure due to the relatively low organic levels in the process wastewaters from the high-temperature U-gas process. The entire demonstration plant wastewater treatment system will be reevaluated prior to completion of the Engineering Report that will be submitted to support the NPDES permit application in mid-1981.

#### Response to EPA Comment No. 36

The process wastewater mixing basin shown in Fig. 2.3 is designed only to allow the complete dissolution of chemical coagulants in the wastewater stream. This is a typical flash mixing application with only a few minutes detention time.

Shock loadings are not expected because of the relative consistency, both in flow and in composition, of the process wastewater streams. Thus, no equalization facilities are included in the wastewater treatment system. In the unlikely event of significant variations, however, provisions in the Sour Water Stripping System design will allow equalization of up to 8 to 12 h of wastewater. This detention time will effectively equalize the vast majority of process wastewaters (i.e., 200 gpm of stripped sour water and another 200 gpm of clarifier overflow from gas cooling and scrubbing).

#### Response to EPA Comment No. 37

Recarbonation is accomplished with a vent gas stream from Tail-Gas Treating. This stream contains 48.1 mol %  $\text{CO}_2$  and is, therefore, an excellent and inexpensive source of  $\text{CO}_2$ .

Recarbonation converts the hydroxides and carbonates which are produced during lime addition, and during the resulting pH increase, to bicarbonates. Single-state recarbonation is the preferred method in this, and other "primary," applications. This type of recarbonation allows reduction of pH levels from about 10-11 to about 7 in a single step and, furthermore, results in no noticeable calcium carbonate precipitation.

A dual-media filter follows recarbonation. The purpose of this filter is to reduce suspended-solids loadings and thereby ozone consumption.

Sufficient ammonia is present in the wastewater to serve as a nutrient for biological activity. The only other nutrient required for biological activity is phosphorous. Thus, a small dose of phosphoric acid is metered into the system to meet this requirement. In the event that ozonation makes further ammonia necessary, the adjustment will be made.

Response to EPA Comment No. 38

See Response to EPA-47.

Response to EPA Comment No. 39

The "oxygenation" referred to in Sect. 2.2.1.2 is the addition of oxygen (with small quantities of residual ozone) to the wastewater stream just upstream of carbon adsorption. The source of this oxygen is the off-gas from the ozone/wastewater contacting chamber. Oxygen added at this point is expected to replenish the oxygen/ozone depleted through biological activity occurring in the post-ozonation pressure filters. This added oxygen will prevent the occurrence of possible anaerobic conditions in the carbon adsorbers and will thereby allow residual biological activity beyond that already occurring in the postozonation pressure filters.

Response to EPA Comment No. 40

Currently, the carbon adsorption columns are designed according to guidelines developed by the Cleveland Western Industrial Treatment Facility; this facility developed the basic design used in the demonstration plant. This is a conservative design providing low hydraulic loadings (1.0 to 2.5 gpm/ft<sup>2</sup>) and fairly long contact times (15 to 30 min). The carbon adsorption system will, however, be reevaluated after the treatability studies currently in progress are completed. These studies will either verify the current design or provide a definitive basis for a subsequent design. (See Response to Comment EPA-35).

Current plans call for the onsite reactivation of carbon in either a traditional multiple-hearth furnace regeneration system or a more recently developed fluid bed regeneration system (provided by Westvaco Corp.). The necessity and desirability of onsite regeneration depends to a large extent on the actual carbon exhaustion rate experienced in the demonstration plant. Again, the treatability studies will provide data to either substantiate or refute the past assumption. Should these studies show a low exhaustion rate, based on adsorption isotherms, offsite regeneration will be investigated. This type of service is offered by various activated-carbon vendors and consists of a contract hauling-regeneration-and resupply system.

Response to EPA Comment No. 41

Nitrogen as shown in Fig. 2.3 of the DEIS was originally specified because the demonstration plant design did not include a plant air system. This has now been changed because of concerns for workmen's safety. As a result, plant air will now be used in the dissolved air flotation system. Figure 2.3 has been revised accordingly.

Response to EPA Comment No. 42

Neutralization water from the utility area shown in Fig. 2.3 refers to the high TDS wastewater intermittently generated from the regeneration (and subsequent neutralization) of the demineralization system (i.e., the boiler feedwater preparation system).

Response to EPA Comment No. 43

The IFGDP will use a dry fly ash handling system so as not to preclude the possible commercial marketability of fly ash. The dry handling system (similar to many in use at utility power plants) consists of dust collectors, conveyors, surge bins, and fly ash blow pots which will transport dry fly ash to a large silo from where it can be trucked offsite. If no market for the fly ash develops, it will be mixed with spray water (recycled water from ash handling), and could be mixed with flue gas desulfurization sludge, before being trucked to the onsite ash pile for disposal. (See also response to comment No. EPA-34.) The sludge-fly ash mix would have better landfill properties than sludge alone.

Response to EPA Comment No. 44

Bottom ash slurry is sent to two dewatering bins in parallel. Ash from these bins will be trucked to an onsite landfill area for disposal. Overflow from the bins will be clarified and then held in a recycle water surge tank, from where it will be recycled to the bottom ash disposal system. The entire cycle requires a small amount of makeup water so that there is no water discharged (i.e., no blowdown). (See also response to comment No. EPA-34.)

Response to EPA Comment No. 45

Table 2.4 (now Table 2.5) has been modified. Should NSPS require the IFGDP to maintain a total residual chlorine concentration of not more than 0.14 ppm, this limit can be met with existing technology. Total residual chlorine analyzers are available which, through a logarithmic responding scale, are capable of very low readings. For example, Orion Research markets a total residual chlorine analyzer with a detection limit of less than 1 ppb, on which 0.14 ppm represents a reading of less than 50% of scale. This analyzer can be tied into the chlorine feeding system to automatically control residuals to the required limit. Additional reductions, although not quantified, can be expected to occur in the chromate destruct system.

Response to EPA Comment No. 46

The proposed chromate-zinc corrosion inhibiting system has a long and successful history in the water treatment industry. Although chromium and zinc blowdown streams are potentially hazardous, effective treatment of these blowdowns with an electrochemical destruct system is a proven reliable technology. These processes guarantee hexavalent chromium and zinc removals to 0.05 mg/liter, and additionally, leachates from chromate destruct system sludges average about 0.05 mg/liter and are therefore nonhazardous.

Nonchromate inhibitor systems, while generally available, have not proven to be satisfactory. One of the most widely used treatments has been the phosphate/phosphonate type. A major problem with all phosphate based treatments has been uncontrolled precipitation of calcium orthophosphate salts. This salt (tricalcium phosphate) is very insoluble and precipitates more rapidly as the temperature and pH are increased. This means that deposition is most severe on heat transfer surfaces and at active corrosion sites. The result is both increased fouling and increased corrosion.

Although a new deposit control agent has been reported which allows the use of high orthophosphate levels without fouling on heat transfer surfaces (Betz-Dianodic II), this cooling water treatment system was neither widely available nor sufficiently proven at the time the proposed chromate-zinc system was selected.

Should final regulations prohibit the use of chromate-zinc, the Betz system (and others similar to it) would be employed.

Response to EPA Comment No. 47

The "biox filters" are postozonation pressure filters. There are no inherently special features designed into these filters. Their function, however, is not only to remove suspended matter from the wastewater stream, but also to provide a large surface area on which biological assimilation of organic material may take place. Oxygen necessary for this activity is supplied in the form of ozone previously mixed with the wastewater in a contracting chamber. The ozone addition itself can provide some direct oxidation of organic material; the residual oxygen is then used to allow further organic removal in the "biox filter."

The symbiotic relationship between ozone addition and filtration and carbon adsorption is well documented in studies performed at the Cleveland Western Industrial Treatment Facility. It is this type of relationship which the "biox filter" is designed to foster. Although no actual kinetic constants have been developed for this system, or for this application, it is expected that organic removals well beyond those obtainable from a physical-chemical system (chemical clarification, filtration, and carbon adsorption) will result.

(See also Comment EPA-38.)

Response to EPA Comment No. 48

(See response to EPA Comment-23.) Runoff and leachate from the gasifier ash pile are collected in a sump for pumping to wastewater treatment. Sufficient plot area exists for the equalization of this flow prior to pumping, so that an average flow of only 20 gpm is expected. It is therefore quite possible to treat the ash pile runoff along with the process wastewater streams, should this become necessary. This additional flow can be easily incorporated into the process wastewater system design. In this manner, ash pile runoff could receive full physical-chemical treatment prior to discharge.

Ash pile runoff will be covered by the NPDES permit. Runoff will be treated prior to discharge if necessary as outlined in response to comment EPA-23.

The landfill will be designed to meet current RCRA requirements.

Response to EPA Comment No. 49

It is recognized that continued wastewater treatment of runoff from the process areas and the solid waste disposal area may be required as a result of facility decommissioning (DEIS Sect. 2.3.1.2). The Maxson Wastewater Treatment Facility has been contacted and it has been determined that this treatment facility could accept this from the MLGW plant.

Response to EPA Comment No. 50

Cooling ponds or spray canals could be used at a larger site. The use of these alternative cooling systems could reduce the thermal and chlorine impacts to a natural receiving water body as a result of greater surface heat transfer and residence time. However, these systems would not reduce the discharge TDS concentrations, since they would require a blowdown similar to that required for cooling towers.

Response to EPA Comment No. 51

The description of the proposed wastewater treatment system and the comparison of wastewater treatment alternatives was prepared by John S. Gordon. His credentials are given in the List of Preparers under Process Description.

Solid Wastes will be stored in segregated landfills prior to sale to preclude contamination. No plan currently exists to market mixed solid wastes.

Response to NRDC Comment No. 1

The DOE is meeting the requirements for programmatic environmental information for the synthetic fuels demonstration projects through several related actions.

The broadest, most comprehensive treatment of the programmatic aspects of synthetic fuels development is contained in the FEIS for the Alternative Fuels Demonstration Program (September 1977).

The Alternative Fuels Demonstration Program EIS presents a generic assessment of the potential environmental impacts associated with the commercialization of synthetic fuels processes. The processes included high- and low-Btu coal gasification, coal liquefaction (direct and indirect), oil shale, and solid waste conversion. Environmental impacts were assessed for various production levels from various combinations of these processes.

It addressed alternatives to the program that included

- direct utilization of coal,
- increased energy conservation,
- nuclear energy,
- geothermal energy,
- solar energy,
- wind energy,
- hydroelectric energy,
- tidal energy,
- tar sands,
- increased domestic oil and gas production,
- hydrogen economy, and
- energy from solid wastes.

These alternatives were assessed from the standpoints of technology status, potential energy contributions, and environmental impacts. In addition, an environmental trade-off analysis was conducted to assess those alternatives that were judged to be reasonable and to assess how those alternatives could meet the goals of the program. The alternatives assessed in this regard were (1) conservation, (2) increase oil and natural gas imports (the no-action alternative), (3) increase domestic oil and natural gas production, and (4) direct coal utilization.

The information contained in the Alternative Fuels EIS provides a basis upon which decisions can be made regarding synthetic fuel versus other energy options, various mixes of synthetic fuels, and total production goals for a mature synthetic fuels industry. In conjunction with

this, information in the Memphis EIS completes the programmatic treatment of all levels of analysis appropriate for coal gasification. The Memphis EIS places the DOE medium-Btu gasification program in perspective regarding information needs, program justification, and DOE's strategy for energy policy responses. This is done in a tiered fashion beginning with the evolution of national energy policy and the obligations of DOE under various Presidential pronouncements and congressional energy acts.

a. The programmatic materials at the beginning of the EIS serve three functions: to provide an assessment of the environmental consequences of commercialization of the U-gas process as a result of the DOE Low-/Medium-Btu Demonstration Plant Program, to focus on how the Memphis plant in particular and the medium-Btu coal gasification program in general fit into the program goals and objectives, and to focus on environmental impacts as discussed in The Alternative Fuels EIS. A commercialization scenario for medium-Btu gas based upon reasonable estimates of demand is provided in Sect. 1.4.3. This scenario places a series of plants throughout the country based upon regional demand and the availability of coal and water. Section 1.4.6 provides an environmental analysis of the impacts associated with commercialization, while Sect. 1.4.7 examines alternatives to and within the program. As noted in Sect. 1.4.7.1, the environmental consequences of these alternatives have been examined in the environmental development plans for underground coal gasification and for unconventional gas recovery. These materials along with the programmatic materials incorporated into the DEIS and the more comprehensive treatment in the Alternative Fuels EIS provide an effective mechanism for reviewing the program in relation to other elements of DOE's Program for Technology Development (Sect. 1.2.2). These materials, when used with the annually produced Fossil Energy Program Summary Document, referenced at the end of Sect. 1, provide a framework for making decisions concerning a particular project within the program. Decision points are also provided within individual projects. Such decision points concerning continued support of the MLGW project are discussed in Sect. 1.1.3 of the DEIS.

b. The merits and environmental impacts of the synthetic fuels program as a whole were presented in the Alternative Fuels EIS, along with a parallel analysis of reasonable alternatives. An analysis of the costs of the synthetic fuels program in comparison with the benefits was not judged to be appropriate because of the overriding qualitative considerations.

Reasonable alternatives to the Low-/Medium-Btu Demonstration Plant Program are discussed in Sect. 1.4.7 of the DEIS.

c. Energy technology research, development, and demonstration projects supported by the DOE are subject to critical review on continuing bases. In addition, a series of check points is built into the development schedule to provide positive control of the decision-making process. These check points include design and operator review, operational and monitoring plans, and project termination decisions. Use of check points during project design, development, and operation allows for project termination at any point where further commitment of funds or resources would not be warranted in terms of anticipated benefits. This approach further allows for allocating funds to a variety of promising but largely untried technologies, thereby limiting the possibility that development of one technology would preclude development of other alternative technologies.

Data derived from demonstration projects provide a basis for government and industry decision makers on whether or not a particular technology is feasible in economic and environmental terms. Decision points concerning the MLGW project are noted in Sect. 1.1.3, Project Review Procedures.

d. National energy policy as embodied in the Energy Security Act of 1980 and other legislation discussed in Sect. 1.2 of the FEIS calls for reducing oil imports through a combination of programs designed to foster energy conservation, increase utilization of domestic resources, and provide for early implementation of alternative energy technologies. Implementation of this policy through DOE's program for technology development calls for application of funds and resources to develop the broadest practical range of promising technologies. Given the limits of available funds, decisions concerning which technologies to support, when to support them, and to what degree, must be based upon the following criteria: potential for energy production or reduction in consumption, the current status of the technology, the resources required for further development, and the economic and environmental risks associated with commercial application.

The criteria for government involvement in synthetic fuel research, development, and demonstration programs with the private sector are listed in Sect. 1.2.1. In cost-sharing projects such as the MLGW project, the government assumes a portion of the risks, but not the entire risk. The benefits of such demonstration programs are that they accelerate development of alternative technologies while at the same time providing necessary information concerning controls necessary to reduce environmental problems associated with each technology. Environmental data from previous and ongoing demonstration programs are currently being used by EPA to prepare pollution control guidance documents for each of the synthetic fuel technologies now under development.

As noted in Sect. 1.1.1, the MLGW project was chosen for funding on the basis of competitive proposals submitted in response to RFP-E (49-18)-2043 entitled "Fuel Gas Program." The objectives of the program are noted in Sect. 1.1.1, and these include demonstrating the technical, environmental, and economic feasibility of medium-Btu gasification and securing a demonstration plant to advance the current state of the art in medium-Btu coal gasification technology. The primary purpose of the Memphis plant is to test the feasibility of medium-Btu gasification and to advance the state of the art in keeping with these objectives. Questions concerning the most appropriate use of area coal or the amount of displacement of oil, gas, or coal (direct use) are more appropriate for a commercial facility using a proven technology. Estimates of the potential national market by 1992 for medium-Btu gas are given in Sect. 1.3.1.

Existing gasification technologies are limited in their reliability, range of acceptable coals, and efficiency. Furthermore, existing gasification plants in this country and in other countries have not utilized a high degree of pollution control. DOE funding in its gasification demonstration programs is intended to develop gasifier technologies that are capable of accepting a wide variety of coal and to develop environmental controls that would allow gasification plants to meet Federal and State standards. These and other technical advancements are discussed in Sect. 1.3.3.1.

The 96th Congress provided major funding for the DOE's Alternative Fuels Production Program and the Synthetic Fuels Corporation, both of which are major elements of the National Synfuels Production Program. Under the Alternative Fuels Production Program, DOE is empowered to share the risks of synthetic fuel project development with the private sector through cost-sharing agreements, loan guarantees, price guarantees, purchase agreements to produce synfuels, and other mechanisms. These same powers extend to the Synthetic Fuels Corporation. Neither the Alternative Fuel Production Program nor the Synthetic Fuels Corporation existed before last year. All Federal support for the Memphis project has been provided from the DOE's (and, previously, ERDA's) Fossil Energy program, which is a separate program from the two enacted by the 96th Congress.

The commercialization scenario in Sect. 1 was derived to establish, among other things, that there are many areas of the country that could support medium-Btu coal gasification facilities based upon the availability of coal, water, labor resources and transportation networks including coal moving and pipelines. The scenario also established that these areas existed where demand for medium-Btu gas was likely to be high in the next 10 years. Individual plant-siting decisions will be a function of perceived market demand and area-specific environmental constraints. These decisions will be made by the private sector with government involvement limited to existing permitting and regulatory functions.

e. The subject of cumulative impacts from broad synthetic fuel development is addressed in the programmatic EIS for the Alternative Fuels Demonstration Program. This same document also discusses potential mitigating measures.

The approach taken to addressing cumulative environmental impacts from commercialization of medium-Btu gasification is the same as that used in the Alternative Fuels program.

A State-level analysis was chosen because it was felt that this was the smallest area that could be discussed without getting into site-specific questions that would be inappropriate in a programmatic treatment. Specific areas were discussed from a nonimpact standpoint for the purpose of establishing that viable areas existed. Current environmental statutes and regulations impose siting constraints by requiring adequate air and water resources, among other things, thereby mitigating against unreasonable impacts in any one region.

#### Response to NRDC Comment No. 2

The DOE believes that environmental concerns are adequately addressed in the FEIS.

All major components have been identified and are analyzed. Fugitive emissions are addressed using available information and worst-case assumptions. The MLGW design philosophy is to minimize fugitive emissions by conservative design supplemented by thorough process monitoring and mitigation procedures.

The FEIS has been issued based on best available information in compliance with the requirements of NEPA prior to proceeding with design efforts and beginning construction of the MLGW facility.

Response to NRDC Comment No. 3

Stabilization of the dredge fill will be achieved by vibroflotation or a comparable commercially proven procedure. A testing program will be executed during and after the densification process to ensure that fill materials have sufficient strength to bear the anticipated loads. The nature of the filling and compaction process is such that there should be no differential settlement.

The fact that Memphis lies in a high seismic-risk area is acknowledged. Prior to initiation of construction, vegetation and silty surficial soils will be removed from the site. The filling operation will be conducted under the supervision of geotechnical engineers, and the fill beneath process areas will be compacted to a depth of 15 m (50 ft). Existing soils below the 15 m depth are expected to be compacted by the load of the overlying fill. Penetration resistance testing to be carried out in conjunction with the fill consolidation will ensure densification of the sand sufficient to prevent liquefaction of the foundation.

A safety factor of 3 against foundation-bearing-capacity failure is used in computing allowable foundation loads on footings. An additional loading of 1/3 the design load is used in calculations involving seismic or wind loading. The ultimate bearing capacity of the soils is estimated to be 2.25- (improperly given as 1.33 in the DEIS) times the maximum applied load under these criteria. Thus, under normal sustained operating conditions, the foundations will stress the soil at no more than one-third of its strength. Under earthquake or 100-year wind conditions, the soil will be stressed at most to only four-ninths of its strength.

Final design of the coal and ash storage liner systems is not complete. Soil testing and possibly some soil-stabilizing treatment will be performed prior to installation of the liners. During the demonstration phase operation, wastes will be stored in landfills designed to comply with proposed hazardous waste disposal guidelines. Monitoring of the wastes generated by the process during the demonstration phase will establish the degree of hazard they represent.

It is physically impossible to locate any facility in Shelby County and not overlie the 500-ft or 1400-ft sand aquifer. The aquifer is extensive beneath this portion of the Mississippi Embayment.

Response to NRDC Comment No. 4

The issue of damage to the plant by flooding has been discussed in response to Comment EPA-32. The wastewater treatment area will be diked to elevation 71.6 m (235 ft), 3.3 m (11 ft) above the estimated 100-year flood elevation and about 1 m (3 ft) above the project design flood. Inspection of the U.S.G.S. topographic map of the area indicates levee crest elevations above 71.6 m (235 ft) on the east and west river banks adjacent to the site. A flood of a magnitude greater than the Corps of Engineers project design flood would be required to directly affect the process and water treatment areas. Stability of liners beneath the coal and waste storage areas was also discussed in the response to EPA-32.

As is explained in Appendix C of the FEIS, the physical model of the Mississippi River between Cairo, Illinois, and Helena, Arkansas, was calibrated to reproduce floodwater elevations observed during the 1973 flood event cited by NRDC. The proposed fill was not inundated during the model test.

Response to NRDC Comment No. 5

Appendix C contains extensive analytical results on bottom sediment from the Mississippi River and Lake McKellar. Review of the tables in Appendix C.3.1 leads to the conclusion that of the available sources of fill material (Mississippi River and Lake McKellar), the Mississippi River's sediment contains lower concentrations of potentially toxic substances than does Lake McKellar's sediment. Maximum recorded values for most substances are higher in Lake McKellar's sediment than in the river's sediment. The potential is low for trace metals or organic substances to affect the aquifer in the 500-ft sand by leaching of the fill material. Existing data indicates that no hydraulic connection exists beneath the site; however, the uncertainties of the integrity of the Jackson clay throughout the area beneath the alluvial plain make it impossible to totally discount communication between the alluvial aquifer and the 500-ft sand. If communication does exist, dilution and dispersion of infiltrating water within the alluvium would reduce concentrations of dissolved substances contributed by the infiltration.



Response to NRDC Comment No. 6

See response to NRDC comment No. 3.

Response to NRDC Comment No. 7

The procedures cited in this comment were described in Sect. 1.4.8.5 of the DEIS and are expanded in Sect. 1.4.8.3 of the FEIS. This procedure will be followed in a health risk assessment to be completed prior to the start of plant operations.\* Since the DEIS was issued, new data from pilot plant studies has become available. Based on this data, a preliminary risk assessment has been performed and is now provided in Sect. 4.4 of the FEIS. The List of Preparers (Sect. 5) now includes the name and qualifications of the health scientist who contributed to the preparation of the DEIS and the FEIS.

A preliminary health risk assessment has been performed based on pilot plant data. The results of this analysis are given in Sect. 4.4 of the FEIS.

Response to NRDC Comment No. 8

The implication that the presence of a chemical species in a process stream indicates, per se, toxicity of that stream is unfounded. This implication stems from using high (or just subtoxic) levels to infer that the same type of health defects are present at low levels of exposure. Taking arsenic as an example, it must have a nontoxic threshold because it is essential to hemopoiesis and as a catalyst in phosphorylation (G. B. Gori, 1980, "The Regulation of Carcinogenic Hazards," *Science* 208). The same is true for nickel, chromium, selenium, and numerous other agents. Thus, there is probably a spectrum of biological effects. At very low levels the effects often appear to be those which support essential biological processes. At higher levels undesirable, stochastic, chronic effects may be introduced. Sometimes biosystems are extremely sensitive to a particular compound. For example, selenium is a necessary element and selenium deficiencies are common, yet the toxic level of selenium is only a factor of 3 from the essential level. Obviously, threshold and dose rate effects are to be expected,† because the epidemiological studies of cigarette smokers shows that risk decreases to the nonsmoking rate for former cigarette smokers. Also, the resistance of certain species to known carcinogens, even at maximum tolerated doses, could be considered evidence that no-effect thresholds are a most common phenomenon. Such evidence is widespread and should not be treated as exception. Specific examples include animal experiments that involved smoking, benzene (a human leukemogen) given to mice, arsenic (a human carcinogen) given to mice, and croton oil (or TPA) applied, in the manner of a promoter, to rat or hamster skin.‡ None of these animal tests revealed any carcinogenic potential of the test agent.

Concerns that any type of PNA exposure leads inevitably to cancer should be tempered by understanding of the mechanistic approach used in the experiments. Experiments in which single doses of benzo[a]pyrene are carcinogenic can be cited, but such experiments use sustained promotion from line oil. Promoters are not regulated currently, but it is widely known that the dose and dose rate of the promoting agent controls the cancer incidence in an initiated (at subcarcinogenic levels) population. Thus, threshold and tolerance doses are well established concepts for promoters and may be involved to illustrate the benign nature of low-level exposures. Several compounds such as chrysene, benzo[a]anthracene,  $\beta$ -naphthylamine, phenanthrene, and dimethylnitrosamine have been considered, and derived permissible concentrations in air are recommended.

The FEIS has focused on those issues of greatest significance at the present time (i.e., exposure to CO and H<sub>2</sub>S) and has indicated how the remaining issues will be handled as the design evolves. The preliminary analysis given in the FEIS indicates that exposures to toxic materials can be controlled to low levels by controlling CO and H<sub>2</sub>S to levels below their Threshold Limit Values (TLVs). Based on currently available information, the materials listed in the comment will probably be below their TLVs by orders of magnitude (see FEIS, Sect. 4.4).

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\* This commitment is contingent upon future DOE involvement in the project.

† T. D. Jones et al., "Empirical Observations in Support of 'Carcinogenic Promotion' as a Tool for Screening and Regulation of Toxic Agents," in *Proc. of the Fifth International Symposium on Polynuclear Aromatic Hydrocarbons*, Oct. 28-30, 1980, Battelle Memorial Institute, Columbus, Ohio (in press).

‡ J. C. Barrett and E. E. Siskin, "Studies on Why 12-O-tetradecanoyl-phorbol-13 acetate (TPA) Does Not Promote Epidermal Carcinogenesis of Hamsters," in *Carcinogenesis: Fundamental Mechanisms and Environ. Effects*, B. Pullman, P.O.P. Ts'o, and H. Gelboin, eds., 1980.

Response to NRDC Comment No. 9

The FEIS provides an expanded discussion of fugitive emissions. Pages 1-21 and 2-11 of the DEIS provided plant design descriptions. Air quality concerns including fugitive emissions are addressed in Sect. 4.1.1.2 of the FEIS. The number of potential emission points is not a significant factor. Potential emission points include valves, flanges, and seals. Unlike other synthetic fuel technologies, which operate at 500-2000 psi, the low pressure (90 psia) in this design will minimize leak risks and release rates. Furthermore, the in-plant monitoring program and the routine maintenance and inspection programs, described in Sect. 4.5.1, are designed to detect and eliminate fugitive emissions. Fugitive emissions will not be collected and conveyed to the flare because such a procedure would create fire and explosion risks.

Upset conditions are not related to fugitive emissions. Upset conditions are discussed in Sect. 2.2.1.11.

Response to NRDC Comment No. 10

The statement on page 1-15 of the DEIS has been corrected. The statement on page 1-18 of the DEIS is correct. All hydrocarbons more complex than methane are unstable at the temperatures in question and, as a result, are converted to synthesis gas.

The study cited was for a coal pyrolysis process designed to produce a liquid fuel. Exposures to organic base liquids, such as occurred at the West Virginia facility, are not of concern at the MLGW facility. Should these species occur, their relative concentrations would be such that from a health perspective, their existence would pose a risk at least three orders of magnitude less than exposure to CO and two orders of magnitude less than exposure to H<sub>2</sub>S (Sect. 4.4).

Respirators will not be used routinely; their use will be limited to emergency situations. See Sect. 4.6.9.

Final contingency plans for occupational health and safety are being developed.

See responses to NRDC comments 7, 8, and 9 (or see Sects. 4.4, 4.5.8, and 4.6.9).

Response to NRDC Comment No. 11

The design of the Memphis plant does include a controlled combustor designed for constant temperature and residence time for routine conversion of gaseous compounds produced by the process into acceptable emissions (see Appendix B.0.4). This combustor was referred to as an incinerator in the DEIS. In addition, the Memphis plant, like the Solvent Refined Coal-II plant, has a flare that is relied upon only as a back-up. A flare is commonly used to start up or shut down a plant and in emergencies. The combustion efficiency of the flare for hydrocarbons is greater than 99%.

The occurrence of a total flare failure was considered by the designers at the preliminary design stage.

However, should flare failure occur, raw product gas rich in H<sub>2</sub>S would be emitted to the atmosphere, possibly resulting in potentially fatal concentrations up to several miles offsite. Such a condition would require immediate correction or plant shutdown. Design provisions exist to minimize the probability of flare failure to less than once in 100,000 years (see Sect. 2.2.1.18).

The purpose of a flare is not to collect fugitive leaks for burning. The flare will handle (non-normal operation) gaseous effluent from safety or vent valves when they open in order to protect the plant. It will also handle off-specification product gas during plant startup or shutdown.

Response to NRDC Comment No. 12

The design of the heat exchangers, like the design of other process equipment in the plant, is based on considerations of the conditions to which the equipment will be exposed. Materials are specified to minimize the risk of failure while providing long useful life. This is the design philosophy employed.

Impacts of chromium deposition are discussed in Sect. 4.1.7.2 of the FEIS. Nonchromate alternatives are less effective. Because no significant impacts resulting from chromium deposition are expected, alternatives are not considered.

During the life of the plant, it is possible that process heat exchangers may develop leaks and allow gases containing CO or H<sub>2</sub>S to enter the cooling water. The amount of such leakage would depend upon the size of the leak but would be minimized by conservative design practices and by the low operating pressure of the plant (90 psia). Such contaminants would be released from the cooling tower until the system was repaired. Leakage would be detected by continuous instrumental gas monitors on probes located in the cooling tower exhaust. Amperometric H<sub>2</sub>S analyzers for parts-per-million H<sub>2</sub>S concentrations are currently the preferred type of instrument for this service. Analyzer output would be recorded and displayed on the operator's panel for corrective action. The number, type, and location of probes and analyzers will be determined in the detail design phase. If a faulty heat exchanger can be isolated, it will be taken out of service for repair. If the heat exchanger cannot be isolated, plant shutdown would be required for repair. Immediate plant shutdown would not be necessary for most leaks, because the concentrations of materials of concern resulting from small leaks will be below their TLVs; however, the precise shutdown schedule will depend upon the size of the leak. Based on the limited magnitude and short duration of extreme nonroutine emissions, synergistic effects are not expected to be significant.

Response to NRDC Comment No. 13

Data for SO<sub>2</sub> were collected at the monitoring station for the indicated period. However, the extensive SO<sub>2</sub> data collected by the TVA monitoring network are for more than one annual cycle and support the conclusions drawn from the project monitoring data.

The particulate sampling dates are now included in Table 3.1.

The proposed facility emits only a small amount of SO<sub>2</sub>, particularly when considered in a regional context. No viable analytical techniques exist to quantify the impact of the proposed facility on regional precipitation acidification.

Based on regional data, all of Shelby County has been classified as not attaining the NAAQS for ozone. Data collected at the site air quality monitoring location do show one exceedance of the NAAQS in each of two calendar years but do not show a violation of the ozone standard. However, the data do exhibit a tendency towards high ozone concentrations, which the operation of the proposed facility could exacerbate. With currently available atmospheric models, no definitive conclusions concerning the impact of the proposed facility upon the ozone levels of Shelby County can be drawn.

Offsets will not be required because the MLGW project has been classified as a minor source of hydrocarbons by Shelby County and the state of Tennessee.

Response to NRDC Comment No. 14

The requested data on process condensates and slop oils is given in Table 2.1 of the FEIS.

Process effluents and coal pile leachate will receive flocculation/clarification, aeration, and settling, as well as neutralization. In the flocculation step of treatment, oxygen is bubbled through the water to oxidize dissolved trace elements, which will then precipitate. Arsenic will be removed to a level of approximately 0.01 mg/liter and selenium will be removed to approximately 0.02 mg/liter (see EPA, *Treatability Manual*, vol. 1, pp. I.4.2-4 and I.4.12-4, EPA 600/8-80-042a, 1980). Dispersion of the effluent through the diffuser will reduce these concentrations at the outfall to even lower levels.

The use of granular activated carbon is widely recognized as an effective method of treatment for polynuclear aromatic hydrocarbons (PAHs). In conjunction with ozonation and the biological activity the ozone will promote on the carbon surface, even higher removals can be expected. Biodegradation has been demonstrated to achieve an 80% removal efficiency for a number of PAH compounds (Stamoudis and Luthy, *Water Research*, vol. 14, pp. 1143-1156, 1980 and EPA, *Treatability Manual*, vol. 1, Sect. I.10, EPA 600/8-80-042a, 1980). The use of this treatment together with ozonation and carbon adsorption will reduce total PAH concentrations to less than 1 µg/liter, or a total removal efficiency of greater than 90%.

Under normal conditions, all PAH species produced in the U-gas process will be at concentrations of less than 0.1 µg/liter in the effluent. Under upset conditions, the concentrations in the effluent may reach the parts-per-billion range. Resultant river concentrations, however, will still be in the 0.1 µg/liter range. Bioaccumulation is discussed in response to comment NRDC 15(d).

Response to NRDC Comment No. 15(a)

Though changes in coal feed may affect the concentration of trace elements in raw wastewater, the concentration changes caused by different coals are not expected to produce equivalent changes in the composition of effluent discharged from the plant. The variations are damped out in the treatment chain. The wastewater treatment system is designed to handle large influent variations caused by changes in coal feed. The chemical loading from the plant to the river is expected to be very close to that presented in Table 4.6, irrespective of coal feed and process variations.

Response to NRDC Comment No. 15(b)

See Comment and Response EPA-29.

Response to NRDC Comment No. 15(c)

Section 3.1.3.1 indicates that the concentrations of phenol, mercury, iron, manganese, and phosphorus consistently exceeded the criteria levels, whereas cadmium and cyanide occasionally exceed criteria levels. The FEIS indicates that industrial discharges and natural conditions produce inferior water quality, which may cause chronic sublethal effects to some aquatic organisms.

The FEIS notes that the wastewater discharge from the MLGW industrial fuel gas demonstration plant will cause an adverse impact because of the very slight increases in the concentrations of those water quality constituents in the Mississippi River which currently exceed water quality criteria. Because of the Mississippi River's enormous dilution capacity, most of the potentially toxic constituents in the wastewater will be rapidly diluted below the criteria concentrations. The mixing zone will be very small, and except in the immediate vicinity of the discharge, no increases in the concentrations of water quality constituents will be detectable.

The wastewater discharge will satisfy the NPDES permit issued pursuant to the Clean Water Act.

The analysis of alternative wastewater treatment systems has estimated the additional costs of a zero-discharge system to be \$5 million in capital costs and \$1.2 million/year in operating costs. Zero discharge of liquid effluent would also produce a solid waste which could require chemical fixation and disposal in a secure landfill.

Response to NRDC Comment No. 15(d)

The EPA draft criteria for potentially toxic pollutants are presented in Table C.4.1, Appendix C.4.

Response to NRDC Comment No. 16

Water quality impacts resulting from filling the site with Mississippi River sediment are in Sect. 4.1.3.1. Characterization of the fill is given in Appendix C.3.1. Even though testing indicates that waste stored onsite is nonhazardous, it is protected by a secure landfill. Leachate will be collected and monitored.

Investigations performed on the proposed site have established that directly beneath the site the Jackson formation does provide a barrier between the two aquifers. Continued monitoring of numerous observation wells in the western Shelby County area may indicate where alluvial groundwater enters the potable aquifer if, in fact, communication does occur between the two aquifers.

The commenters state that the contamination of the alluvial aquifer by project activities on the Mississippi alluvial plain could render the Memphis water supply unusable. The proposed site lies several miles from the nearest utility well field and, at the site, is vertically separated from the aquifer by 78 m (250 ft) of sediment including about 40 m (130 ft) of clayey-to-slightly sandy silt of the Jackson formation. Data on directions and rates of groundwater movement in the alluvium are not generally available. It is suspected that since the piezometric surface beneath the site responds rapidly to river level fluctuations, groundwater movement within the upper few meters of the alluvium would be characterized as an oscillatory movement with a strong lateral component which responds to cyclic hydraulic gradient fluctuations caused by changes in river level. Water entering the surface of the alluvial water table would move downward if it was moving down-gradient into a drawdown cone or if it was much denser than the water within the aquifer. Neither of these conditions is expected to occur beneath the Allen site. In the

event that contaminated water infiltrates beneath the site, it would very likely enter Lake McKellar below water level.

Water quality beneath the site will be monitored as described in Sect. 4.5 of the FEIS. In the event that contaminants are detected beneath waste storage areas, pumping of the affected area can be initiated to remove the soluble contaminants. Pumped water would be appropriately treated before discharge.

Response to NRDC Comment No. 17

The commentor disagrees with the use of the EPA extraction procedure as an indicator of environmental hazard of the process wastes. It is true that the EPA procedure does not simulate conditions of long-term storage of a waste during which unforeseeable chemical and biological activity may affect the chemical stability of the waste. It is for this very reason that project designers are treating as hazardous this waste which, according to the letter of the law, is not hazardous. During the demonstration period of operation all wastes will be placed in a landfill that meets hazardous waste disposal regulations.

As is discussed in Appendix C.2.2, in addition to the EPA extraction procedure, four other extraction procedures were used. Two of the other procedures exposed the waste to conditions at least as severe as are expected in the landfill, albeit for a short extraction period. Trace metal concentrations in the extracts were within the range acceptable for potable water in all cases except the 0.1 N nitric acid extraction in which barium exceeded the drinking water standard by a factor of 2.8, and chromium exceeded the standard by a factor of 1.5.

Response to NRDC Comment No. 18

Details of the hypalon liner and its life expectancy are provided in Sect. 2.2.1.8. No long-term onsite disposal of hazardous wastes is anticipated so no long-term repair strategy is required. Tests indicate that the wastes to be stored onsite are nonhazardous. During the demonstration period, the short-term landfill will be monitored, and leaks will be detected and repaired as described in Sect. 2.3.2.1. Should the gasifier ash be found hazardous, RCRA requirements will apply, including postclosure maintenance. With regard to seismic and flooding events, see responses to EPA-32 and NRDC-3.

Response to NRDC Comment No. 19

Four years of observations of waste characteristics will be beneficial in designing the long-term waste storage facility. The value of containing all wastes as planned is that leachates will be contained, collected, and analyzed. If trace metals are prone to leach out of the waste because of weathering action, an increase in the concentrations of certain elements could be expected within a four-year period.

Response to NRDC Comment No. 20

Offsite disposal of gasifier ash is less desirable than onsite disposal for the reasons cited in this document. It is anticipated that the gasifier ash will be utilized commercially. Because the long-term landfill as currently designed cannot accommodate the full volume of non-hazardous solid waste generated over the lifetime of the plant, offsite disposal may be necessary. Should this be the case, the waste would be transported offsite by barge. Barges will be unloaded by rotary bucket equipment having minimal dust emission characteristics. No offsite disposal area has been identified.

Response to NRDC Comment No. 21

There is no scientific evidence that the Memphis drinking water supply has already been contaminated. See the response to NRDC Comment No. 16.

Response to NRDC Comment No. 22

Kentucky No. 9 coal is the intended feed coal, and leachate data on that coal were included. Data on Illinois No. 6 coal, a possible alternative feed coal, were also included. The other three coals tested were feed coals for other synfuels facilities located in areas so far from Shelby County that transportation of the coal would be impractical. It is expected that coal from western Kentucky will be the predominant feed coal used at the facility.

Response to NRDC Comment No. 23

The commenter requests data on toxic contaminants in the product gas from the U-gas process. In comment EPA-14, EPA requested data on HCN, and this data has been provided in the response.

In the report cited by NRDC, the Institute of Gas Technology (IGT) attempted to determine the fate of elements such as arsenic in a Hygas gasification reactor. Hygas operation (hydrogenation of coal to form methane) is substantially different from the U-gas process, which reacts steam/oxygen with coal, forming medium-Btu fuel gas ( $\text{CO} + \text{H}_2$ ). IGT encountered a deficient mass balance for arsenic and several other elements. Analytical precision for arsenic in coal and in plant residues is rather poor.

Test and evaluation programs are currently under way at the IGT U-gas pilot plant to measure the fate of trace elements and by-products. These studies are being conducted for the risk assessment study and to ensure that all trace elements are accounted for and controlled prior to the sale of product gas.

Response to NRDC Comment No. 24

The DOE is aware of the cited studies; however, data from these studies are not relevant to the U-gas process, in general, or to the specific MLGW plant design. The cited studies were based on a facility using a vastly different Lurgi process and with minimal environmental control equipment.

Concerning the comment on the West Virginia facility, see the response to NRDC-10.

Since issuance of the DEIS, U-gas pilot plant process data have become available. Based on this data, a preliminary health risk assessment has been performed and is described in Sect. 4.4.

Response to MAS Comment No. 1

The use of aquifer water for plant makeup will have a negligible impact on water availability in Memphis and Shelby County over the life of the plant. An analysis of this and alternative plant makeup water sources is given in Sect. 2.3.2.1, Alternative plant makeup water sources.

Response to MAS Comment No. 2

Air monitors now operated by TVA and the Memphis-Shelby County Health Department and the operational monitor to be located on Presidents Island throughout the operating lifetime of the MLGW facility will provide sufficient information to determine the impacts of plant operation. Incremental ground-level concentrations of atmospheric effluents during nonroutine plant operations are predicted to be higher than from normal operations but still small and in compliance with air quality standards. Modeling studies indicate that no violations of any air quality standards will occur (Sect. 4.1.1.2). The proposed monitoring site is located in the region predicted to have the greatest ground-level concentrations (between 1 and 2 km north of the site). To establish an air quality monitor at the site proposed by the Memphis Audubon Society (MAS) would move it too far from the source to permit impacts of plant operation to be quantified. Additional monitoring stations far removed from the proposed site would quantify local air quality but would not provide additional information on the impacts of the MLGW facility.

Response to MAS Comment No. 3

Construction activities will affect the local population of the six-lined racerunner. A population is expected to reestablish after construction. The site provides a low-quality habitat for the swamp rabbit because of the lack of understory cover onsite. The site is used only for foraging by the Mississippi kite. For mitigation of terrestrial impacts, see Sects. 4.6.7 and 4.7.5.

Response to MCBC Comment No. 1

These cited measures will be performed. See Sect. 4.1.8.1.

Response to CBF Comment No. 1

The DOE shares the same concerns about the impacts of land use changes on wildlife, including those on the Mississippi kite, which is listed as endangered at the State level, but is apparently doing well as a species (J. W. Parker and J. C. Ogden, "The Recent History and Status of the Mississippi Kite, *Am. Birds* 33: 119-129). Locating the proposed project at the Pidgeon site (Sect. 4.3.7) would affect wildlife less in general; however, this reduced impact is, in part, offset by loss of prime agricultural land currently under cultivation. Furthermore, locating a barge facility for the Pidgeon site along the Mississippi River west of the site would destroy approximately 20 ha (50 acres) of high-quality wetlands, whereas locating a barge facility for the Pidgeon site in the barge turning basin of Lake McKellar would also destroy wetlands of lesser value and would require a long coal conveyor, with its associated visual impacts.

Response to CBF Comment No. 2

See response to comment MAS-1.

Response to CBF Comment No. 3

No plans exist to convert to alternative makeup water sources because an analysis shows that the consumptive use of aquifer water does not conflict with expected water uses over the lifetime of the plant. See Sect. 2.3.2.1 for a discussion of the proposed and alternative plant makeup water sources.

Response to CBF Comment No. 4

See Appendix C.8 for an evaluation of floodplain-wetland losses. The site in question is insignificant to flood control and does not appreciably contribute to recharge of the aquifer.

Response to CBF Comment No. 5

A thorough monitoring is planned for the MLGW facility. Preliminary details of this program are described in Sect. 4.5 of the FEIS. It is currently anticipated that monitoring results will be published quarterly and will be made available to local authorities. Although this reporting frequency may be changed as a result of monitoring experience at this facility, it is believed that this reporting interval is as short as is practicable. More frequent reporting, such as monthly, will not allow adequate time for data analysis and may not provide data record lengths of statistical significance.

The design for this plant utilizes the most practicable environmentally sound technology.

Response to COE Comment No. 1

A comparison of impacts between the proposed site and alternative sites is given in Sect. 2.3.2.2 and Appendix C.8 of the FEIS.

Response to COE Comment No. 2

Section 3.1.7.1 has been revised to indicate that the low-to-medium quality of the wetlands refers only to terrestrial wildlife and to indicate that discontinuing disposal of dredged material would allow revegetation of the forest floor. The other values mentioned in the comment are referred to in Sect. 4.1.7.1, which has been revised to also include the value of floodplain forests as overbank fish-spawning and -feeding areas.

Response to DOI Comment No. 1

Floodplain impacts are described in detail in Sect. 4.7.3 and Appendix C.8. There is no evidence to support the contention that this project will result in further floodplain development and its associated impacts.

Response to DOI Comment No. 2

The 1976 Request for Proposal required the industrial partner to submit a site-specific proposal; however, DOE has conducted an independent alternative site evaluation. Furthermore, in keeping with the NEPA process, DOE issued a Notice of Intent to prepare an environmental impact statement and conducted a public scoping meeting in Memphis in June 1979. DOE believes that the process described above provided ample opportunity for interested Federal and State agencies to comment on the site selection process.

Response to DOI Comment No. 3

The use of the Pidgeon site would result in fewer alterations of flood levels than would the proposed Allen site; however, incremental flood elevations resulting from the filling of the Allen site are predicted to be small (Sect. 4.1.2.1 and Appendix C.2.1). Dredge/fill operations would be similar at both sites. Construction and operation of the proposed facility at the Allen site would result in the loss of about 28 ha (70 acres) of disturbed low- to medium-quality wetlands. Construction and operation of the proposed facility at the Pidgeon site would result in the loss of about 49 ha (123 acres) of prime agricultural land. Additionally, locating a barge slip along the Mississippi River to the west of the Pidgeon site would require the clearing of about 20 ha (50 acres) of high-quality wetlands and would possibly affect nesting sites for the Mississippi kite. Locating the barge facility in the barge turning basin of Lake McKellar would affect a lesser amount of low- to medium-quality wetlands. The use of the Pidgeon site may have less impact on the terrestrial environment than the use of the Allen site; however, other factors, as described in Appendix C.8 indicate that the Allen site is the only practicable site for the proposed facility. Preliminary consultations with the U.S. Fish and Wildlife Service (USFWS) indicate that they no longer consider further study of alternative sites necessary (see FEIS, Sect. 4.7.5).

Response to DOI Comment No. 4

Based on the projected impacts on terrestrial and aquatic biota as described in Sects. 4.1.7 and 4.1.4 and Appendix C.8, DOE does not feel at this time that complete compensation for the affected fish and wildlife habitat is practicable. Planned mitigation measures are described in Sect. 4.6.4 and 4.6.7. Over 405 ha (1000 acres) of high quality wetland habitat is available to wildlife within a 4.82-km (3-mile) radius of the site.

Response to CRC Comment No. 1

DOE is concerned about potential health effects and continues to gather appropriate data. Since issuance of the DEIS, pilot plant data sufficient for a preliminary risk assessment has become available. This preliminary assessment is given in Sect. 4.4 of the FEIS. Based on the composition of the raw product gas from the pilot plant gasifier and on conservative assumptions, it can be concluded that controlling emissions of carbon monoxide below its TLV will ensure that emissions of all other materials of concern will be below their TLVs. After completion of final plant design and before plant operations begin, a complete risk assessment, as described in Sect. 1.4.8.3 of the FEIS, will be performed.\* Results of this study will be used in developing in-plant monitoring and mitigation procedures. Conceptual health monitoring plans and mitigation measures are described in Sects. 4.5.8 and 4.6.9 of the FEIS.

Response to CRC Comment No. 2

The Yugoslavian plant does use a different process and lacks environmental controls that will be present in American facilities. The potential for exposure is clearly recognized. However, the probability of exposure would be much lower in American facilities; furthermore, exposures would be detected early so that effective mitigation measures could be instituted. Design and operational features in this plant preclude the routine emissions of the cited contaminants. See the response to CRC-1 and NRDC-10.

Response to CRC Comment No. 3

The cited sections of the DEIS discuss generic coal gasification processes and do not necessarily apply to this project. DOE does not believe that health effects related to PAH exposures are unavoidable. As is discussed in Sect. 4.4, PAH exposure is not anticipated to be significant. Health effects monitoring and mitigation measures are described in Sects. 4.5.8 and 4.6.9.

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\*This commitment is contingent upon future DOE involvement in the project.



Response to CRC Comment No. 4

Coke oven workers were exposed for long periods of time to high levels of tars, chars, soots, smokes, etc. Lower levels of exposure resulted in lower risks. As is stated in the FEIS, exposure in modern coal conversion facilities are expected to be, at worst, much lower than was the case for earlier coal utilization technologies. The relative concentrations of these substances are expected to be quite low in this facility (Sect. 4.4). Monitoring and mitigation procedures related to your concerns are outlined in Sects. 4.5 and 4.6 of the FEIS. Medical monitoring in the community will not identify impacts of the proposed facility. Therefore, such monitoring will not be performed. DOE does not plan to wait 20 to 30 years to start collecting the necessary information. Data have been collected, as is evidenced by the cited sections of the FEIS, and will continue to be collected and evaluated throughout the demonstration period.

Response to CRC Comment No. 5

See responses to EPA 19 and NRDC-9.

Response to CRC Comment No. 6

The flare is only used during nonroutine operations and represents the best-available technology for this application. See response to NRDC Comment No. 11.

Response to CRC Comment No. 7

Condensate from the pilot plant scrubbed raw gas is currently being analyzed as part of a comprehensive wastewater characterization and treatability study. Results of this study will accurately define the composition of this condensate and its treatability by the waste-water treatment system described in the FEIS. Preliminary analysis of the raw gas from the U-gas pilot plant indicates that the concentration of tars and oils is about  $1 \times 10^{-6}$  lb/scf of dry gas. A more detailed analysis of the raw product gas is given in Sect. 4.4.

Response to CRC Comment No. 8

The credit generation unit is described generally in Sect. 2.2.1. The waste streams generated by the credit generation unit are all further processed in other units and are therefore reported as waste streams from those units given in Sect. 2.2.1.

Carbon monoxide is the primary component of health concern in the product gas (see Sect. 4.4). Although the present CO specification for the product gas from credit generation is 0.5%, the IFGDP has been designed to achieve less than 0.1% residual CO. Because the substitute natural gas (SNG) produced by credit generation is but a small fraction of the total gas distributed in MLGW's pipeline, the effect of dilution will certainly result in a lower CO content in the distribution gas. SNG produced in other plants using methanation catalysts similar to those used in the IFGDP has been injected in pipelines and distributed for general use.

Response to CRC Comment No. 9

As is stated in Sect. 2.2.1.4, the high temperatures and high-conversion characteristic of the U-gas process will minimize PAH formation. The use of granular activated carbon is an effective method of treatment for PAHs. Reported achievable concentrations using granular activated carbon alone typically result in PAHs of 0.1 µg/liter and less. In conjunction with ozonation and the biological activity which ozone will promote on the carbon surface, even higher removals can reasonably be expected. For this reason and because of the high dilution achieved in the Mississippi River, any trace quantities of PAHs will not pose chronic health hazards to a drinking water source. Threshold limit values have been established for PAHs. The analysis given in Sect. 4.4 indicated that controlling the emission of CO below its TLV will result in concentrations of PAHs being several orders of magnitude below their TLVs. See response to NRDC-8.

Response to CRC Comment No. 10

Supporting calculations for all air emissions were performed as part of the PSD/PTC permit process (see PSD/PTC Permit Application, January 1981 — especially Process Emission Sources IV, VII, VIII, and IX). This document is provided in the public reading rooms.

As shown in Table 4.10, based on the carbon content of the gasifier raw gas, VOC generation will be significantly less than 1%. This is expected because of the high temperatures of the gasification reactions. It should be noted that the considerable VOC generation characteristic of low-temperature, low-pressure gasification processes (e.g., the Lurgi process) is not representative of VOC emissions from the U-gas process. For a discussion of PAHs, see the response to comment CRC-9.

#### Response to NWF Comment No. 1

Although the possibility of flare failure exists, design redundancy safety features will greatly minimize this possibility. These features are listed in Sect. 2.2.1.10 of the FEIS. Should the flare fail in spite of these redundancies, the plant would be shut down immediately. The probability of failure and the associated impacts are discussed in Sect. 4.1.1.2. Emissions from the flare are described in the PSD/PTC Permit Application, January 1981 — Process Emission Source X. The emissions are limited to the following values under the respective operating condition:

| <u>Operating condition</u>        | <u>Hydrocarbon emissions<br/>(lb/operating hour)</u> |
|-----------------------------------|------------------------------------------------------|
| Normal                            | 0.01                                                 |
| Sulfur recovery<br>unit emergency | 15                                                   |
| Design maximum                    | 20                                                   |

See also the response to NRDC-11 for further information regarding flare operation and emissions.

#### Response to NWF Comment No. 2

The problem of synergistic effects cannot be quantified. The DEIS does not state that the distribution of PAH emissions is likely to be widespread. In fact, the concentration of PAHs in process streams is relatively low. A preliminary health risk assessment, given in Sect. 4.4 of the FEIS, indicates that CO and H<sub>2</sub>S are the major materials of concern at the MLGW facility. Controlling the emissions of these substances will also maintain emissions of PAHs and other materials of concern below acceptable levels. Emissions can be minimized by judicious plant design and operational maintenance procedures. Proposed in-plant health monitoring and related mitigation measures are described in Sects. 4.5.8 and 4.6.9 of the FEIS.

#### Response to NWF Comment No. 3

See response to NRDC Comment No. 12.

#### Response to NWF Comment No. 4

See response to NRDC-13.

Also, installing an acid rain monitor in the area of plant emissions would be of limited value. Acid rain is a regional problem, resulting from the long-range transport of sulfur and nitrogen. A monitor near the site would provide little information on the effects of the proposed facility upon precipitation.

#### Response to NWF Comment No. 5

In the DEIS (Table 4.7), the wastewater effluent quality was compared with Tennessee's effluent standards for general industry. Worst-case effluent levels of selenium, lead, and cadmium exceeded these effluent standards. These effluent levels were calculated in a very conservative manner, because removal efficiencies of trace elements were uncertain at the time these levels were calculated. From the ongoing phase II treatability study (performed as part of the NPDES permit application) results, more reliable information on trace element concentrations in the process effluents now exists and indicates that effluent standards will be met.

Table A.1 compares the FEIS worst-case effluent quality with effluent quality calculated using treatability study data for key contaminants. The treatability study data show that the levels of trace elements found in raw process wastewaters are much less than the FEIS worst-case values. In addition, treatability study data show that the removal efficiencies of trace elements will be substantially higher than the conservative values assumed in the FEIS estimates. The

Table A.1. DEIS and treatability study estimates of wastewater quality

All data in mg/L

| Parameter | Raw process wastewater |                         | Treated process wastewater |                         | Effluent discharge to Mississippi River |                         | Tennessee General Industrial Effluent Guidelines |
|-----------|------------------------|-------------------------|----------------------------|-------------------------|-----------------------------------------|-------------------------|--------------------------------------------------|
|           | DEIS estimate          | Treatability study data | DEIS estimate              | Treatability study data | DEIS estimate                           | Treatability study data |                                                  |
| Selenium  | 0.2                    | 0.020-0.035             | 0.2                        | 0.002-0.017             | 0.1                                     | 0.006-0.008             | 0.01                                             |
| Lead      | 1.0                    | <0.03                   | 0.2                        | <0.03                   | 0.5                                     | <0.03                   | 0.1                                              |
| Cadmium   | 0.1                    | <0.01                   | 0.1                        | <0.01                   | 0.05                                    | <0.01                   | 0.01                                             |

treatability studies have shown that the removal of selenium by flocculation/clarification will be higher than 50%. Calculation of final wastewater quality using treatability study data shows that concentrations of selenium, lead, and cadmium in the process effluents will meet Tennessee's effluent standards.

The fate of adsorbed PAHs on particulate matter is not clear. Biodegradation is the principal fate of PAHs in general, whereas biodegradation and metabolism are fairly rapid for some specific PAHs. (See U.S.E.P.A., *Water-Related Environmental Fate of 129 Priority Pollutants*, vols. 1 and 2, EPA-4401, 4-79-029, December 1979). However, this does pose a significant health hazard because PAH levels in the liquid effluent are quite low. See Appendix B.0.1.

For the IFGDP, Tennessee will determine plant-specific effluent guidelines based on best available treatment (BAT) technology during the NPDES permit application process. It is likely that Tennessee will develop effluent standards for some parameters on the list of effluent standards for general industry. However, additional parameters may be specified, such as ammonia and PAH. In deriving effluent standards, Tennessee will review the characterization data on the raw process wastewater as well as the removal efficiencies of available treatment processes. The scope of the ongoing wastewater characteristics and treatability studies has been determined in discussion with Tennessee to ensure that BAT-based effluent standards will be met.

#### Response to NWF Comment No. 6

The potential for groundwater contamination is described in Sect. 4.1.2.2 and in response to NRDC comments nos. 5 and 16.

The radioactivity from the radon and radon daughters is of low levels and is short lived; therefore, they would not pose a health problem. Furthermore ash agglomerates containing radio-nuclides are likely to have less leaching potential than does conventional power plant ash.

#### Response to NWF Comment No. 7

Initial consultations with USFWS took place prior to issuance of the DEIS. Since issuance of the DEIS, DOE has continued its consultations with the USFWS and has discussed mitigation measures related to wildlife habitat with the agency. See Sect. 4.5.7. Documentation is provided in Appendix B.3.

#### Response to DHHS Comment No. 1

An assessment of occupational and public health impacts is described in Sect. 4.4 of the FEIS. Monitoring plans are given in Sect. 4.5 of the FEIS. See the response to comment CRC-4.

#### Response to DHHS Comment No. 2

The MLGW industrial hygiene program has been developed with the recognition of NIOSH procedures.

#### A.4 EXCERPTED COMMENTS FROM THE HEARING TRANSCRIPTS

Key to identifier code:

ED — Elaine deLashmit

JR — Jane Rousseau

AF — Allen Fitzgerald

PT — Plato Toulates

KH — Katherine Hunnenin

PB — Presiding Board at the Public Hearing



## Appendix A.4

## EXCERPTED COMMENTS FROM THE HEARING TRANSCRIPTS

ED-1 The first one is the monitoring plan. I couldn't see that any specific guidelines were given in the draft statement. You say that you will do quarterly review of data collected and that immediate mitigation of unacceptable environmental impact will be identified, and that the data will be reviewed quarterly. I was thinking that perhaps it should be reviewed more than quarterly, maybe monthly or bimonthly.

ED-2 Another aspect that really disturbed me was that 100 acres of floodplain forests would be taken. And considering the rate of forest land destruction in the United States, I thought it was appropriate to request from the Department of Energy and Light, Gas & Water that you purchase a parcel of the same size nearby, possibly adjoining T. O. Fuller State Park, to mitigate the losses. The parcel should be strictly used for wildlife habitat.

JR-1 I wish to speak as a private citizen concerned about the use of water from the aquifer when the waters from the Mississippi River are readily accessible.

Although MLGW assures us that only two percent of total usage is involved, it seems irresponsible to use water from the aquifer for cooling purposes. Scientists have warned us that our most precious resource in the future is our drinking water. And if you're having any kind of redesign, I think it would be far more responsible for MLGW to use the water from the Mississippi River.

AF-1 In the event of a disaster how well equipped is our Memphis Fire Department in terms of manpower, specialized training, the specialized equipment needed to handle such a crisis? Can funds be appropriated from DOE to provide the special training for the Memphis Fire Department to handle this type of situation?

PT-1 I would like to speak to a question I think that has already been touched upon, but not in its totality. It has to do with the cumulative effects of not only this plant, but the proposed steam plant using lignite to be located in the northwest part of Mississippi right below Memphis, the proposed sludge and garbage burning plant to also be located in Memphis, and of course this coal gasification plant.

I think that there is a distinct possibility that the cumulative effects of these three plants on air quality, added to our already existing situation, whereby we're in violation of EPA's air quality standards already, has the potential for affecting the health of all of us in the community, and as a citizen that lives in that area, it worries me.

And I also wonder how one air monitor can track emissions when you consider that we've got three prevailing wind directions in the City of Memphis, depending on the time of the year.

I think it would be difficult to find a location where you could get better emission dispersal all out over the community than the location we're talking about, unless you located the plant directly in the middle of the city. Thank you.

KH-1 And I would hope that before there was a conclusion or Final EIS implemented, that there would be an opportunity to greatly expand in detail the health and safety measures that are going to be taken for the in-plant employees.

KH-2 The one example, a glaring example I would suggest that be added to the EIS, would be using carbon monoxide as an indicator gas for leaks in any part of the system. This is very simple; it's certainly not an answer.

The reason for doing this is because carbon monoxide will probably be the largest component, not the most toxic, but the highest percentage of emissions. And their technology for indicating carbon monoxide exposure is already available and in place in a number of plants in the city already, a continuous monitoring individual system that could be placed at any point in the system where there might be suspected leaks or emissions.

This is a very simple item that should be included in the EIS.

KH-3 Without going into much detail about what we already know, the lack of toxicity data on the hundreds of possible organic and inorganic compounds leaves a serious problem.

A number of these agents we do know the toxicity of, and most of them we don't and a lot of them we never will because we don't have the funds and they will not be priority-type pollutants, to where we can afford to do a lot of research on them. So that's going to be an area of short-term testing that is going to have to be pursued along with the actual technical aspects of the in-plant evaluation and control of the emissions.

KH-4 The problem that is not going to be able to be assessed is the synergistic, or the additive effects of these numerous agents in the exposure to employees. And it is the synergistic effects that could possibly be the most drastic, rather than one specific agent or one specific chemical in the fugitive emissions.

KH-5 The whole issue of the latency period for the development of cancer and other problems, such as some reproductive health problems, is also serious because unless there is a very good health study that's undertaken through the whole process until the plant goes into commercial operation — I mean it should continue even after commercial operation — but it is going to be hard to detect at an early stage what might be some of the more serious health problems associated with coal gasification, particularly in the area of reproductive health, because I would imagine a lot of these workers would be young workers of childbearing age, and there is already some precedent for women in the synfuels projects being excluded solely on the basis of their ability to bear children.

This is illegal, and there has been no — They are not addressing where this is happening, to come to Washington. The reproductive health of the male employees is not being addressed.

We don't know about the stratogenicity (teratogenicity), or the potential of these agents to cause birth defects, or the potential of these agents to cause mutagenic, or mutations, mutagenic changes.

KH-6 In the EIS there is one point that I strongly disagree with, and this has to do with the right to know.

The workers, because of the toxic nature of the environment, which in my opinion will be one of the more toxic places in the city — is or has the potential to be excuse me — is the worker's right to know that they are going to be working in highly hazardous environments, or in potentially hazardous environments.

The EIS was incorrect in their statement that workers individually would not have access to their medical records, only their physician. OSHA has a policy that was implemented in August stating that workers do have the right to have access to their medical records, all air sample nature, information of this data.

KH-7 My main point would be that there be adequate funds, substantial funds available to research the health effects of the workers in the plant from the initiation of the project, and that this be a very well-known epidemiologic study done by professionals with training in this area.

KH-8 I would also recommend, and I don't know whether this is being considered or not, but that an industrial hygienist be hired full-time at the plant solely to handle the industrial hygiene problems — not a safety engineer who is going to be given industrial hygiene responsibility, but an industrial hygienist in addition to a safety engineer.

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Re: Report of Presiding Panel  
the Memphis Light, Gas and Water  
Industrial Fuel Gas Demonstration  
Project, DOE/EIS-0071-D, Public  
Hearing in Memphis, Tennessee,  
December 3, 1980

The draft environmental impact statement (DEIS) on the Memphis Light, Gas and Water Industrial Fuel Gas Demonstration Project DOES NOT adequately consider the alternative sources of water for cooling and processing high-sulphur coal at the medium-Btu industrial fuel demonstration project.

Based on the DEIS and the comments submitted at the public hearing in Memphis, Tennessee, December 3, 1980, and thereafter through December 15, to Dr. Robert Laza, as well as the comments of the National Wildlife Federation, this panel submits the following interim report without surrendering any rights to add final comments to the FEIS.

PB-1 The gasification plant design must include a closed-system treated waste water recycling system. Its design must include drawing water initially from the Mississippi River and/or clarified water from the municipal sewage system for the gasification process. The plant must use these alternative sources as soon as practicable.

PB-2 There must be adequate air monitoring of the plant and its emissions so as to insure health safety within the plant and to safeguard all parts of the greater Memphis area. This includes an adequate number of air-monitoring stations, in view of prevailing wind patterns. This must include adequate personnel, training and contingency procedures, and monitoring devices



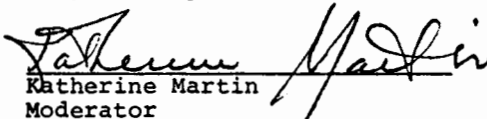
MARTIN, TATE, MORROW & MARSTON, P. C.

Dr. Robert Laza  
January 14, 1981  
Page Two

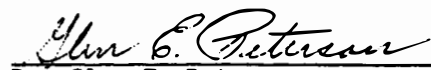
within the plant. See comments submitted by National Wildlife Federation.

PB-3 Finally, the panel urges the purchase of a compensating amount of wet-lands acreage to mitigate the wet-lands loss occasioned by use of the Allen site. The panel urges DOE and MLGW to use their best efforts to obtain funds to purchase substituting acreage.

Respectfully submitted,

  
Katherine Martin  
Moderator

  
Dr. George Hollis  
Panelist

 1/16/81  
Dr. Glen E. Peterson  
Panelist

A.5 RESPONSES TO COMMENTS GIVEN AT THE PUBLIC HEARING



Appendix A.5

RESPONSES TO COMMENTS GIVEN AT THE PUBLIC HEARING

Response to ED Comment No. 1

See response to CBF No. 5.

Response to ED Comment No. 2

See responses to DOI Comment No. 4, MAS Comment No. 3, and MAS Comment No. 5.

Response to JR Comment No. 1

A discussion of the use of alternative water sources has been added to Sect. 2.3.2.1 (Alternative Plant Makeup Water Sources).

Response to AF Comment No. 1

Fire protection is discussed in FEIS Sects. 3.1.8.4 and 4.1.8.2.

Response to PT Comment No. 1

Cumulative effects of future projects cannot be assessed at this time, because these projects are in the early planning stage and no design information is available; however, before any of these plants become operational, their impacts on air quality must be assessed as part of the normal permitting procedure.

The proposed air quality monitor represents an addition to the existing monitoring stations in Memphis and has been placed near the area of maximum projected impacts considering meteorological conditions. The proposed site is sufficiently far removed, considering prevailing wind directions, to minimize ground-level concentrations of atmospheric emissions from the proposed facility in the downtown area.

The distribution of ground-level concentrations of pollutants is given in Sect. 4.1.1.2.

Response to KH Comment No. 1

In-plant health and safety measures are described in Sects. 4.5.8 and 4.6.9 of the FEIS.

Response to KH Comment No. 2

Carbon monoxide will be used as an indicator compound. See Sect. 4.5.8 of the FEIS.

Response to KH Comment No. 3

See Sect. 4.4 and response to comment NWF-2.

Response to KH Comment No. 4

A comprehensive health effects study dealing with the concerns you have raised is planned. Details of this study are given in FEIS Sect. 1.4.8.3. See Sect. 4.4 for the results of a preliminary analysis.

Response to KH Comment No. 5

An occupational health study will be performed as described in Sect. 1.4.8.3. Medical monitoring and surveillance is discussed in Sect. 4.5.8. Based on a preliminary health risk assessment, no health concerns have been identified that would indicate that the cited effects are to be expected.

Response to KH Comment No. 6

Workers will have access to their medical records in accordance with OSHA policy. Furthermore, a worker education program is planned (Sect. 4.6.9 of the FEIS).

Air monitoring data will be made available to the public.

Response to KH Comment No. 7

Sufficient resources will be provided for an adequate industrial hygiene program.

MLGW's commitments towards worker safety and protection are given in Sects. 4.5.8 and 4.6.9 of the FEIS.

Response to KH Comment No. 8

At this time, it is not expected that a full-time industrial hygienist will be required.

Response to PB Comment No. 1

The zero-liquid discharge option and alternative plant makeup water sources are discussed in Sect. 2.3.2.1 of the FEIS. These options will be considered in the decision-making process.

Response to PB Comment No. 2

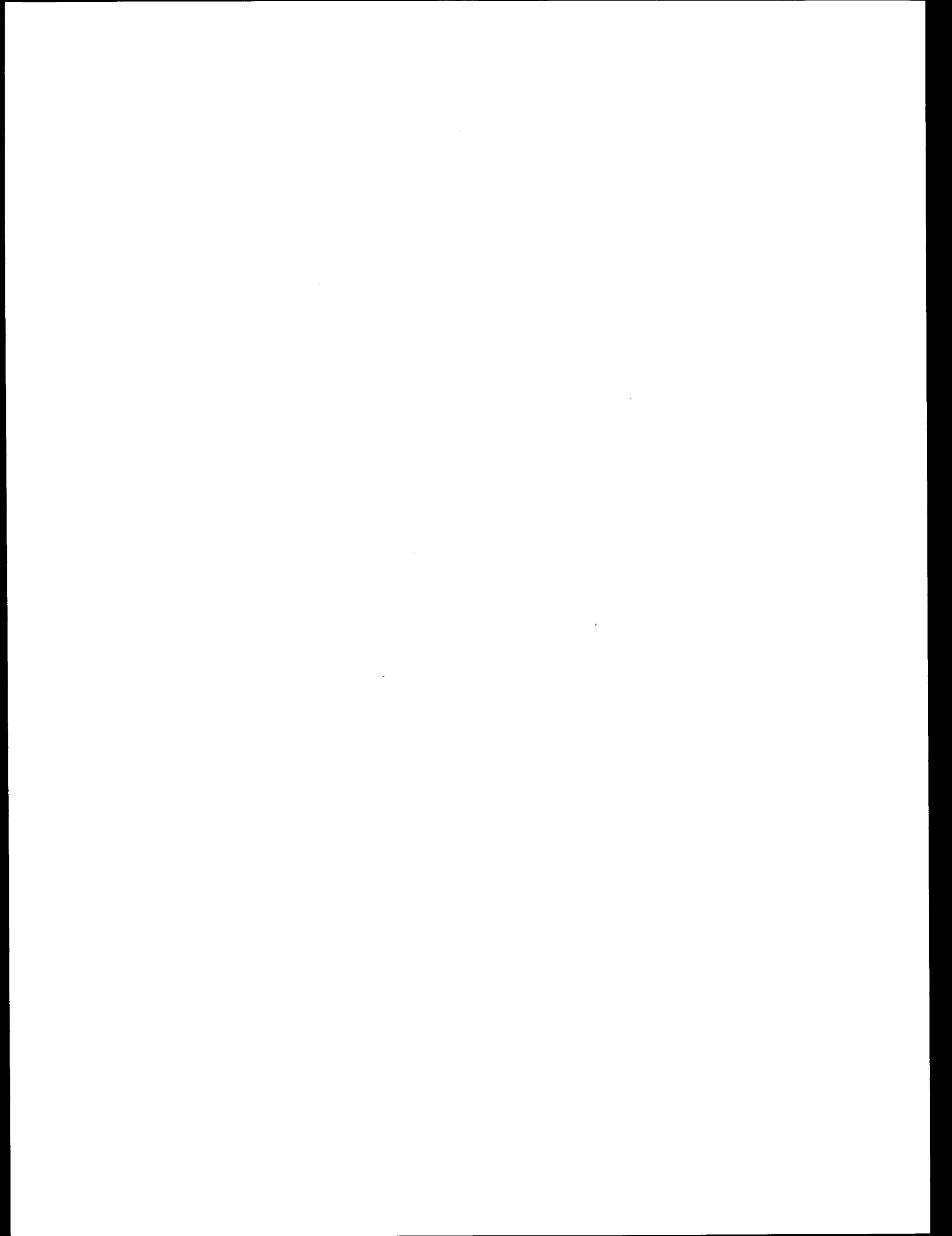
Air quality monitoring is described in Sect. 4.5.2 of the FEIS. Health concerns are addressed in Sects. 4.4, 4.5.8, and 4.6.9 of the FEIS. DOE feels that these monitoring programs are adequate to address your concerns. The adequacy of the siting of air quality monitors is discussed in response to MAS Comment No. 2.

Response to PB Comment No. 3

See response to DOI Comment No. 4.

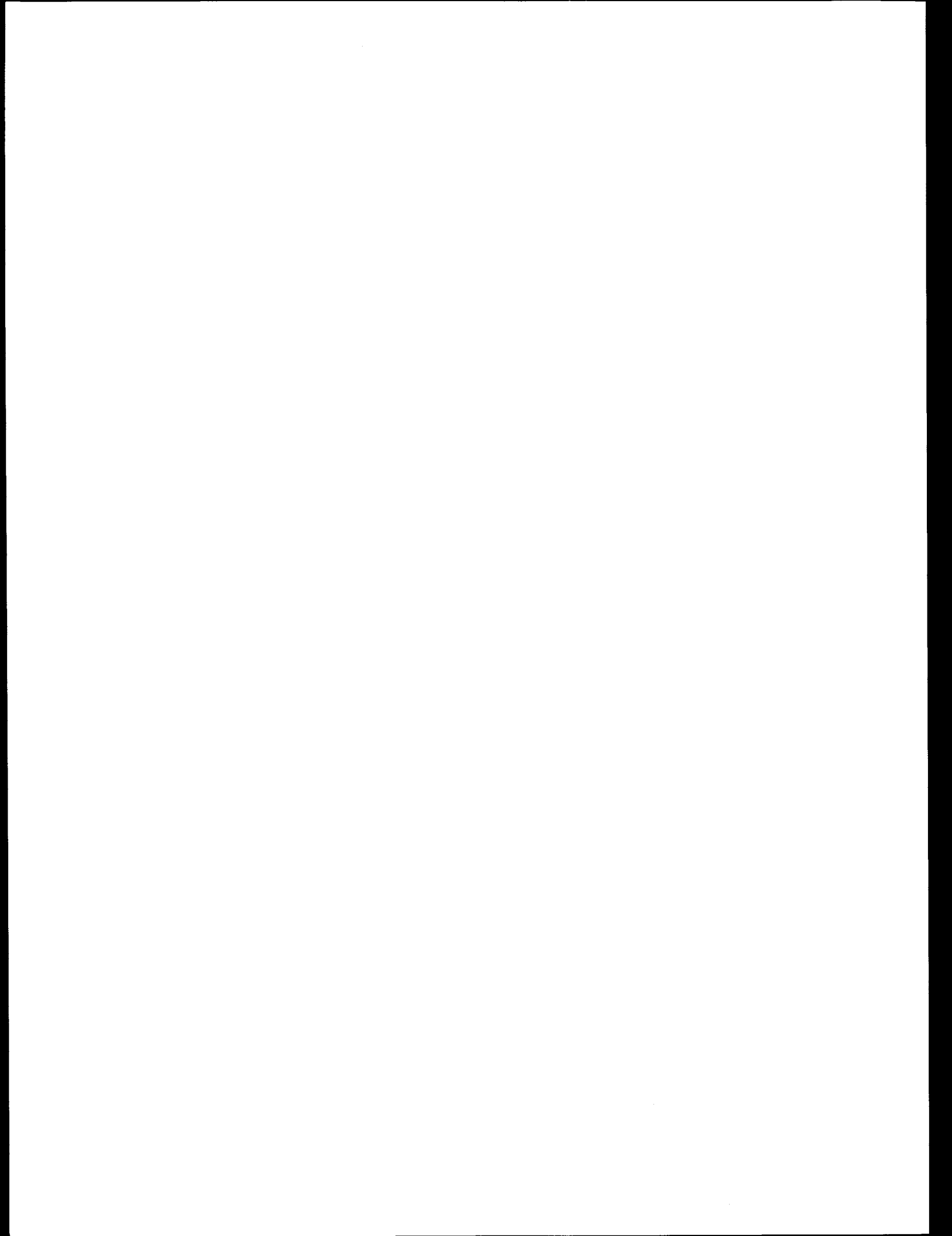
## Appendix B.1

### HYDROLOGY



Appendix B  
TECHNIQUES AND DATA





Appendix B.0  
PROCESS DESCRIPTION



## Appendix B.O.1

## EFFLUENT CHARACTERISTICS — POLYCYCLIC AROMATIC HYDROCARBONS

The concentrations of polycyclic aromatic hydrocarbons (PAHs) in the effluent-treated wastewater from the MLGW demonstration plant are expected to be relatively low. The high temperatures and high conversions characteristic of the U-gas gasification process minimize the formation of tars, oils, and PAH species. Relatively little quantitative information is available on PAH levels in coal conversion process streams.

Wastewater samples were collected from the raw-gas quench scrubber at IGT's U-gas pilot plant and analyzed by Energy Impact Associates.<sup>1</sup> The concentrations in the demonstration plant (with the waste heat boiler preceding the raw-gas scrubber) may differ because the pilot plant has no waste heat boiler. The results at steady-state conditions indicate that the U-gas pilot plant produces a fairly clean scrubber effluent stream:

| <u>Compound</u> | <u>Concentration (ppm)</u> |
|-----------------|----------------------------|
| Naphthalene     | 0.14                       |
| Acenaphthylene  | 0.006                      |
| Fluorene        | 0.002                      |
| Fluoranthene    | 0.1                        |
| Pyrene          | 0.11                       |
| Phenanthrene    | 0.79                       |
| Anthracene      | 0.006                      |
| Total phenols   | 0.26                       |
| Cyanides        | <0.1                       |
| Benzene         | 0.45                       |
| Toluene         | 0.004                      |
| Chloroform      | 0.13                       |

Compared with these steady-state values, the transient startup PAH values (where temperatures and coal conversion efficiencies were lower) from the U-gas process were observed to be higher. It was also observed that most of the organic pollutants were quantitatively adsorbed on the carbonaceous particulate matter present in the raw-gas scrubber effluent.

The treated wastewater, compared with the raw scrubber liquor, would have substantially less PAH. The removal percentages that could be expected in a conservatively designed water treatment facility can be approximated by using data derived from an SRC-I liquefaction plant, where the raw-water PAH concentrations were generally 4 to 100 times higher than shown previously for U-gas. For a system incorporating biological oxidation plus carbon, the removal percentages for a slate of PAH species ranged from 75 to 96%.

In such a study conducted at an SRC pilot plant in Ft. Lewis, Washington, PAHs were found in the effluent while the plant was operating in the SRC-I mode using Kentucky high-sulfur bituminous coal; values were reported by Hittman.<sup>2</sup> Although environmental concern exists because of their carcinogenic potential, the small quantities of PAH found in the process wastewater were below those levels considered hazardous. Even before wastewater treatment, the PAH levels were 1 to 6 orders of magnitude below the minimum acute toxicity effluent (MATE) values based on health effects.<sup>3</sup>

Very limited data are available on the low-level chronic effects of PAHs. Many of the available studies have focused on the long-range effects of oil spills and other petroleum pollution, but the extent of the PAH effect is not discernible from these studies. Biodegradation is expected to be variable; it can reduce some species concentrations 30% or more and, by itself, cannot be depended on to reduce the level of any particular PAH compound in the effluent streams by more than 80%. Activated carbon treatment following the biological oxidation stage can be expected to reduce an additional 75% of the final effluent to be discharged to the river.

Dilution by river water, even under ten-year low-flow conditions, leads to vanishingly small concentrations, in the 0.1 µg/liter range for many of the species.

## Appendix B.0.2

## SOURCE PARAMETERS FOR GASEOUS EMISSIONS

| <u>Stream</u>                 | <u>Stretford<br/>vent<br/>gas</u> | <u>Boiler<br/>stack<br/>gas<sup>a</sup></u> | <u>Cooling<br/>tower</u> | <u>Flare<br/>gas</u> |
|-------------------------------|-----------------------------------|---------------------------------------------|--------------------------|----------------------|
| Temperature, °C               | 107                               | 204                                         |                          | 93                   |
| Velocity, m/sec               | 37                                | 14                                          |                          | 6                    |
| Diameter, cm                  | 43                                | 340                                         |                          | 127                  |
| Height, meters above<br>grade | 30                                | 46                                          |                          | 76                   |
| Coordinates, m                |                                   |                                             |                          |                      |
| $x$ (east) <sup>b</sup>       | 260                               | 260                                         | 260-273                  | 488                  |
| $y$ (north) <sup>b</sup>      | 305                               | 152                                         | 46-91                    | 411                  |

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<sup>a</sup>Includes incinerator off-gas.

<sup>b</sup> $x = y = 0$  at southwest corner of plant.

## Appendix B.0.3

## RESOURCE REQUIREMENTS FOR CONSTRUCTION AND OPERATION

Materials for construction

Significant quantities of materials are to be consumed during the construction phase. Estimates of major resources include:

|                                    |                                                         |
|------------------------------------|---------------------------------------------------------|
| Water                              | $4.38 \times 10^{-4} \text{ m}^3/\text{s}$ (10,000 gpd) |
| Concrete                           | $26,759 \text{ m}^3$ (35,000 yd <sup>3</sup> )          |
| Steel (structural and reinforcing) | 5750 tons                                               |
| Surfacing                          | $267,560 \text{ m}^2$ (320,000 yd <sup>2</sup> )        |
| Roofing                            | $1393 \text{ m}^2$ (15,000 ft <sup>2</sup> )            |
| Tile flooring                      | $1393 \text{ m}^2$ (15,000 ft <sup>2</sup> )            |
| Acoustical ceiling                 | $1393 \text{ m}^2$ (15,000 ft <sup>2</sup> )            |
| Wood                               | $47 \text{ m}^3$ (20,000 bd ft)                         |
| Glass                              | $279 \text{ m}^2$ (3,000 ft <sup>2</sup> )              |
| Pipe                               | 4000 tons                                               |
| Electrical wiring                  | 609,600 m (2,000,000 ft) (various sizes)                |
| Fuel (propane)                     |                                                         |
| Electricity                        |                                                         |

Materials for operation

Significant quantities of resources are to be consumed during operation of the demonstration facilities. Estimates of major consumables include:

|                               |                                                                                    |
|-------------------------------|------------------------------------------------------------------------------------|
| Coal (western Kentucky No. 9) | 1,042,140 tons per year                                                            |
| Water                         | $5.09 \times 10^6 \text{ m}^3/\text{year}$ ( $0.89 \times 10^9 \text{ gal/year}$ ) |
| Electricity                   | 356 MW/year                                                                        |
| Natural gas                   | $0.11 \times 10^6 \text{ m}^3$ ( $3.8 \times 10^6 \text{ ft}^3/\text{year}$ )      |
| Phosphate                     | 3.0 tons per year                                                                  |
| Selexol solvent               | 20.3 tons per year                                                                 |
| Sodium carbonate (soda ash)   | 456.2 tons per year                                                                |
| Potassium carbonate           | 22.6 tons per year                                                                 |
| Sulfuric acid                 | 223.7 tons per year                                                                |

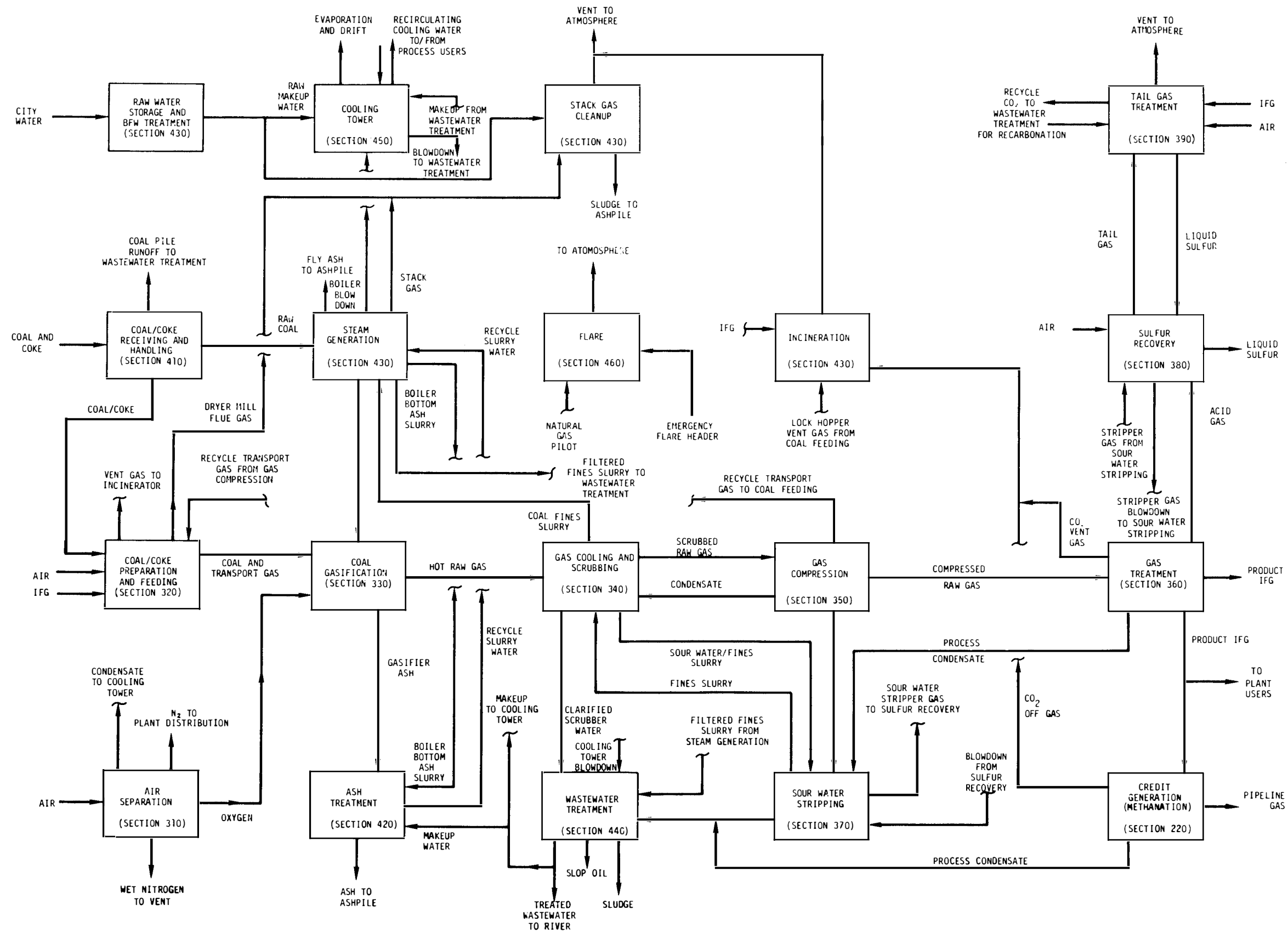
|                                                            |                    |
|------------------------------------------------------------|--------------------|
| Caustic (50% NaOH)                                         | 5.9 tons per year  |
| Amine                                                      | 0.05 tons per year |
| Hydrazine                                                  | 2.1 tons per year  |
| Corrosion inhibitor                                        | 21.5 tons per year |
| Dispersant                                                 | 11.5 tons per year |
| Chlorine                                                   | 14.9 tons per year |
| Activated carbon                                           | 50.0 tons per year |
| Hydrated lime                                              | 4518 tons per year |
| Polymer                                                    | 0.66 tons per year |
| Phosphoric acid                                            | 3.3 tons per year  |
| Rhone Progil type CR<br>catalyst (sulfur<br>recovery)      | 20.6 tons per year |
| N-25 American Cyanamid<br>catalyst (tail-gas<br>treatment) | 3.2 tons per year  |
| Methanation catalyst                                       | 5.3 tons per year  |
| United G3/C catalyst<br>(credit generation)                | 4.0 tons per year  |
| United C72 catalyst<br>(credit generation)                 | 6.1 tons per year  |

Appendix B.0.4  
OVERALL BLOCK FLOW DIAGRAM OF THE IFGDP

Source: ER, Fig. 2.11, p. 2-38









## Appendix B.1

### HYDROLOGY

Generally, for planning purposes, floods having an assigned risk are selected for use in the design. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2% chance, respectively, of being equaled or exceeded during any year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1% chance of annual occurrence) in any 50-year period is about 40%; for any 90-year period, the risk increases to about 60%.

To predict the magnitude of any flooding event, two important sets of parameters may be identified: maximum flows to be conveyed during the flood and the hydraulic characteristics of the stream system that will convey the flood.

Maximum flows are determined by using gages to analyze historic flow data of streams. Probabilities are assigned, based on a process of ranking historic maximums. The longer the period of recorded data, the more reliable the flow calculations. Regression equations have been developed for ungaged streams in most areas of the country, based on the following drainage basin characteristics: drainage area, channel slope, land use, soil type, percentage of area that serves for storage of surface water, and index of average annual excess precipitation. Once the flows have been determined, physical hydraulic characteristics of the stream to be analyzed must be determined. The cross-sectional area of the stream must be determined, and obstructions to flow, such as bridges and dams, must be surveyed. Manning's "N" values must be assigned to the reaches of the stream. Methodologies exist for hand-calculating the flood elevations, based on this data. However, this calculation is very lengthy and tedious. Computer models have been developed to do the work faster and more accurately. Even with the sophistication of the computer models, it can be very difficult to identify the physical parameters sufficiently to gain the confidence required for the project. The ultimate method of analysis would employ a physical model of the stream in question, but the cost factor is prohibitive in most cases.

The reliability of the flood elevations and discharges is good for the proposed site. Gage data for the Mississippi River have been recorded continuously for 29 years. Therefore, flow determinations are extremely reliable. The hydraulic analysis was determined by using the U.S. Army Corps of Engineers' (COE) physical model of the Mississippi River. The elevations developed by the model are extremely reliable, assuming there are no failures in the levee system along the Mississippi River.



Appendix B.2

GEOLOGY, SOILS, AND GROUNDWATER CHARACTERISTICS



## Appendix B.2.1

## GEOLOGY

Geology of the Memphis area is illustrated in the block diagram in Fig. B.1. Regional westward dip of bedrock is reflected in the local structure. The diagram also shows lateral discontinuity of the Jackson clay in the southeast Memphis area. Major physiographic features shown include the Mississippi River floodplain, the terrace and loess deposits, and major streams draining the area.

The block diagram shows very general stratigraphic information for rocks and sediments older than Eocene Age. Figure B.2 gives a more complete stratigraphic column for rock units underlying the site at depth.

The site is underlain by about 46 m (150 ft) of sand and gravel river alluvium, which lies unconformably on the Jackson clay. Topography of the eroded surface of the Jackson clay is irregular and has been mapped by the Corps of Engineers<sup>4</sup> (Fig. B.3). Borings made during site investigations show the elevation of the alluvium-clay interface to be 16 to 18 m (55 to 60 ft) and 20 to 22 m (65 to 70 ft) in two locations. These elevations generally support the topographic interpretation by Krinitsky and Wire.<sup>4</sup>

The Jackson clay forms an aquiclude separating groundwater of the alluvium from the hydrologic system of the Memphis sand or 500-ft sand beneath most of the Memphis area. The Jackson clay is absent to the southeast of Memphis, and terrace deposits are in contact with the aquifer sands in that area.<sup>5</sup> Texture of sediment in the Jackson formation is variable; some areas are sandy, and there is indication that leakage may occur in some areas.<sup>5</sup> One area suspected of leakage is beneath Nonconnah Creek. It has been suggested that the course of the creek is controlled by an east-west trending fault.<sup>5</sup> Conclusive evidence to support or refute hydrologic interaction between the alluvium and the potable aquifer or the existence of a fault does not currently exist; however, these hypotheses have been developed to explain hydrologic behavior of the aquifer and well log observations. Figure B.4 shows the areal extent of the cone of depression in the 500-ft sand. The site is located near the western edge, the general area in which leakage through the Jackson clay may occur. Site-specific subsurface investigations extending into the Memphis sands have been performed; however, the thickness of the Jackson formation at the site indicates that it is both intact and extensive. A subsurface profile based upon the investigations is shown in Fig. B.5. In the unlikely event that a connection were present in the area of the site, serious contamination of the alluvial aquifer in this area could potentially result in contamination of the Memphis water supply. To minimize this possibility, the plant's coal and ash storage areas will be lined with an impermeable synthetic liner to collect leachate and prevent it from contaminating the alluvial aquifer. Leaks will be identified through the use of underliner drains and will be located and repaired before the leak worsens.

Seismicity in the Memphis area is related to seismic activity in the New Madrid fault zone and associated structures in the Rough Creek and St. Genevieve fault zones. Figure B.6 shows the general locations of the major fault systems of the northern Mississippi embayment and adjacent areas. The Big Creek fault zone, part of the New Madrid system of faults, lies a few miles west of Memphis.

The distribution of earthquake epicenters in Fig. B.7 shows that the focus of seismic events in the upper embayment is in the New Madrid zone. The historic recurrence interval of earthquakes with intensities of VII or greater for the region is about 11 years.<sup>6</sup> The recurrence interval of damaging quakes in the Memphis area is about 40 years.<sup>6</sup>



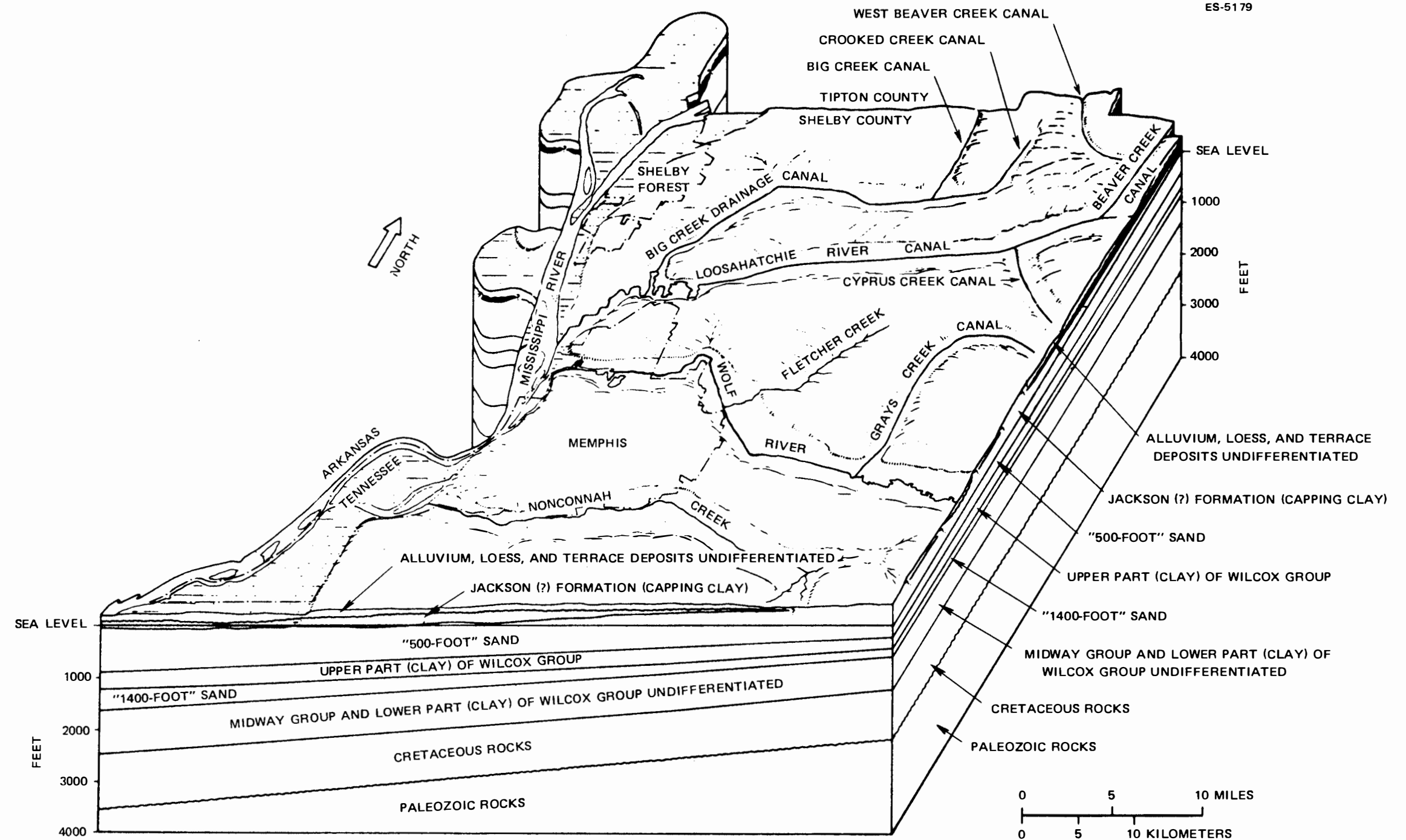


Fig. B.1. Block diagram showing physiographic and geologic features of the Memphis, Tennessee, area. Source: ER, Fig. 1-25, p. 3-73.

| Era        | System         | Series                        | Subdivisions                                     |
|------------|----------------|-------------------------------|--------------------------------------------------|
| Cenozoic.  | Quaternary     | Recent.                       | Alluvium.                                        |
|            |                | Pleistocene.                  | Loess.                                           |
|            | Tertiary       | Pliocene.                     | Gravel (some of the terrace may be Pleistocene). |
|            |                | Eocene.                       | Jackson formation.                               |
|            |                |                               | Upland group                                     |
| Mesozoic.  | Cretaceous.    | Upper Cretaceous.             | Holly Springs sand.                              |
|            |                |                               | Ackerman formation.                              |
|            |                |                               | Porters Creek clay.                              |
|            |                |                               | Clayton formation.                               |
|            |                |                               | Ripley formation.                                |
| Paleozoic. | Carboniferous. | Mississippian.                | McNairy sand member.                             |
|            |                |                               | Coon Creek tongue.                               |
|            |                |                               | Selma clay.                                      |
|            |                |                               | Coffee sand member.                              |
|            |                |                               | Tombigbee sand member.                           |
|            |                |                               | Tuscaloosa formation.                            |
|            |                |                               | St. Louis limestone.                             |
|            |                |                               | Fort Payne chert.                                |
|            |                |                               | Ridgetop shale.                                  |
|            |                |                               | Chattanooga shale.                               |
| Paleozoic. | Devonian.      | Lower Devonian.               | Pegram limestone.                                |
|            |                |                               | Camden chert.                                    |
|            |                |                               | Harriman chert.                                  |
|            |                |                               | Quail limestone.                                 |
|            |                |                               | Decaturville chert.                              |
|            |                |                               | Birdsong shale.                                  |
|            |                |                               | Flat Gap limestone member.                       |
|            |                |                               | Olive Hill formation.                            |
|            |                |                               | Bear Branch limestone member.                    |
|            |                |                               | Ross limestone member.                           |
| Paleozoic. | Silurian.      | Silurian.                     | Rockhouse shale.                                 |
|            |                |                               | Decatur limestone.                               |
|            |                |                               | Bransford formation.                             |
|            |                |                               | Lobbville shaly limestone member.                |
|            |                |                               | Bed crystalline limestone member.                |
|            |                |                               | Boon River shaly limestone member.               |
|            |                |                               | Dixon early limestone member.                    |
|            |                |                               | Lega limestone member.                           |
|            |                |                               | Waldron clay member.                             |
|            |                |                               | Laurel limestone member.                         |
| Paleozoic. | Ordovician.    | Upper Ordovician (Cincinnati) | Ferriss formation.                               |
|            |                | Middle Ordovician (Mohawk)    | Arbela limestone.                                |
|            |                |                               | Waverly formation.                               |

Fig. 8.7. Generalized stratigraphic column of the geologic formations in western Tennessee. Source: ES, Table 3-1, pp. 1-6 and 3-7.



ES-4999

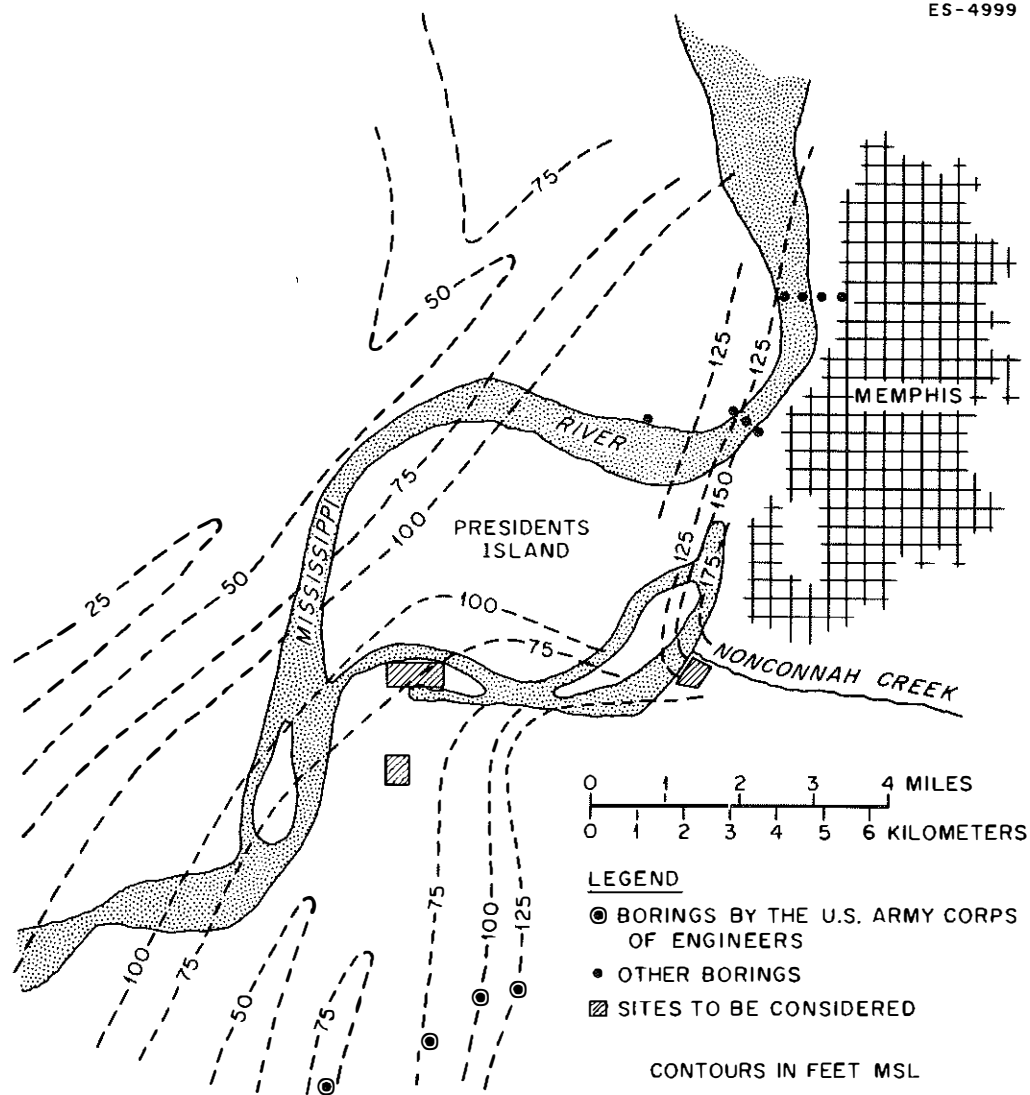


Fig. B.3. Topography of the eroded surface of Jackson clay. Source: Modified from E. L. Krinitzsky and J. C. Wire, *Groundwater in Alluvium of the Lower Mississippi Valley (Upper and Central Areas)*, Tech. Rep. 3-658, Vol. 2, U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss., September 1964.

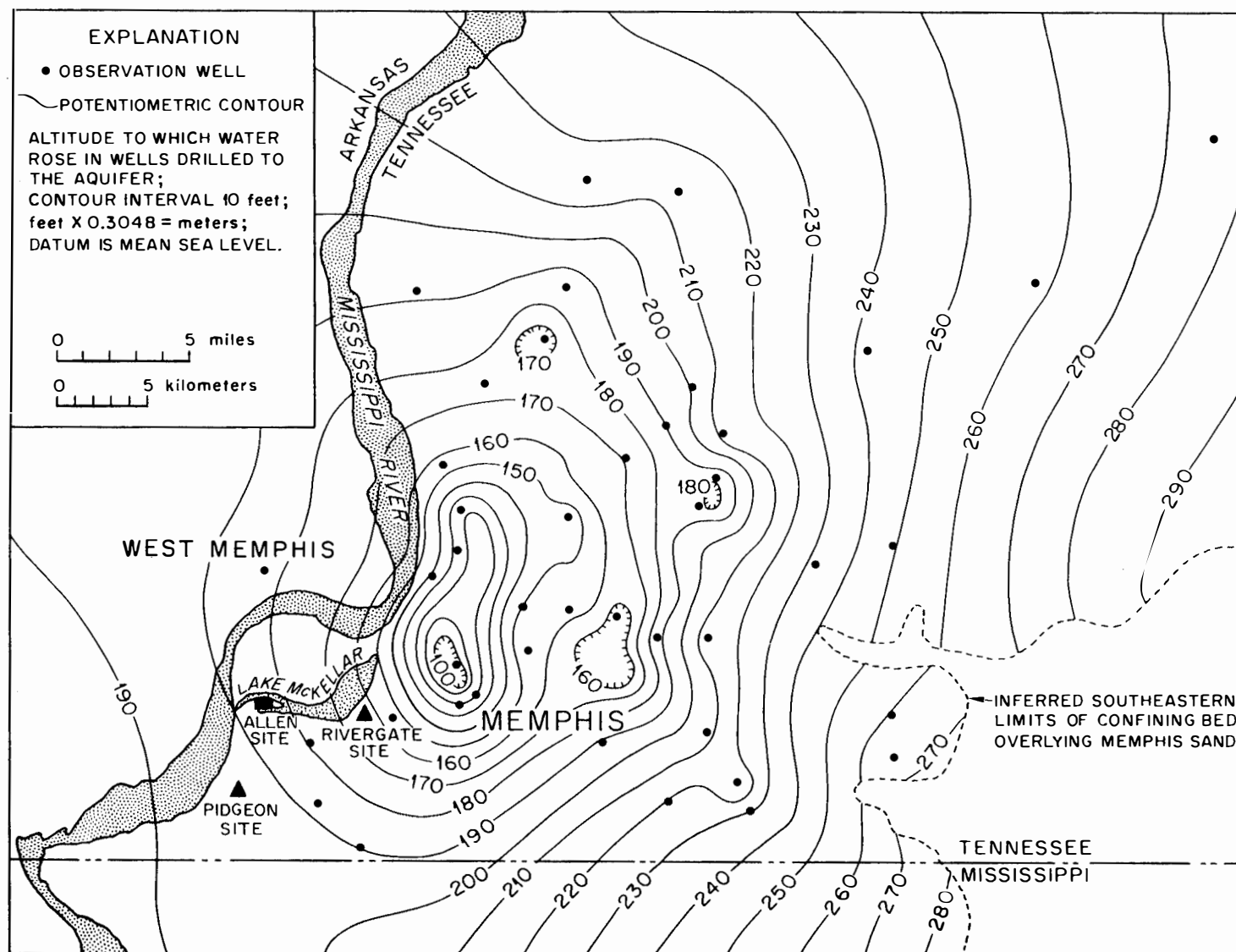


Fig. B.4. Potentiometric surface of Memphis sand, 1970. Source: Modified from J. H. Criner and W. S. Parks, *Historic Water-Level Changes and Pumpage from the Principal Aquifer of the Memphis Area, Tennessee: 1886-1975*, U.S. Geological Survey Water Resources Investigation 76-67, 1976.

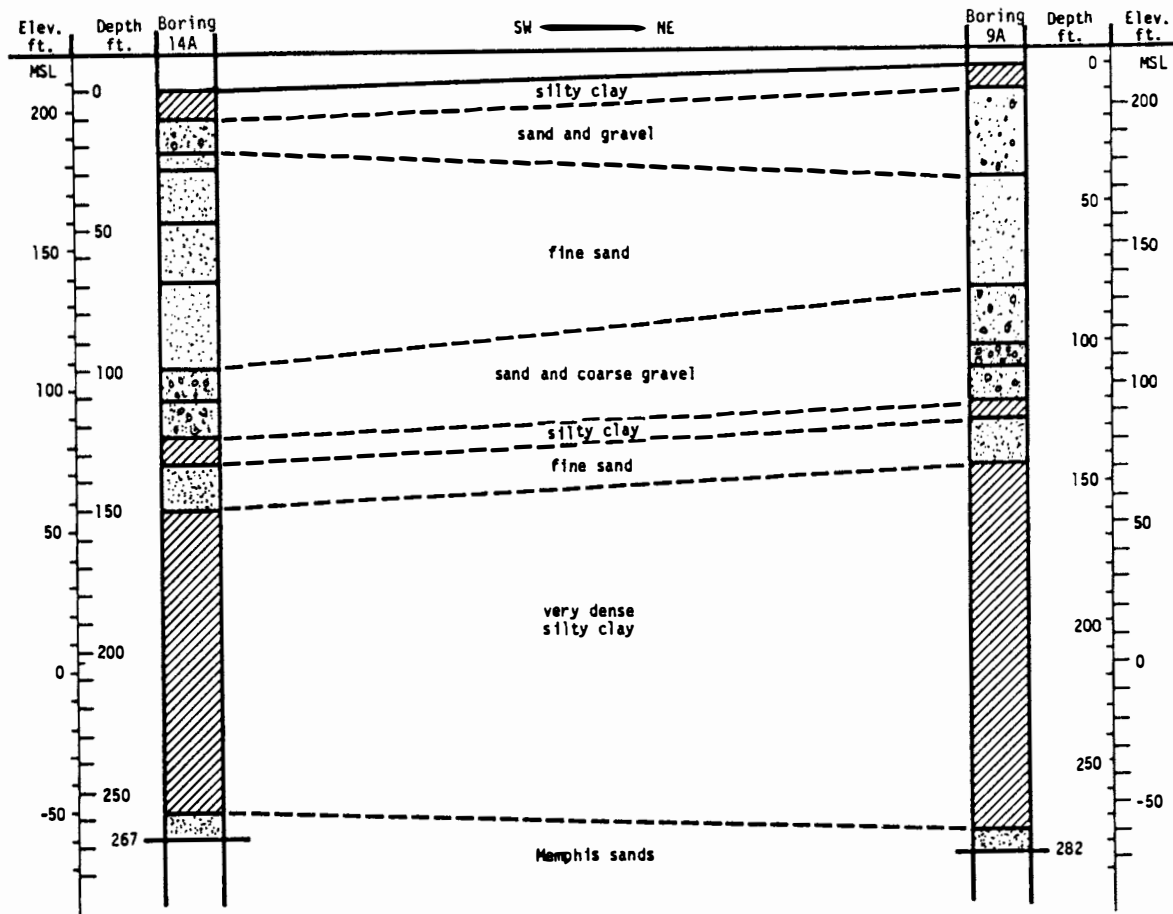


Fig. B.5. Generalized subsurface profile.

ES-5205A

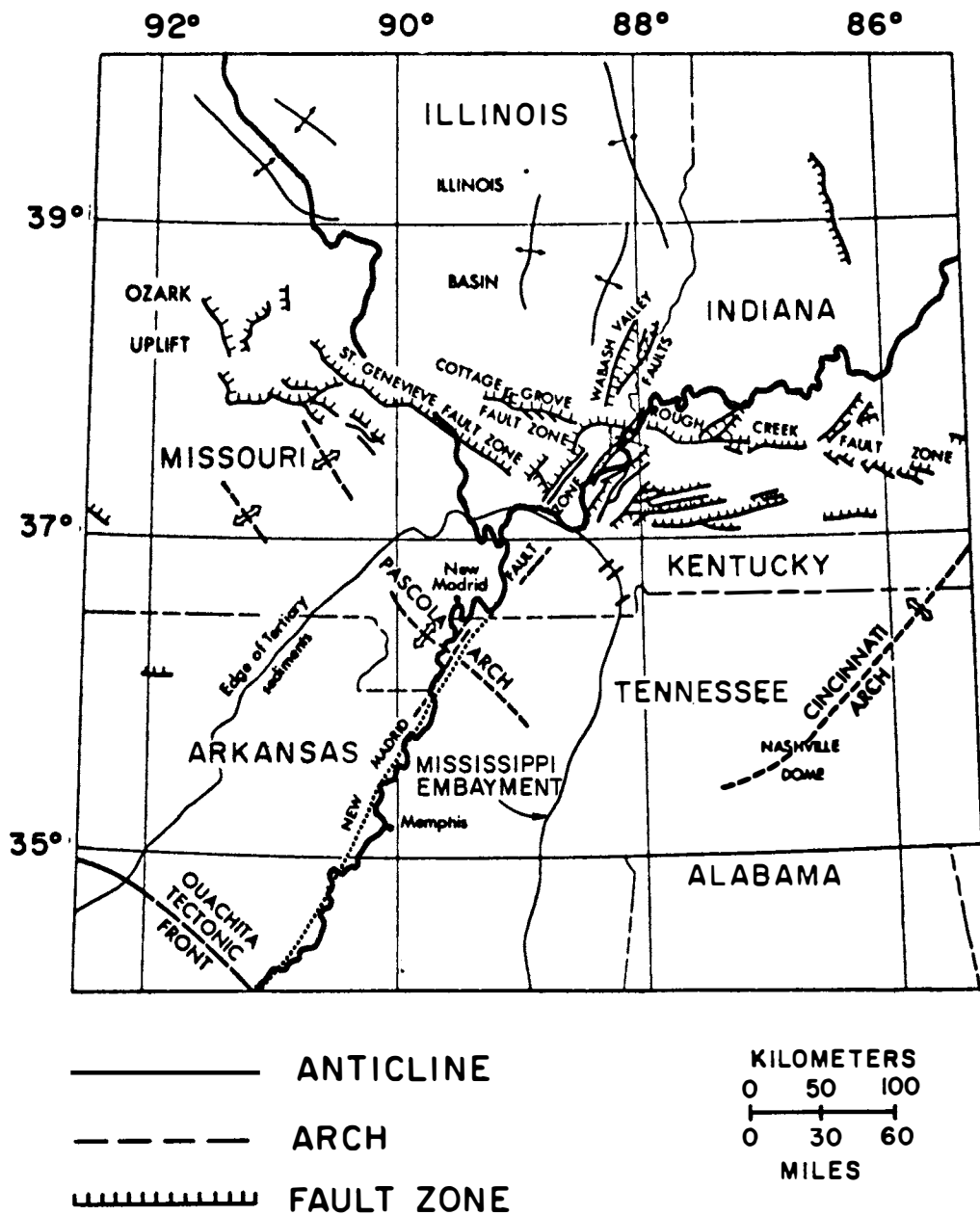


Fig. B.6. Tectonic map of intersection area of the extension of the New Madrid Seismic Zone and the 38th parallel lineament. Source: Modified from W. J. Hinze, L. W. Braile, G. R. Keller, and E. G. Lidiak, *A Tectonic Overview of the Central Midcontinent*, NUREG-0382, U.S. Nuclear Regulatory Commission, Washington, D.C., 1977, p. 10.

ES-4996

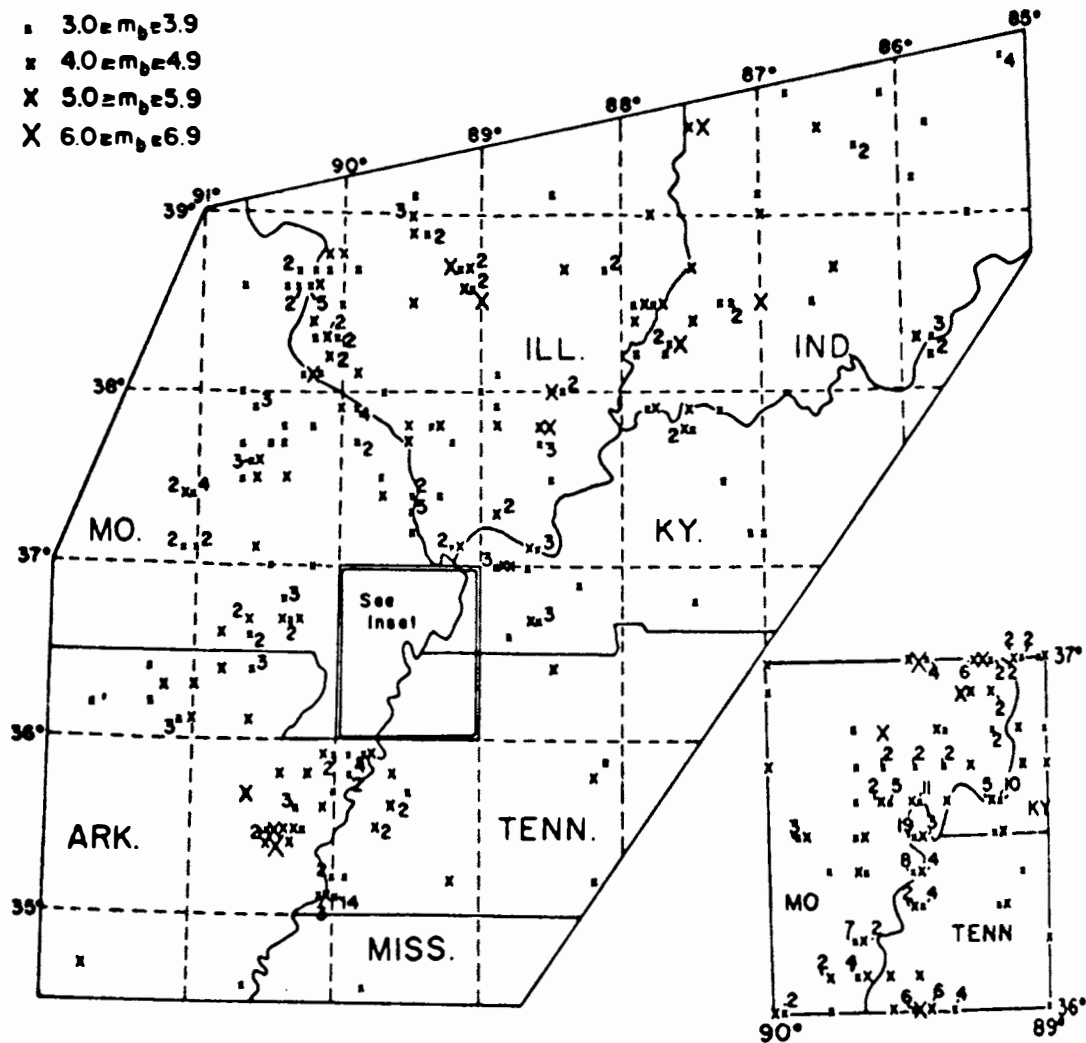


Fig. B.7. Distribution of reported earthquakes of  $m_b \geq 3.0$  from 1833 through 1972 in the Central Midcontinent. The numbers refer to the number of earthquakes with the same epicenter. Source: W. J. Hinze, L. W. Braile, G. R. Keller, and E. G. Lidiak, *A Tectonic Overview of the Central Midcontinent*, NUREG-0382, U.S. Nuclear Regulatory Commission, Washington, D.C., 1977, p. 29.



## Appendix B.2.2

## SOIL AND GROUNDWATER CHARACTERISTICS OF THE PROPOSED SITE

Both the soils existing on the proposed site and the material to be used in filling the area to grade elevation consist of fine to coarse sand having little silt and clay content. The soil is permeable, is well drained near the surface, and has low ion exchange potential. High water in the Mississippi River and Lake McKellar saturates the soils, resulting in anaerobic conditions coupled with elevated rates of groundwater movement in the phreatic zone.

The dominant soil-groundwater interactions known to occur in the alluvial soils in this area are related to the carbonate and bicarbonate buffer reactions (ER, vol. 2, Sect. 3.3.2.3, p. 3-87). Results of groundwater monitoring during 1978 and 1979 are summarized in Table 8.2. Groundwater is neutral to slightly alkaline, is high in total dissolved solids, and contains the major dissolved species calcium, magnesium, iron, bicarbonate, and sulfate. Reduced conditions, or formation of metal complexes in groundwater, are reflected in the relatively high dissolved iron content observed during the monitoring program (Table 8.1).

Groundwater movement beneath the site is known to respond rapidly to fluctuations in the water level of adjacent surface water bodies. Table 8.2 presents the results of groundwater level monitoring correlated with water levels in Lake McKellar. Direction of movement at shallow depth is generally assumed to be largely lateral and in a downgradient direction, normally toward a surface water body, with direction of movement reversing during floods. Horizontal permeability of the shallow is greater than vertical permeability (ER, vol. 2, Sect. 3.3.2.3, p. 3-82). Upon completion of the site fill, vertical groundwater fluctuation may range from an average low lake level of about 57 m (185 ft) to the level of a 100-year frequency flood, about 69 m (225 ft), a range of 12 m (40 ft). Lateral groundwater movement from the center of the site to Lake McKellar is about 305 m (1000 ft).

Table B.1. Summary statistics of seasonal shallow groundwater field surveys conducted between May 1978 and January 1979

| Parameter <sup>a</sup>  | Range low/high | Mean    | Number of observations | Standard deviation |
|-------------------------|----------------|---------|------------------------|--------------------|
| Physical                |                |         |                        |                    |
| pH, units               | 6.7/6.7        | 6.7     | 2                      | 0                  |
| Total dissolved solids  | 408/450        | 434.2   | 6                      | 17.1               |
| Total suspended solids  | 32/78          | 45.4    | 8                      | 14.1               |
| Total alkalinity        | 332/365        | 354.0   | 8                      | 12.7               |
| Oil and grease          | 0.2/1.1        | <0.71   | 8                      | b                  |
| Nutrients               |                |         |                        |                    |
| Total kjeldahl nitrogen | 0.16/1.06      | 0.52    | 8                      | 0.291              |
| Nitrite nitrogen        | 0.015/0.095    | 0.039   | 8                      | 0.032              |
| Nitrate nitrogen        | 0.02/1.15      | 0.327   | 8                      | 0.478              |
| Ammonia nitrogen        | 0.07/0.510     | 0.293   | 8                      | 0.184              |
| Total phosphorus        | 0.19/0.44      | 0.365   | 8                      | 0.098              |
| Organic phosphorus      | <0.01/0.09     | <0.045  | 8                      | b                  |
| Orthophosphate          | <0.03/0.37     | <0.253  | 8                      | b                  |
| Organics                |                |         |                        |                    |
| BOD <sub>5</sub>        | 0.9/8.0        | 5.48    | 8                      | 2.95               |
| COD                     | 4/26.0         | 12.73   | 8                      | 7.55               |
| TOC, present            | 4.1/11.0       | 7.02    | 6                      | 2.78               |
| DOC                     | 3.1/7.2        | 5.15    | 6                      | 1.57               |
| Phenol                  | 0.007/0.021    | 0.0126  | 8                      | 0.0052             |
| Major anions            |                |         |                        |                    |
| Chloride                | <0.5/9.0       | <4.483  | 8                      | b                  |
| Cyanide                 | <0.005/<0.005  | <0.005  | 8                      | b                  |
| Fluoride                | 0.06/0.24      | 0.159   | 8                      | 0.167              |
| Sulfate                 | 24/75          | 42.63   | 8                      | 21.421             |
| Major cations           |                |         |                        |                    |
| Aluminum                | <0.05/0.4      | <0.16   | 8                      | b                  |
| Barium                  | 0.4/1.73       | 1.003   | 8                      | 0.508              |
| Calcium                 | 90.2/103.5     | 96.26   | 10                     | 5.03               |
| Iron                    | 16.0/21.5      | 19.41   | 10                     | 1.99               |
| Magnesium               | 10.0/33.4      | 26.76   | 10                     | 8.95               |
| Other metals            |                |         |                        | b                  |
| Antimony                | <0.01/<0.1     | <0.055  | 8                      | b                  |
| Arsenic                 | <0.01/0.02     | <0.046  | 8                      | b                  |
| Beryllium               | <0.002/<0.002  | <0.002  | 6                      | b                  |
| Boron                   | <0.01/0.19     | 0.09    | 6                      | b                  |
| Cadmium                 | 0.0025/<0.01   | <0.006  | 8                      | b                  |
| Chromium, total         | 0.005/0.008    | <0.020  | 7                      | b                  |
| Chromium, hexavalent    | <0.01/<0.01    | <0.01   | 6                      | b                  |
| Cobalt                  | <0.01/0.01     | <0.01   | 8                      | b                  |
| Copper                  | <0.005/0.066   | <0.0158 | 7                      | b                  |
| Lead                    | <0.01/0.02     | <0.019  | 7                      | b                  |
| Manganese               | 0.01/29.0      | 10.76   | 7                      | 12.46              |
| Mercury (µg/liter)      | <0.2/2.0       | <0.675  | 8                      | b                  |
| Molybdenum              | <0.03/<0.03    | <0.03   | 6                      | b                  |
| Nickel                  | 0.007/0.02     | 0.011   | 5                      | 0.005              |
| Selenium                | <0.005/<0.01   | <0.008  | 6                      | b                  |
| Strontium               | 0.21/0.339     | 0.269   | 8                      | 0.0468             |
| Titanium                | <0.01/<0.1     | <0.07   | 6                      | b                  |
| Uranium                 | <1.0/<1.0      | <1.0    | 4                      | b                  |
| Vanadium                | <0.08/<0.08    | <0.08   | 6                      | b                  |
| Zinc                    | 0.022/0.033    | 0.026   | 7                      | 0.0057             |
| Zirconium               | <2.0/2.0       | <2.0    | 6                      | b                  |

<sup>a</sup>In mg/liter, except as otherwise noted.

<sup>b</sup>Standard deviation not computed.

Note: For calculation of means and standard deviations, all less-than-detectable values were assumed to equal the limits of detection. Means calculated in this way reflect higher values than actually occur and should be regarded as maximum possible mean values. Standard deviations were not determined for parameters that were present at less than detectable levels.

Source: Energy Impact Associates.

Table B.2. Well measurements, shallow well at Allen site (once weekly)

| Date<br>(1979) | Time     | Measured<br>depth to<br>water <sup>a</sup> | Remarks                                       | Lake McKellar<br>level at the Ensley<br>Engineering Yard<br>(ft above mean<br>sea level) | Measured<br>level of water<br>in well<br>(ft above mean<br>sea level) | Increment between<br>well and lake levels<br>(ft; + indicates well<br>level was above<br>lake level) |
|----------------|----------|--------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Jan. 19        | 1:23 PM  | 11'0"                                      | Rainy; top of<br>orange casing                | 200.25                                                                                   | 201.5                                                                 | +1.2                                                                                                 |
| Feb. 7         | 10:40 AM | 13'0"                                      | Top of casing                                 | 198.05                                                                                   | 199.5                                                                 | +1.4                                                                                                 |
| Feb. 22        | 11:45 AM | 21'9"                                      | Top of casing                                 | 191.15                                                                                   | 190.7                                                                 | -0.4                                                                                                 |
| Mar. 2         | 3:00 PM  | 5'9"                                       | Top of casing; sunny                          | 207.25                                                                                   | 206.7                                                                 | -0.5                                                                                                 |
| Mar. 9         | 4:00 PM  | Unable to<br>measure                       | Area flooded                                  | 213.55                                                                                   |                                                                       |                                                                                                      |
| Mar. 16        | 3:30 PM  | Same                                       | Same                                          | 216.85                                                                                   |                                                                       |                                                                                                      |
| Mar. 23        | 2:00 PM  | Same                                       | Same                                          | 215.05                                                                                   |                                                                       |                                                                                                      |
| Mar. 30        | 1:30 PM  | Same                                       | Same                                          | 212.05                                                                                   |                                                                       |                                                                                                      |
| Apr. 6         | 9:00 AM  | Same                                       | Same                                          | 213.45                                                                                   |                                                                       |                                                                                                      |
| Apr. 13        | 7:00 AM  | Same                                       | Same                                          | 216.45                                                                                   |                                                                       |                                                                                                      |
| Apr. 20        | 6:00 AM  | Same                                       | Same                                          | 218.15                                                                                   |                                                                       |                                                                                                      |
| Apr. 27        | 6:30 AM  | Same                                       | Same                                          | 217.15                                                                                   |                                                                       |                                                                                                      |
| May 4          | 7:00 AM  | Same                                       | Same                                          | 211.65                                                                                   |                                                                       |                                                                                                      |
| May 10         | 4:30 AM  | Same                                       | River dropping; well<br>still inaccessible    | 208.85                                                                                   |                                                                       |                                                                                                      |
| May 18         | 5:30 PM  | 7'3"                                       | Sunny; area surround-<br>ing well finally dry | 204.95                                                                                   | 205.2                                                                 | +0.3                                                                                                 |
| May 24         | 7:30 AM  | 10'4"                                      | Sunny                                         | 200.75                                                                                   | 202.2                                                                 | +1.4                                                                                                 |
| June 2         | 12:05 PM | 12'8"                                      | Rain                                          | 198.25                                                                                   | 199.8                                                                 | +1.6                                                                                                 |
| June 7         | 4:30 PM  | 11'11"                                     | Sunny                                         | 200.05                                                                                   | 200.6                                                                 | +0.5                                                                                                 |
| June 14        | 10:00 AM | 14'6"                                      | Sunny                                         | 197.55                                                                                   | 198.0                                                                 | +0.4                                                                                                 |
| June 21        | 8:00 AM  | 17'10"                                     | Sunny                                         | 193.35                                                                                   | 194.7                                                                 | +1.3                                                                                                 |
| June 30        | 8:45 AM  | 17'9"                                      | Sunny                                         | 194.95                                                                                   | 194.7                                                                 | -0.2                                                                                                 |
| July 7         | 10:00 AM | 20'0"                                      | Cloudy, rain                                  | 191.55                                                                                   | 192.5                                                                 | +0.9                                                                                                 |
| July 12        | 6:45 PM  | 20'2"                                      | Sunny                                         | 192.55                                                                                   | 192.3                                                                 | -0.2                                                                                                 |
| July 20        | 8:30 AM  | 19'2"                                      | Cloudy                                        | 193.15                                                                                   | 193.3                                                                 | +0.2                                                                                                 |

<sup>a</sup> Elevation of well casing top 212.48 ft above mean sea level.<sup>b</sup> Determined by calling U.S. COE, Memphis District.

Source: Monitoring data from Energy Impact Associates.

## Appendix B.2.3

## MOBILITY OF CONTAMINANTS IN THE SOIL-GROUNDWATER ENVIRONMENT

Movement of potential contaminants in the soil and groundwater environment is difficult to predict because so many factors enter into soil and groundwater chemistry. Available general information pertaining to soil character and groundwater monitoring is sufficient to allow prediction of the general behavior of several potentially toxic elements in the subsurface.

Many factors, both internal and external to the soil system, influence movement of trace elements in soils. External factors include climate and related factors such as moisture input and temperature. Soil properties exerting the greatest effect on the chemistry of soil attenuation include (1) the surface area and amount and types of clays present (related to soil texture); (2) the amount of iron, aluminum, and manganese hydroxy oxides; (3) pH; (4) redox conditions; (5) organic matter content; and (6) the type and concentration of other ions or gases in the soil. Other factors such as biological activity, hydrology, pore-space geometry, disposal-area design, time since disposal, and initial waste chemistry will also influence the final soil solution chemistry.

Table B.3 shows general mobility relationships for several toxic trace elements under aerobic and anaerobic, acid to alkaline conditions.<sup>7</sup> Soil conditions beneath the waste disposal areas and coal pile are expected to be predominantly in the anaerobic-neutral to alkaline condition. The soil generally has a low attenuation capacity for most metals because permeability is high, clay content is low resulting in low cation exchange coefficient (CEC), and reducing conditions are expected to predominate below shallow depths.

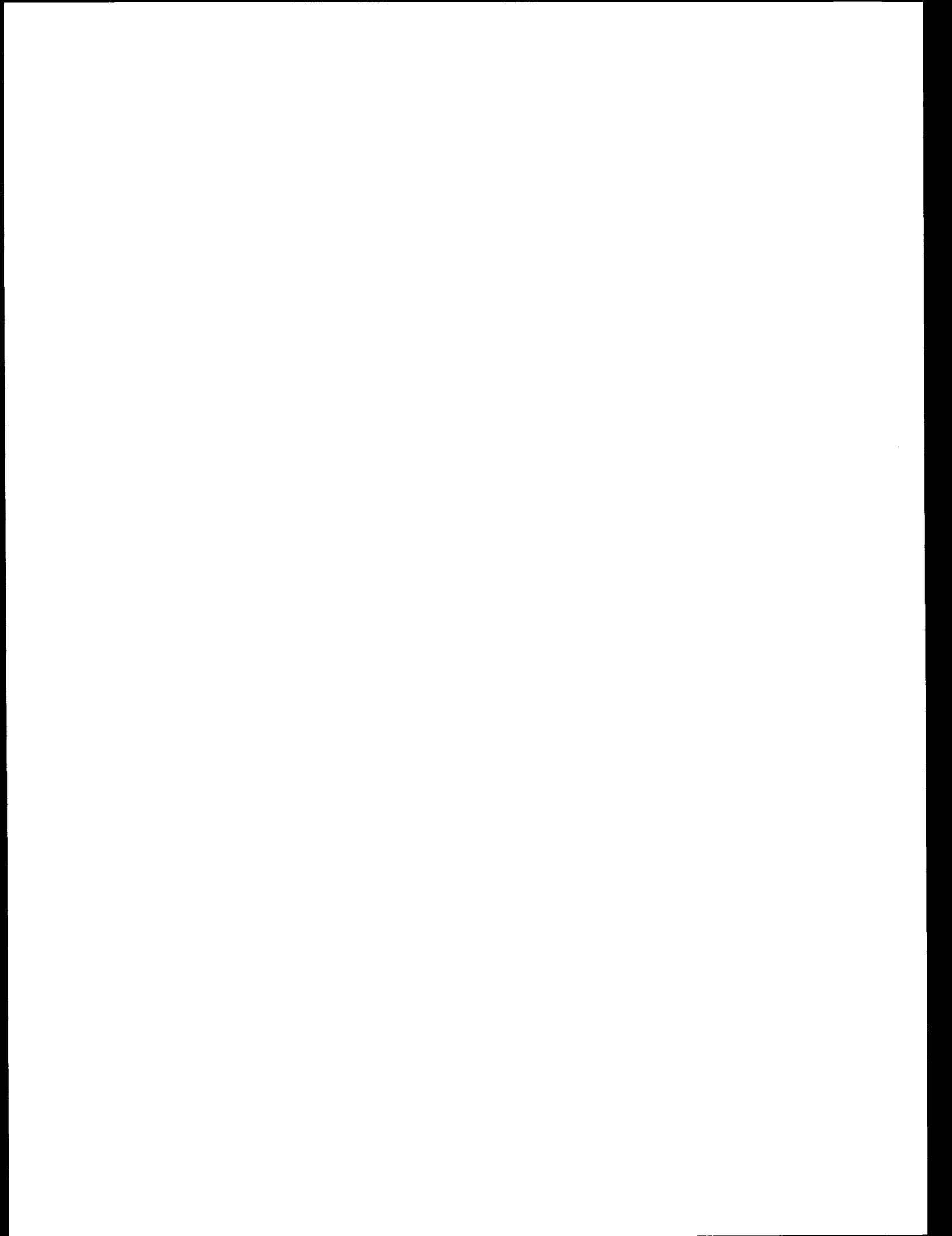
Table B.3. General mobility of selected elements under aerobic and anaerobic conditions

| Mobility in leachate | Aerobic conditions | Anaerobic/acid | Anaerobic/neutral to alkaline |
|----------------------|--------------------|----------------|-------------------------------|
| High                 | Se                 | Cd, Ni, Hg, Zn | As, Cr                        |
| Medium               | Fe, Zn, Pb, Cr     | As, Be, Cr     | Cd, Hg, Se, Zn                |
| Low                  | As, Cd, Cr, Hg     | Cu, Pb, Se     | Cu, Pb, Ni                    |

Source: Adapted from W. H. Fuller, *Movement of Selected Metals, Asbestos, and Cyanide in Soil: Applications to Waste Disposal Problems*, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1977.

Soil and groundwater buffering is strong, and acidity of any infiltrating waters is expected to be rapidly attenuated in the system. Existing subsurface soils on the site are reduced; iron oxide accumulations are not noted in subsurface materials. Monitoring data indicate that iron is mobile in the groundwater. Soil potential for attenuating iron, arsenic, chromium, zinc, cadmium, mercury, and selenium is low under the existing anaerobic conditions. The mobility of copper, nickel, and lead is expected to be low in the soil. Barium mobility is limited by solubility of barium sulfate.<sup>8</sup> Sulfate is present in the groundwater and is likely to be abundant in leachate from coal storage and waste storage areas within the plant (ER, vol. 2, Sect. 3.3.2.3, p. 3-87). Polycyclic aromatic hydrocarbons (PAHs) have low solubility in water, but, once carried into solution by detergents, oils, or organic compounds, they are quite mobile in permeable soils.<sup>9</sup> Photooxidation and microbial attack are the primary degrading mechanisms for PAHs.<sup>9</sup> Polycyclic aromatic hydrocarbons leached into the subsurface may be adsorbed onto soil particles, microbially degraded, or transported in groundwater.

Appendix B.3  
TERRESTRIAL ECOLOGY





Department of Energy  
Chicago Operations and Regional Office  
9800 South Cass Avenue  
Argonne, Illinois 60439

MAR 31 1981

Mr. Thomas S. Talley  
Field Supervisor  
U. S. Fish and Wildlife Service  
Division of Ecological Services  
P. O. Box 845  
Cookeville, Tennessee 38501

Dear Mr. Talley:

SUBJECT: FISH AND WILDLIFE COORDINATION ACT CONSULTATION REQUIREMENTS FOR  
THE MEMPHIS LIGHT, GAS & WATER DIVISION (MLGW) INDUSTRIAL FUEL GAS  
DEMONSTRATION PLANT (IFGDP)

Reference: Letter, Talley to Laza, dated December 28, 1979

Reference is made to your letter of December 28, 1979, which discussed the fish and wildlife aspects of the proposed MLGW IFGDP project. Included in your letter are comments pertaining to the site selection process, anticipated project impacts on fish and wildlife, and suggested project features to compensate those impacts. At the time of your letter, DOE was not in the position to formally respond to your comments and recommendations since this was prior to the development of the MLGW Draft and Final Environmental Impact Statements (EIS). Throughout the development of the EIS, as well as other agency documents, DOE has been in contact with various individuals from the Fish and Wildlife Services (FWS) and has given full consideration to the FWS' recommendations. As such, responses to your concerns and recommendations can be found in the final draft of the EIS. DOE is currently looking to issue the Final EIS in early May.

The following is our response to your specific recommendations found on page 4 of the referenced letter:

1. The agencies involved with the MLGW project did consider relocating the project outside of the floodplains. Separate studies conducted by the Industrial Team and DOE arrived at the conclusion that no practicable alternative to locating at the proposed site existed. Rationale for this decision is detailed in the Floodplains/Wetlands determination document (See Comment 2 below).

MAR 31 1981

Mr. Thomas S. Talley

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2. In order to comply with Executive Orders 11988 and 11990, DOE developed a report (Identification and Evaluation of Alternatives to the Location of a Proposed Federal Action in the Floodplain) which identified and evaluated the alternatives to the proposed action. As a result of this report, on May 22, 1980, DOE published their Preliminary Statement of Findings in the Federal Register. This Preliminary Statement of Findings and supporting rationale concluded that there is no practicable alternative to locating a plant in the Mississippi River Floodplain/Wetlands. No comments were received concerning this Statement of Findings.
3. In the development of the MLCW EIS, DOE has addressed and incorporated various mitigation means and measures into the project so as to minimize environmental impacts. The Final EIS will discuss those actions which have been determined to be appropriate for the project. The types of action discussed included ways to avoid the impact, minimize the impact, rectify the impact, and reduce or eliminate the impact over time (i.e., avoid construction activities in sunfish spawning area east of the site, schedule initial construction activities during low water period, use of rip rap on dike surfaces to provide fish spawning habitat, development and implementation of an operational monitoring program).

In conclusion, DOE, through the EIS and other related documents, has given full consideration to the recommendations submitted in the reference letter and appreciate the input which the Fish and Wildlife Service has provided. Therefore, it is DOE's belief that this response will fulfill our consultation requirements under the Fish and Wildlife Coordination Act, and no further action is required.

Sincerely,



Richard C. Martello  
Acting MLCW Project Manager  
Project Management Division



U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION  
CHICAGO OPERATIONS OFFICE

RECORD OF TELEPHONE CALL(S)

|                              |                                                    |
|------------------------------|----------------------------------------------------|
| CALL DATE:<br>March 17, 1981 | CH DIVISION/OFFICE:<br>Project Management Division |
| DISTRIBUTION                 |                                                    |
| Office of Manager            | Office Systems and Services                        |
| Batavia Area Office          | Organization and Personnel                         |
| Brookhaven Area Office       | Patent                                             |
| Budget Division              | Princeton Area Office                              |
| CH Site Office — INEL        | Reactor Programs                                   |
| Contracts Management         | Safeguards & Security                              |
| Counsel                      | Safety                                             |
| Engineering Constr. & Fac.   | Technical Support                                  |
| Financial Management         |                                                    |
| New Brunswick Laboratory     |                                                    |
| Office of Public Affairs     |                                                    |
|                              |                                                    |
|                              |                                                    |

Initiator: Robert W. Laza      Receiver: Mr. Robert Currie

(Contractor: \_\_\_\_\_ Contractor No.: \_\_\_\_\_)

Content of Conversation:

SUBJECT: MEMPHIS INDUSTRIAL FUEL GAS DEMONSTRATION COMPLIANCE WITH SECTION 7 OF THE ENDANGERED SPECIES ACT

Reference: Letter dated June 12, 1981, Hinckling to Laza

The referenced letter stated that there are no federally listed species or proposed endangered plant or animal species in the impact area of the MLGW project and that the letter fulfilled the requirements of 7(c) of the act. The letter further stated however, that the letter did not constitute a consultation as required by Section 7(a).

The purpose of the call was to inquire if additional action was required by DOE. Mr. Currie's comment was that since there were no endangered species or proposed endangered species in the impact area, our responsibilities under section 7 were complete.

cc ✓ Mr. Robert Currie  
       Mr. M. Ragowsky  
       Mr. A. Witten



## United States Department of the Interior

### FISH AND WILDLIFE SERVICE

ROOM 279, FEDERAL BUILDING  
ASHEVILLE, NORTH CAROLINA 28801

June 12, 1980

Mr. Robert W. Laza  
Director, Projects Management Div.  
Department of Energy  
Chicago Operations Office  
9800 South Cass Avenue  
Argonne, Illinois 60439

Re: 4-2-80-I-44

Dear Mr. Laza:

We have reviewed the proposed construction of a coal gasification plant in Shelby County, Tennessee, as requested by letter of November 13, 1979, received November 15, 1979.

We apologize for our extended delay in responding to your request for a list of species. As you know, the original request was lost in transit between our offices.

We have reviewed the information in our files and based on this review, it is our belief that there are no federally listed or proposed Endangered or Threatened plant or animal species in the impact area of the project, and that the requirements of Section 7(c) are fulfilled. In view of this, we believe that you have satisfied the requirements of Section 7 of the Endangered Species Act.

This letter does not constitute a consultation as required by Section 7(a) of the Act nor a Biological Opinion of the Fish and Wildlife Service. It is intended only as a response to your request under Section 7(c) relative to biological assessments. If this plan is substantially modified so as to alter the impact area of the project, you must reconsider your obligations under Section 7(c) of the Act.

Specific comments on the material you provided us for review follow:

1. Page 3-180 - 3.6.1.6

Only the U.S. Fish and Wildlife Service has authority to list species under the Federal Endangered Species Act. The State of Tennessee cooperates with the Service in implementing this and other portions of the Act, but only the Service can add or remove species from the list. The State has developed its own list of species that includes all the species on the Federal list plus several other species not currently considered endangered or threatened from the national perspective.

2. Page 3-199 - 3.6.2.5

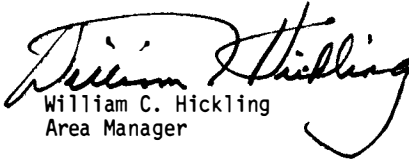
Section 9 of the Act prohibits taking of listed species without a permit from the Wildlife Permit Office (Fish and Wildlife Service) in Washington, DC, rather than categorically prohibiting their destruction. The Critical Habitat statement should be rewritten to more accurately reflect the prohibitions associated with it. The Act does not restrict all disturbance within designated Critical Habitat. Only those activities which reduce the ability of the area to support the listed species are restricted.

3. Page 4-23, second paragraph

The bobcat is not listed as threatened by the U.S. Fish and Wildlife Service.

If you have any questions concerning this letter, please contact Mr. Robert R. Currie at FTS 672-0321, commercial 704/258-2850, ext. 321.

Sincerely yours,

  
William C. Hickling  
Area Manager



## United States Department of the Interior

### FISH AND WILDLIFE SERVICE

Division of Ecological Services  
Post Office Box 845  
Cookeville, TN 38501

December 28, 1979

Mr. Robert W. Laza  
Director, Projects Management Div.  
Department of Energy  
Chicago Operations Office  
9800 South Cass Avenue  
Argonne, Illinois 60439

Dear Mr. Laza:

Reference is made to your letter of November 13, requesting Fish and Wildlife Service comment on proposed medium BTU coal gasification demonstration projects at Baskett, Kentucky, and Memphis, Tennessee. Your letters specifically request information on endangered species in the project area. This type of information is available only through the Regional Office of the U. S. Fish and Wildlife Service in Atlanta, Georgia, and will come to you under separate cover. This report will discuss in general the fish and wildlife aspects of the proposed projects. Due to the lack of available information on the Baskett, Kentucky site, it would be inappropriate for this office to offer comment on this site at this time. However, once supplied with additional information and performing an on-site inspection we would be glad to submit comments on this site. Information on the Memphis, Tennessee site has been made available to this office, and we have participated in a field investigation of the site. Therefore, the following comments pertain specifically to the Memphis project including the site selection process, anticipated project impacts on fish and wildlife, and suggested project features to compensate those impacts.

Concerning site selection, the Fish and Wildlife Service was not involved in any of the processes resulting in the selection of the proposed site. The proposed site is situated on a point which projects into Lake McKellar, an oxbow of the Mississippi River providing a still-water port for the city of Memphis. This Service has several concerns on the choice of project sites. The selected project location is adjacent to an existing Corps of Engineers dredge material disposal

Robert W. Laza

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December 28, 1979

site. Dredge material from the Mississippi River and the port access channel is pumped into the disposal site in a slurry. Excess water from the disposal site is directed eastward onto the project site where a levee-dike system has been constructed to slow the flow of outwash and allow more opportunity for sediment deposition prior to the outwash returning to the lake. Project construction, in the proposed location, will interrupt the well designed flow pattern of the outwash causing the introduction of heavier sediment loads into the lake and river. Satisfaction of this concern will require either the relocation of the project site or the construction of an outwash flow pattern with sediment removal capabilities equivalent to the existing system. Also of concern to the Service is the fact that the selected site is within the active floodplain of the Mississippi River. According to Corps of Engineers data, the proposed site will be totally inundated by the Mississippi River high flows every two years, and partially inundated annually. To alleviate this problem the engineering design of the project calls for the entire area to be raised above project flood levels (approximately 30 feet). To say the least this design feature will be difficult to stabilize as well as expensive. On a 100-acre site, approximately 4,840,000 cubic yards of fill material will be required for the raising; and, in addition, special stabilization features will have to be included to assure the site will withstand the destructive force of the Mississippi River during out-of-bank flood periods. It appears that this location fails to comply with Executive Order 11988 entitled "Floodplain Management". This order directs Federal agencies to take action "...to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains..". If an agency determines siting in a floodplain is essential, that agency must explain why the action is proposed in a floodplain and design the action to minimize harm to the floodplain. This E.O. was precipitated by continuing floodplain development, which increases downstream flooding as well as economic losses during flood situations. Several alternative sites were considered by those involved in the site selection process, some of which are in nearby upland areas out of the floodplain. To bring this Federally funded activity into compliance with E.O. 11988 would require the relocation of the project site to one of these upland areas.

An additional concern this Service has over the site selection process is the loss of fish and wildlife resources associated with project construction. Bottomland hardwoods in the Lower Mississippi River Valley are renowned for the fish and wildlife resources they support. They support highly diverse terrestrial populations including game birds, songbirds, furbearers, and game and nongame mammals. The fishery is also benefitted by bottomland hardwoods during flood stages with increased food, cover, and spawning area. The selected site is roughly 70 per cent early successional bottomland hardwoods, with willow and cottonwood as the dominant tree species. The remaining area

Robert W. Laza

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December 28, 1979

is a meadow complex with a highly diverse herbaceous plant community. Under the Fish and Wildlife Service wetland classification system, both of these habitat types are classified as wetlands. Executive Order 11990 entitled "Protection of Wetlands" directs Federal Agencies to "...take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands..." The E.O. refers directly to the numerous intrinsic values of wetlands such as flood control, groundwater recharge, water quality, and fish and wildlife resources.

Currently the selected site supports a low to moderate wildlife community with the most common game mammal being the Eastern cottontail rabbit. Other wildlife species known to utilize the area include deer, turkey, squirrel, raccoon, swamp rabbit, bobwhite quail, mourning dove, beaver, muskrat, wood duck, migratory waterfowl, raptors, and numerous species of songbirds. The area does not have permanent water areas; therefore, there is no permanent fishery. However, the area is valuable to the adjacent fishery of Lake McKellar and the Mississippi River as spawning and feeding habitat during floods. Human utilization of the fishery is apparent on the site with remnant trot lines from past floods tied to the trees. As mentioned previously, the current value of the area to fish and wildlife is low to moderate, however, natural succession on the area is an ongoing process and the site has the potential of becoming a high value bottomland hardwood site. Therefore, the proposed project on this site will not only destroy the existing low to moderate fish and wildlife resource of the area but also remove the potential for future increases in those resources. The only alternative available to bring this project into compliance with E.O. 11990 is to relocate the project site to an upland location. This action would also be highly desirable in minimizing the adverse impacts of the project on existing and future fish and wildlife resources.

A final concern to the Fish and Wildlife Service is compensation of fish and wildlife resource losses associated with this project. In developing compensation recommendations, the following factors should be taken into account:

1. The complete and immediate loss of approximately 100 acres of early successional bottomland hardwoods, with low to moderate fish and wildlife value.
2. The loss of 100 acres of potential mature bottomland hardwoods with high fish and wildlife value which would develop on the site without the project.
3. The loss of an area utilized by local residents for consumptive and non-consumptive wildlife oriented recreation.

1/ U. S. Department of the Interior. Fish and Wildlife Service.  
"Classification of Wetlands and Deep-Water Habitats of the United States (An Operational Draft), October 1977.

Robert M. Laza

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December 28, 1979

Compensation of these losses will require locating an area, and enhancing that area through management to a point where the level of enhancement is equal to the level of project-induced loss.

Energy Impact Associates has discussed the possibility of utilizing the nearby Round Lake wetland complex to compensate project-induced losses. This office is familiar with this site and recognize it as an area of high-value forested wetlands that is slowly being degraded by agricultural encroachment. With appropriate enhancement and protection from further degradation this area could serve as a suitable compensation site. In addition, because of the proximity of this site to the proposed project site, project-induced losses to public utilization could also be offset.

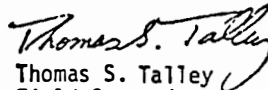
In conclusion, the following recommendations are submitted for your consideration:

1. The agencies involved should consider relocating the project site to one of the upland locations outside of the floodplain. This action would bring the project into compliance with E.O.'s 11988 and 11990, and significantly reduce the fish and wildlife resource losses expected to occur.
2. If recommendation 1. above is not accepted to comply with E.O.'s 11988 and 11990 the action in floodplains should be fully justified in all documents subject to public review, as well as documents relating to funding appropriations. Action should also be taken to minimize the adverse impact of the project on the fish and wildlife resources of the area.
3. Regardless of the project site finally agreed upon, the agencies involved should completely compensate the adverse impacts to fish and wildlife expected to accrue as a result of the project. At its current location, the project will have significant associated fish and wildlife losses. The Round Lake area is an acceptable area for compensation of this project, due to its proximity, fish and wildlife value, and current condition.

These recommendations, along with the information supplied concerning endangered species should be fully addressed in future documents concerning the proposed project.

This opportunity for early input is appreciated.

Sincerely yours,

  
Thomas S. Talley  
Field Supervisor

TST/JMK/sz

cc: AO/Asheville NC  
Gary Henry, Endangered Species

NOV 18 1978

Mr. William Hickling  
Ashville Area Office  
U.S. Fish and Wildlife Service  
Federal Building, Room 279  
Ashville, North Carolina 28301

Dear Mr. Hickling:

DOE PROPOSED MEDIUM BTU COAL GASIFICATION DEMONSTRATION  
AT MEMPHIS, TENNESSEE

As previously discussed with Dave Parsons of your Cookeville office, the Department of Energy (DOE) is preparing an Environmental Impact Statement on the proposed construction and operation of a medium Btu Coal Gasification Demonstration Plant near Memphis, Tennessee. During the preparation of the Environmental Report, the industrial partner of DOE, Memphis Gas, Light, and Water, has contacted the U.S. Fish and Wildlife Service and other agencies, and has provided data on the potential species and on the critical habitat for such species. Copies of appropriate sections of the Environmental Report and a map showing the location of the proposed site are attached to this letter.

In compliance with Section 7(c) of the Endangered Species Act Amendments of 1978 (P.L. 95-632, November 10, 1978), the Department of Energy requests any information available from the U.S. Fish and Wildlife Service on the presence of any listed or proposed to be listed endangered or threatened species or critical habitat. We would also like the results of your evaluation on possible wetlands and other comments to be considered in the preparation of the draft EIS.



NOV 13 1979

William Hickling

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Please contact Mr. Jerry Wilson, 214/273-0350, of our Operational and Environmental Safety Division, for further information.

Sincerely,



Robert G. Lase, Director  
Project Management Division

## Enclosures:

1. 6y sections of Environmental Report
2. Gap

cc: H. Parsons, U.S. Fish & Wildlife, w/encls.  
H. Benson, U.S. Fish & Wildlife, w/o encls.

bc: R. Reed, ORNL, w/o encls.  
D. Morgan, MRC, w/o encls.

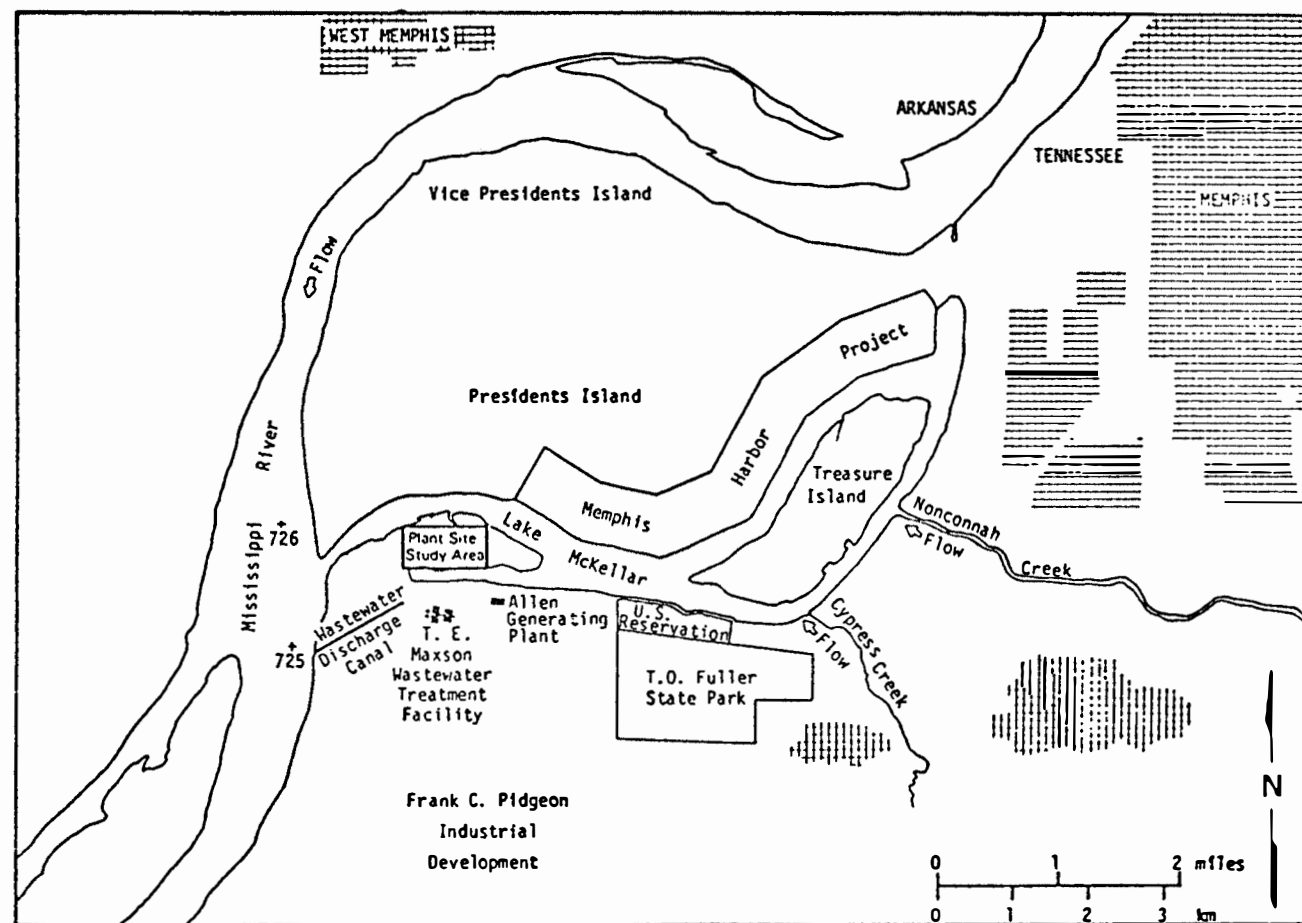


Figure 1-1. Proposed Site for the Memphis Industrial Fuel Gas Demonstration Plant

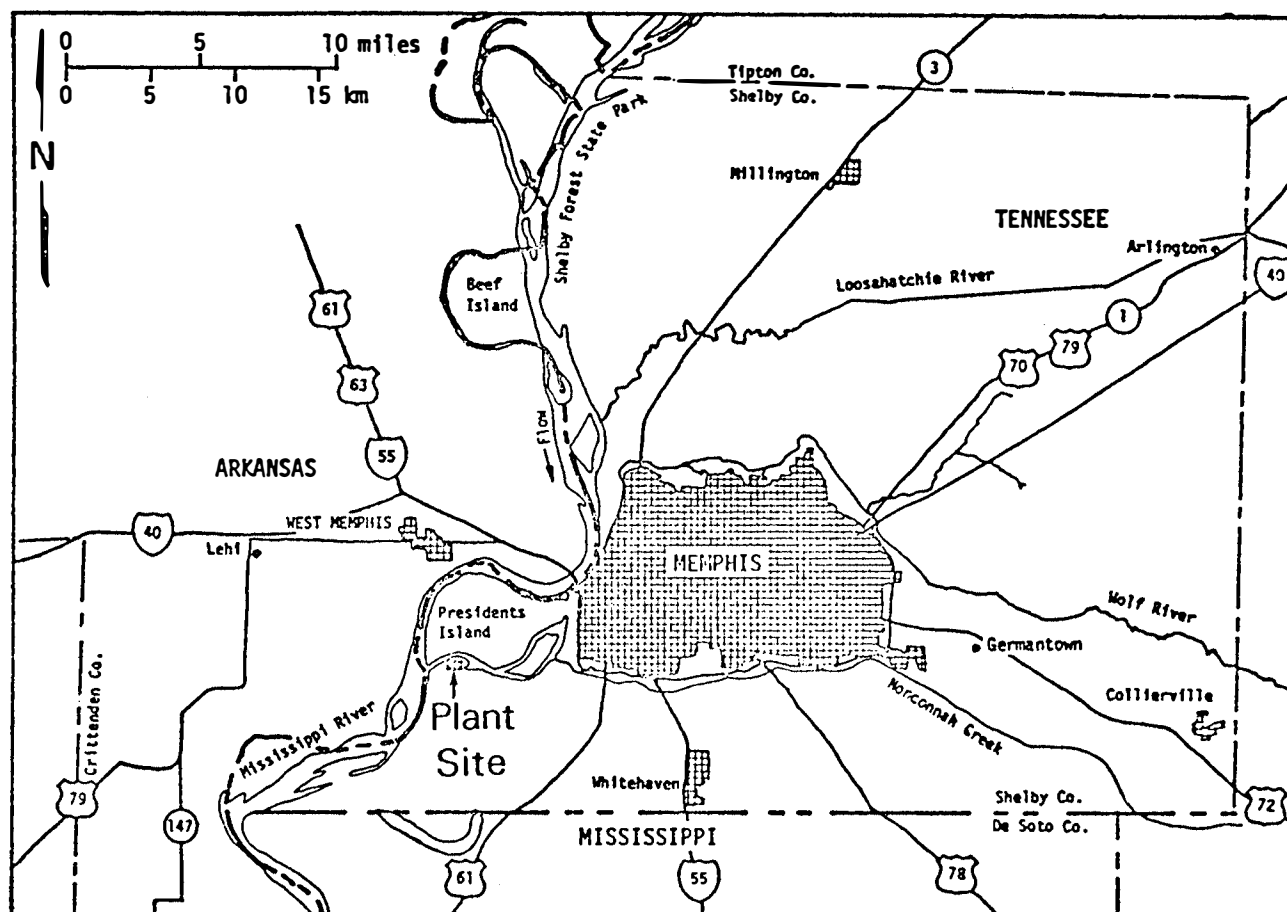


Figure 2-1. Plant Site Location

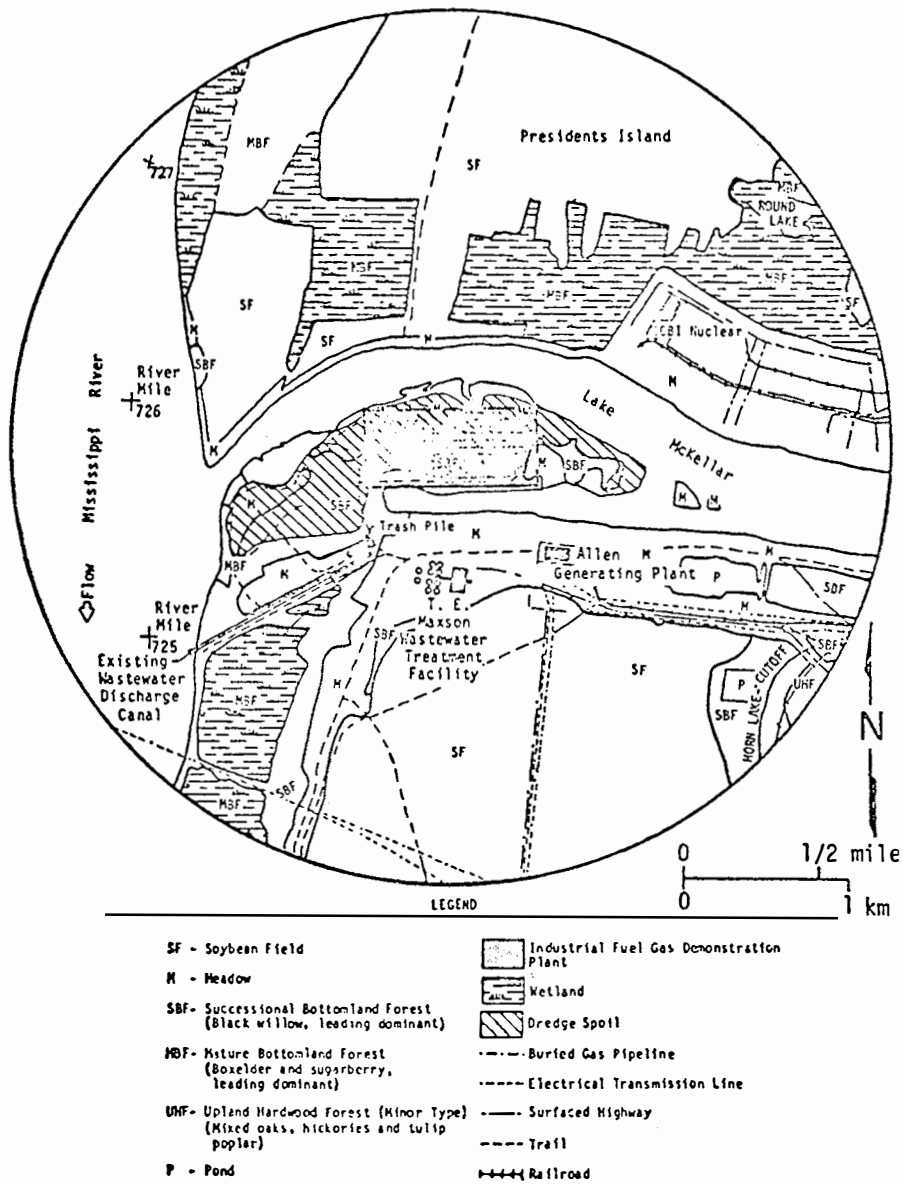


Figure 3-34. Vegetation Types Within 3 Kilometers of the IFGDP Site Center

### 3.6.1.6 THREATENED AND ENDANGERED PLANT SPECIES

Under the Endangered Species Act of 1973 as amended, the U.S. Department of Interior was granted the authority to promulgate a list of threatened and endangered plant and animal species and regulations governing both the species and the habitat in which they occur. The State of Tennessee has similar authority under the same act.

No plant species either on or proposed for these lists<sup>(11-14)</sup> were observed within 3 kilometers of the site after a careful search of this area.

### 3.6.2 TERRESTRIAL WILDLIFE

Sections 3.6.2.1 through 3.6.2.4 contain discussions of wildlife resources within 3 kilometers of the IFGDP site based on field studies and literature review.<sup>(21-34)</sup> Endangered and threatened species are discussed in Section 3.6.2.5.

#### 3.6.2.1 REGIONAL FAUNA

Wildlife in the site region are influenced by the Mississippi River and the nearly level floodplain habitats described in Section 3.6.1. Wildlife of the IFGDP site are considered under the subheadings of mammals (Section 3.6.2.2), avifauna (Section 3.6.2.3) and amphibians and reptiles (Section 3.6.2.4). Many species fly, swim or run over large parts of the local region within 3 kilometers of the site. Many migrant birds (avifauna) fly past the site following the Mississippi River flyway northward in the spring and southward in the fall. Consequently, the discussion evaluates the species' importance in the whole ecosystem, not just one portion of it. Vegetation types have been described in Section 3.6.1.

The close proximity of the site to the City of Memphis enables numerous local residents to run their dogs, hunt, fish, shoot clay pigeons and drive dune buggies near it. Stray cats and dogs also hunt in the area. These activities

In general, amphibians were active in cool, moist habitats in the spring and summer and consumed insects. The reptiles were generally most active in the hot summer and fall and consumed a variety of foods. Lizards consumed small insects, small arthropods and similar sized animals and lived in meadow or forest. Turtles consumed larger insects, larger arthropods and vegetation and stayed in or near water, snapping turtle (Chelydra serpentina) and pond slider (Pseudemys scripta), or ranged widely, box turtle (Terrapene carolina). Snakes consumed small mammals, birds' eggs, amphibians, lizards and other snakes. Snake habitat usage varied from primarily aquatic, cottonmouth (Agkistrodon piscivorus), diamondback water snake (Natrix rhombifera) and yellow-bellied water snake (Natrix erythrogaster), to primarily upland in meadow and open successional forest habitat, southern black racer (Coluber constrictor), eastern hognose (Heterodon platyrhinos), speckled kingsnake (Lampropeltis getulus) and western ribbon snake (Thamnophis proximus).

### 3.6.2.5 ENDANGERED AND THREATENED FAUNAL SPECIES

Under the Endangered Species Act of 1973, animal species cited as threatened or endangered by the U.S. Department of Interior, Fish and Wildlife Service are protected to the extent that individuals may not be destroyed and their critical habitat may not be disturbed.<sup>(11,37)</sup> The State of Tennessee also maintains an official list of endangered and threatened fauna.<sup>(13)</sup> The state of Tennessee also maintains a category termed "special management." The special management category indicates that the species may be abundant locally in Tennessee, but the habitat is so restricted that special management is required to maintain both habitat integrity and high populations within the restricted habitat. Species fitting one or more of these categories are listed in Table 3-56.

The only species found within 3 kilometers of the site that appears on the U.S. List of Endangered and Threatened Fauna is the bobcat (threatened).<sup>(37)</sup> The bobcat is a spotted cat and is threatened as a result of trapping and sale of pelts for use in fur coat manufacturing. The bobcat ranges widely in the site vicinity, but is most common near water and in or near mature bottomland forest north and south of the site.

TABLE 3-56

ENDANGERED, THREATENED AND SPECIAL CONCERN  
SPECIES OBSERVED WITHIN 3 KM OF THE IFGDP SITE

| <u>Common Name</u>             | <u>Scientific Name</u>           | <u>Classification*</u> |                           |
|--------------------------------|----------------------------------|------------------------|---------------------------|
|                                |                                  | <u>United States</u>   | <u>State of Tennessee</u> |
| <u>MAMMALS</u>                 |                                  |                        |                           |
| Swamp rabbit                   | <u>Sylvilagus aquaticus</u>      |                        | S (16)                    |
| Bobcat                         | <u>Lynx rufus</u>                | T (37)                 |                           |
| <u>BIRDS</u>                   |                                  |                        |                           |
| Marsh hawk                     | <u>Circus cyaneus</u>            |                        | T (13)                    |
| Mississippi kite               | <u>Ictinia mississippiensis</u>  |                        | E (13)                    |
| Sharp-shinned hawk             | <u>Accipiter striatus</u>        |                        | T (13)                    |
| <u>AMPHIBIANS AND REPTILES</u> |                                  |                        |                           |
| Six-lined racerunner           | <u>Cnemidophorus sexlineatus</u> |                        | S (16)                    |

- \* E = Endangered - the species is in danger of becoming extirpated in all or part of its range.
- T = Threatened - the species population is declining and protection is required to prevent species endangerment in all or part of its range.
- S = Special - the species is restricted to a very uncommon habitat and special management is required to maintain both habitat integrity and current populations within the habitat.

The Mississippi kite, a bird of prey that is endangered in Tennessee,<sup>(13)</sup> eats large insects and nests in the upper branches of large trees 30 to 45 centimeters stem diameter and 30 meters tall.<sup>(38)</sup> A total of 38 summer resident Mississippi kites were observed in the Mississippi River bottomlands from the City of Memphis to the northern border of the State of Mississippi during the summer of 1978.<sup>(38)</sup> Removal of dense stands of large trees by logging, especially in mature bottomland forest, is the most important reason for the species' endangerment in Tennessee.<sup>(38)</sup>

Both the marsh and sharp-shinned hawks are listed as threatened in Tennessee.<sup>(13)</sup> The marsh hawk feeds on rodents in marshy and bottomland habitats. The sharp-shinned hawk feeds on songbirds, small game birds and occasionally small rodents.<sup>(31)</sup> The marsh hawk is a winter resident and the sharp-shinned hawk an occasional visitor in Shelby County, Tennessee.<sup>(32)</sup>

The swamp rabbit and six-lined racerunner are listed as requiring special management.<sup>(16)</sup> Swamp rabbits are most abundant in mature bottomland forest and adjoining edge habitats where they eat honeysuckle, grasses and forbs. This habitat occurs both north and south of the site. The six-lined racerunner occurs on sandy dredge sediments and sandy floodplains. Dredging operations provide excellent habitat for this species and are an effective management tool to maintain high populations.

The habitat within 3 kilometers of the site that is most sensitive to disturbance is mature bottomland forest. This forest is home to the bobcat, Mississippi kite and swamp rabbit and is extensively used by the marsh and sharp-shinned hawks.

The portion of the meadow vegetation type most sensitive to disturbance is the one formed by sandy dredging sediment extending along Lake McKellar from the Mississippi River to the eastern peninsular tip. The six-lined racerunner is most abundant in this portion of the meadow vegetation type.

The site contains meadow and successional bottomland forest, habitats not critical for the endangered and threatened mammals and birds.



tripunctata var. schizonemoides,\* which is considered to prefer water with a fairly high mineral content. The green alga Oedogonium sp. and the blue-green Oscillatoria sp. were locally abundant taxa. Other commonly encountered species were the diatoms Cyclotella meneqhiana, C. stelligera, Gomphonema parvulum, Melosira distans, M. granulata, Nitzschia palea and Stephanodiscus astraes var. minutula. There were only minor variations in species composition of collections between stations.

In general, the periphyton community in Lake McKellar was indicative of slightly alkaline, moderately to highly organically enriched conditions.

### 3.7.2.5 MACROPHYTES

No larger aquatic plants were observed or collected from Lake McKellar in the vicinity of transects LM1 and LM2 during the 1978-79 surveys (Appendix 3E). Lake fluctuations and high turbidity probably inhibit these organisms.

### 3.7.3 THREATENED AND ENDANGERED AQUATIC SPECIES

No species included in either the U.S. Fish and Wildlife Service's<sup>(10)</sup> or the Tennessee Wildlife Resources Agency's<sup>(11)</sup> list of threatened and endangered species were encountered in Lake McKellar or the Mississippi River during the 1978-79 surveys, nor were any noted in other studies reported upon here.

\* Based on information from personal communication between D. J. Wagner, EIA, and R. Lowe, Bowling Green State University, May 9, 1979.

Portions of the land to be disturbed have been classified as wetland by the U.S. government, as discussed in Section 3.6. The medium to high quality wetland (mature bottomland forest) on Presidents Island has been avoided in pipeline routing. Low to medium quality wetland (successional bottomland forest) on the site peninsula will be disturbed by construction activities to the extent that approximately 28 hectares (69 acres) will be removed.

Vehicle exhaust fumes, fugitive dust, vehicle movements and human disturbance to adjoining vegetation will be minimized during site development. Fugitive dust will be controlled by sprinkling dusty roadways with water and paving all permanent roads.

#### 4.1.6.2 WILDLIFE

Wildlife residing in disturbed vegetation types will be displaced to surrounding habitats. This displacement will exceed the actual area disturbed because wildlife tend to avoid noise associated with human presence.<sup>(1)</sup> For purposes of impact assessment, all mobile wildlife (birds and large mammals) are assumed to be displaced from the site peninsula during the period of construction and from within an area of 50 meters on each side of pipeline corridors during construction of the pipelines. This corresponds to approximately 240 hectares (593 acres) for the period of plant construction and approximately 3 hectares (7.5 acres) temporarily during pipeline construction. Total disturbance will include approximately 9 percent of the area within 3 kilometers (1.8 miles) of the site center.

Impact assessment assumes total failure of mobile wildlife reproduction on the affected areas. Population reductions and increases correspond with vegetation types affected by construction activities as a proportion of baseline populations within 3 kilometers (1.8 miles) of the site center. Displaced animals are assumed to be harvested by predators during construction. For example, plant-eating (herbivorous) animals, such as the eastern cottontail, that reside in meadows and early successional bottomland forest will experience an effective habitat loss of approximately 25 percent and will correspondingly

experience a population decline of approximately 25 percent during construction. The actual effects may be less than predicted because some wildlife will return to feed and perhaps nest in part of the disturbed vegetation during periods of little or no construction activity.

Game mammals and furbearers will be most affected among the mammals. Within 3 kilometers of the site center, eastern cottontail, swamp rabbit, whitetail deer and gray fox populations will probably be reduced by approximately 25 percent and squirrel and opossum populations by approximately 50 percent. Initially, red fox and raccoon populations will probably increase slightly due to harvesting of displaced animals and then decrease by approximately 40 percent. Bobcat populations will probably decrease by approximately 10 percent and remain stable because they tend to avoid man and are slow to respond to food availability. The bobcat is listed as threatened by the U.S. Fish and Wildlife Service.<sup>(2)</sup> Beaver and muskrat will probably not be affected because they reside outside the construction area. Mammal movements across Lake McKellar will be reduced during construction.

Small mammal populations will decrease in proportion to habitat loss provided that the construction site is kept clean. House mice and Norway rats may increase in abundance. Bird species are quite mobile and will very likely continue to feed near the disturbed locations but probably will not nest there. Raptorial species will initially increase in abundance as they migrate nearer the site to harvest surplus animals and then decrease in abundance proportionally with effective habitat loss. Other bird species are likely to decrease in abundance in direct proportion to effective habitat loss. Subsequent to disturbance, species preferring meadow habitat will increase in abundance due to greater availability of this vegetation type on temporarily disturbed land. The Mississippi kite, listed in Tennessee as endangered,<sup>(3)</sup> will decrease in abundance in direct proportion to loss of forest (feeding) habitat even though its nesting habitat should not be affected. Within 3 kilometers of the site center, the nesting success of the Mississippi kite is likely to decline by approximately 25 percent during construction due to human disturbance and then return to nearly preconstruction levels following site development.

The marsh and sharp-shinned hawks, listed in Tennessee as threatened,<sup>(3)</sup> will be affected to the same degree as other raptorial birds--an initial slight increase in local abundance followed by a slight decline.

The bobwhite, woodduck, American woodcock and turkey populations will be reduced in proportion to habitat loss. Other game birds are not likely to be significantly affected by construction because they most extensively utilize aquatic habitats.

Toad and lizard species will initially decrease in abundance in proportion to habitat loss and then increase in abundance as previously forested land develops into meadow. Snakes are likely to decrease greatly in abundance as a result of construction activities. Turtle abundance will change in direct proportion to habitat changes. Populations of the six-lined racerunner will initially decrease during site clearing and then increase as disturbed habitats develop into meadow.

Construction personnel will be instructed not to destroy any wildlife.

Fugitive dust and vehicular fumes will render roadside vegetation less palatable to herbivorous animals and in that way decrease populations slightly. Fugitive dust will be controlled by sprinkling dusty roadways with water and paving all permanent roads. This impact is not expected to change herbivore populations within 3 kilometers (1.8 miles) of the plant-site center by more than 1 or 2 percent, depending on the species.

#### 4.1.7 AQUATIC ECOLOGY

Construction activities (discussed in detail in Section 2.3) that will directly and/or indirectly affect aquatic organisms include various dredging operations, site buildup, construction of the barge unloading area and installation of product and water pipelines across Lake McKellar. Primary impacts include loss of some habitat for bottom-dwelling organisms as well as destruction of

with temporarily submerged habitats will be decreased. However, the areas affected do not represent exceptional resources in this region of the Mississippi River, especially considering the extensive floodplain on the Arkansas side of the river.

Rip-rap where necessary on the outer slopes of the elevated site will provide detriments and benefits to aquatic life similar to those described above (see Section 4.1.7.2.2, Barge Unloading Area).

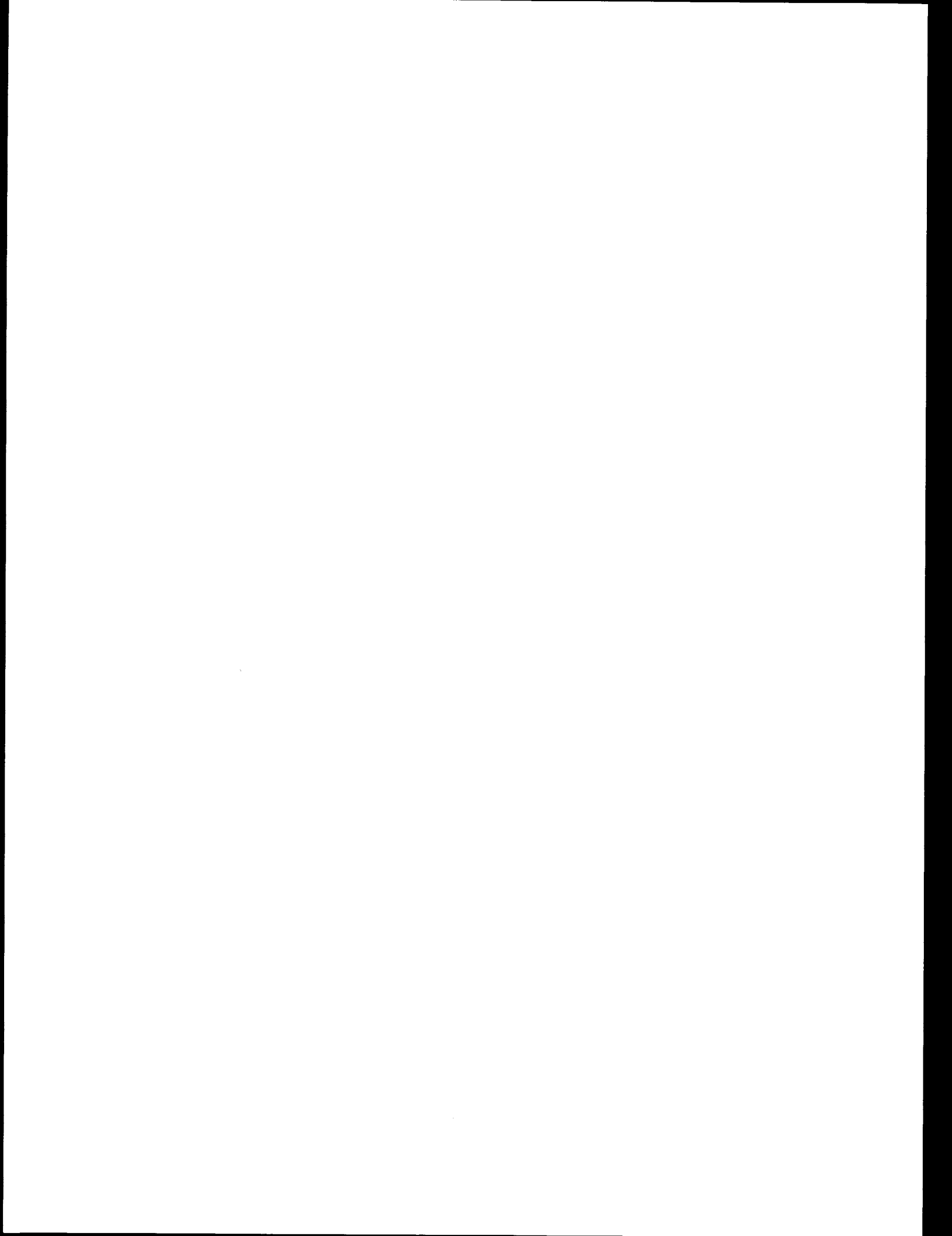
Collection of runoff water into holding ponds before release to the Mississippi River will minimize detrimental impacts to aquatic life associated with increased turbidity and siltation, although short-term effects are expected during buildup of the perimeter of the site. These effects include reduced photosynthesis due to decreased light penetration, avoidance of the construction area by fish and burial of immobile bottom organisms immediately adjacent to the site.

#### 4.1.7.3 THREATENED AND ENDANGERED SPECIES

Since no aquatic organisms included on the federal<sup>(1)</sup> or Tennessee<sup>(2)</sup> lists of threatened and endangered species have been reported in recent surveys of the Mississippi River near Memphis or Lake McKellar (described in Section 3.7), no adverse impacts are anticipated.

#### 4.1.8 LAND USE

This section discusses the effects of project construction on existing and projected site land uses (Section 4.1.8.1) and on regional land use and development (Section 4.1.8.2). The project consists of the elevated plant site and access road, barge unloading area and off-site utilities. Utilities include pipelines for product gas, natural gas, water supply, sanitary sewer and wastewater, as well as power and telephone lines.



Appendix B.4

COMPLIANCE WITH THE NATIONAL HISTORIC PRESERVATION ACT



**TENNESSEE DEPARTMENT OF CONSERVATION**  
TENNESSEE HISTORICAL COMMISSION  
4721 TROUSDALE DRIVE, NASHVILLE 37220  
615/741-2371

February 25, 1980

Mr. Peter Lui  
Project Manager  
Dept. of Energy  
Chicago Operations and Regional Office.  
9800 South Cass Avenue  
Argonne, Illinois 60439

Re: Proposed Industrial Fuel Gas Demonstration Plant, Memphis,  
Shelby County

Dear Mr. Lui:

The State Historic Preservation Officer and his staff have reviewed results of an archaeological survey conducted in the above project impact area. Based on the findings of that survey we conclude that the Department of Energy has adequately addressed their responsibilities to identify National Register and eligible properties as mandated by Section 106 of the National Historic Preservation Act. Therefore, unless project plans are changed or archaeological remains are discovered during construction, no further action is necessary to comply with Section 106.

A copy of our comments should be included in the EIS as evidence of compliance. Thank you for your cooperation.

Sincerely,

Herbert L. Harper  
Executive Director and  
State Historic Preservation Officer

HLH:SDW:sh



Appendix B.5  
ALGORITHMS FOR UNIT PLANT LOADINGS



## 1.0 INTRODUCTION

In Section 1.4.1.2, the Memphis plant was chosen as the baseline unit plant. In developing the commercialization scenario, it was assumed that all other U-gas plants would have the same Btu output as the Memphis plant, but that inputs and effluents would vary according to coal type and quantity used as gasifier and boiler feedstocks.

In order to estimate environmental impacts associated with unit plant operations, a series of algorithms was developed. These algorithms are based upon the Memphis plant characteristics. State-level input and output loadings for the plant distribution scenario can be calculated by multiplying unit plant loadings by the number of plants located in a state.

Coal mining impact algorithms have been developed on the basis of coal input to a unit plant, calculated in terms of total Btus required to produce 171 million standard cubic feet per day of industrial fuel gas with a heating value of  $300 + 30$  Btu/scf. In terms of the Memphis plant and, thus, the unit plant, required coal input would be approximately  $70 \times 10^9$  Btu/day. To calculate state-level coal requirements and the effluent loadings associated with this level of coal production, multiply the number of unit plants supplied by a state coal by the unit plant coal requirement or the effluent loading factor resulting from coal production to supply a unit plant. Unit plants are assumed to use intrastate coal, except for plants located in Delaware and New Jersey which use Pennsylvania coal and California plants which use Utah coals.

## 2.0 ALGORITHMS

### 2.1 Unit Plant Construction

All unit plants are assumed to be comparable to the Memphis plant and thus construction-related loadings and material, land, and manpower requirements are presented in Chapter 2 and Appendix B.0.3.

### 2.2 Unit Plant Operation

#### 2.2.1 Coal Requirements

##### Assumptions:

- o Each unit plant requires a coal input of  $70 \times 10^9$  Btus per stream day, or  $23.1 \times 10^{12}$  Btus per year, based on 330 days of plant operation per year, 11,080 Btu per pound of coal feed,<sup>10</sup> and 3,155 tons of coal feed per day.
- o The Btu content (proximate analysis) of coal fed to a plant is representative of the coal mined in the state that supplies the plant.

##### Algorithms:

$$o \text{ Unit Plant Coal Requirement (tons/year)} = \frac{23.1 \times 10^{12} \text{ Btu/year}}{B}$$

where: B = the heat content (Btu/ton) of the coal as established by proximate analysis

#### 2.2.2 Air emissions

##### Assumptions:

- o The auxiliary steam boilers require a coal input equivalent to  $8.3 \times 10^9$  Btu per day, or  $2.7 \times 10^{12}$  Btu per year. Therefore, the amount of coal feed to the steam boilers in tons per year for a regional or state coal is  $2.7 \times 10^{12}/A$ , where A is the heat content of the coal in Btus per ton.
- o The efficiency of particulate matter control is 99.4 percent.
- o The efficiency of sulfur oxides control is 90.0 percent.
- o No control technology is applied to nitrogen oxides, organics, or carbon monoxide emissions beyond meeting new source performance standards for boilers.
- o The heat, ash, moisture, and sulfur content of the coal feed to the steam boilers is the same as to the gasifier.
- o The air pollution emission inventory for the unit plant includes emissions from the flue gas stream, coal preparation vent gas, flared lock hopper vent gas, Beavon Unit vent gas, and fugitive sources. All emission factors are from Reference 11, or are calculated on the basis of design data in Reference 10.
- o Coal preparation vent gas, flared lock hopper vent gas, and Beavon Unit vent gas emissions are proportional to the baseline unit plant emissions from these sources on the basis of coal input to the gasifier.

Flue Gas Stream Emissions Algorithms

o Particulate Matter (LB/YR) = (0.006) (A) (B)

where: 0.006 = emission factor resulting from particulate emission control efficiency of 0.994

A = 16 pounds per ton (ash content of coal)

B = coal feed to boiler in tons per year

o Sulfur Oxides (LB/YR) = (0.10)(A)(B)

where: 0.10 = emission factor resulting from sulfur oxides control efficiency of 0.90

A = 38 pounds per ton (sulfur content of coal)

B = coal feed to boiler in tons per year

o Nitrogen Oxides (LB/YR) = (A)(B)

where: A = 30 pounds of nitrogen oxides per ton of coal combusted

B = coal feed to boiler in tons per year

o Organics (LB/YR) = (A)(B)

where: A = 0.03 pounds of organics per ton of coal combusted

B = coal feed to steam boiler in tons per year

o Carbon Monoxide (LB/YR) = (A)(B)

where: A = 1.0 pound of carbon monoxide per ton of coal combusted

B = coal feed to the steam boiler in tons per year

Coal preparation vent gas emission algorithms

o Particulate Matter (LB/YR) = 0.034(A)

where: 0.034 = particulate emission factor (LB/T) of coal fed to gasifier (Reference 10)

A = coal feed to gasifier in tons per year

o Sulfur Oxides (LB/YR) = 0.017(A)

where: 0.017 = sulfur oxides emission factor in pounds per ton (Reference 10)

A = coal feed to gasifier in tons per year

Flared lock hopper vent gas emissions algorithms

o Particulate Matter (LB/YR) = 0.0017(A)

where: 0.0017 = emission factor in pounds per ton (Reference 10)

A = coal feed to gasifier in tons per year

o Sulfur Oxides - same as for particulate matter

o Nitrogen Oxides - same as for particulate matter

o Hydrocarbons (LB/YR) = 0.0001(A)

where: 0.0001 = emission factor in pounds per ton (Reference 10)

A = coal feed to gasifier in tons per year

- o Carbon Monoxide (LB/YR) =  $0.0003(A)$

where: 0.0003 = emission factor in pounds per ton (Reference 10)

A = coal feed to gasifier in tons per year

#### Beavon Unit vent gas emissions algorithm

- o Hydrogen Sulfide (LB/YR) =  $0.0026(A)$

where: 0.0026 = emission factor in pounds per ton (Reference 10)

A = coal feed to gasifier in tons per year

#### Fugitive sources emissions algorithms

- o Particulate Matter (LB/YR) =  $0.034(A)$

where: 0.034 = emission factor in pounds per ton of coal feed

A = coal feed to plant in tons per year

- o Hydrogen Sulfide (LB/YR) =  $0.0001(A)$

where: 0.0001 = emission factor in pounds per ton of coal feed

A = coal feed to plant in tons per year

- o Carbon Monoxide (LB/YR) =  $0.0017(A)$

where: 0.0017 = emission factor in pounds per ton of coal feed

A = coal feed in tons per year

#### 2.2.3 Water use

Water use for a unit plant is assumed to be equivalent to water consumption for the Memphis plant, 2,710,000 gallons per day (8.317 acre-feet per day), or 894,300,000 gallons per year (2,744.6 acre-feet per year).

#### 2.2.4 Solid waste

##### Assumptions

- o Eighty-eight percent of total coal input goes to gasification. The remaining 12 percent is boiler feed.
- o Solid waste from gasification is made up of 90 percent ash, the balance being composed primarily of carbon and sulfur (Reference 10)
- o Solid waste from steam boilers is composed of both fly ash and bottom ash, the total of which is equivalent to the ash content of the feed coal.
- o Sludges from flue gas desulfurization, wastewater treatment, and chromate destruction are generated at the rate of approximately 40,000 tons per year (wet weight), or 22,700 tons per year (dry weight) per unit plant.

#### Agglomerated gasifier ash algorithm

- o Agglomerated Gasifier Ash (Tons/Year) =  $(1.11)(A)(B)$

where: 1.11 = gasification waste factor assuming 0.90 ash content of agglomerated ash

A = ash content of coal feed to gasifier in percent

B = coal input to gasifier in tons per year

Auxiliary waste algorithm

$$o \text{ Auxiliary Boiler Waste (Tons/Year)} = (A)(B)$$

where: A = ash content of boiler feed coal in percent

B = coal feed to boiler in tons per year

Flue gas desulfurization, wastewater treatment, and chromate destruction sludges

Flue gas desulfurization, wastewater treatment, and chromate destruction sludges (dry weight) for a unit plant are assumed comparable to sludge generation from the Memphis plant.

2.3 Coal Mining2.3.1 Coal mining by stateAssumptions:

- o Except for Delaware, New Jersey, and California, coal for a plant is intrastate coal. Coal for unit plants located in Delaware and New Jersey is supplied by Pennsylvania mines and coal for California plants is supplied by Utah mines.
- o The Btu content (proximate analysis) of coal fed to a plant is representative of the coal mined in the state that supplies the plant. Each unit plant requires a coal input of  $70 \times 10^9$  Btus per stream day, or  $23.1 \times 10^{12}$  Btus per year, based upon 330 days of operation per year, 11,080 Btu per pound of coal feed,<sup>10</sup> and 3,155 tons of coal feed per day.

Algorithm

$$o \text{ Coal Mined for Unit Plant (Tons/Year)} = \frac{23.1 \times 10^{12}}{A}$$

where:  $23.1 \times 10^{12}$  = coal input to a unit plant in Btus/year

A = heat content of coal in Btus/ton

2.3.2 Land disturbed by surface miningAssumptions:

- o Land disturbed by underground mining is considered minimal.
- o The density of coal in a seam is 1,750 tons per acre-foot.

Algorithm:

$$o \text{ Surface Area Disturbed (Acres)} = \frac{1}{(1750)(A)} (B)(C)$$

where: 1750 = density of coal in a seam in tons per acre-foot

A = average seam thickness (Table B.4)

B = proportion of coal strip mined in a state (Table B.4)

C = coal input to unit plant in tons per year

2.3.3 Air emissionsAssumptions:

- o Emissions from underground mining are minor due to the predominance of electric-powered equipment.
- o Emission factors for strip mining are from Reference 11 and are listed in Table B.5.

Algorithm:

$$o \text{ Air Emission by Pollutant (Tons/Year)} = \frac{(A)(B)(C)}{10^5}$$

where: A = loading factor by state, for particulate matter, sulfur oxides, nitrogen oxides, carbon monoxide, and organics in tons per 10<sup>5</sup> tons of coal strip mined (Table B.5)

B = coal mined per unit plant in tons per year

C = percentage of coal strip mined by state (Table B.4)

2.3.4 Water useAssumptions:

- o Coal mining activities which result in water consumption include dust control for roads, mines, and embankments and revegetation of reclaimed areas.
- o Regional water use factors reflecting dust control and revegetation activities are from Reference 12.

Algorithms:

$$o \text{ Surface Mining Water Use (Acre-Feet/Year)} = (A)(C)/100,000$$

where: A = surface mining use factor in acre-feet per 100,000 tons of coal mined (Table B.6)

C = coal input to unit plant from surface mines in tons per year

$$o \text{ Underground Mining Water Use (Acre-Feet/Year)} = (B)(C)/100,000$$

where: B = underground mining water use factor in acre-feet per 100,000 tons of coal (Table B.6)

C = coal input to unit plant from underground mines in tons per year

2.3.5 Solid wasteAssumptions:

- o For surface mining, solid wastes generated are returned to mining pits and are not considered a solid waste for disposal calculations.
- o For underground mining, the amount of solid waste generated is approximately three percent of coal extracted.<sup>12</sup> These wastes, known as "gob," correspond in composition to the overburden removed in surface mining.
- o The percentage of a state coal supplied for gasification that is underground mined is equivalent to the percentage of all coal mined in a state that is underground mined.

Algorithm:

$$o \text{ Mining Wastes (Tons/Year)} = (0.03)(A)(B)$$

where: 0.03 = solid waste generation factor for underground mined coal (Reference 12)

A = percentage of underground mined coal

B = coal supplied to unit plant in tons per year



**Table B.4. Average seam thickness and percentage of total coal strip-mined for selected states**

|              | Average seam thickness<br>[m (ft)] | Percentage strip mined<br>(%) |
|--------------|------------------------------------|-------------------------------|
| Pennsylvania | 6                                  | 43                            |
| Maryland     | 6                                  | 43                            |
| Ohio         | 6                                  | 43                            |
| Indiana      | 5.5                                | 75                            |
| Illinois     | 5.5                                | 75                            |
| Kentucky     | 6                                  | 40                            |
| Tennessee    | 6                                  | 37                            |
| Texas        | 8                                  | 100                           |
| North Dakota | 10                                 | 100                           |
| Wyoming      | 26                                 | 100                           |
| Colorado     | 8                                  | 100                           |
| Utah         | 8                                  | 0                             |

Source: U.S. Department of the Interior, *Final Environmental Statement, Federal Management Program*, Report No. 1972(142), Bureau of Land Management, Washington, D.C., 1979.

**Table B.5. Strip mining air pollutant loading factors for selected states**

| State        | Strip mining pollutants<br>(in T/10 <sup>6</sup> tons of coal mined) |               |                 |                 |          |
|--------------|----------------------------------------------------------------------|---------------|-----------------|-----------------|----------|
|              | Particulate matter                                                   | Sulfur oxides | Nitrogen oxides | Carbon monoxide | Organics |
| Pennsylvania | 0.15                                                                 | 0.30          | 3.90            | 2.35            | 0.40     |
| Maryland     | 0.15                                                                 | 0.30          | 3.90            | 2.35            | 0.40     |
| Ohio         | 0.15                                                                 | 0.30          | 3.90            | 2.35            | 0.40     |
| Indiana      | 0.50                                                                 | 0.45          | 6.25            | 3.80            | 0.70     |
| Illinois     | 0.50                                                                 | 0.45          | 6.25            | 3.80            | 0.70     |
| Kentucky     | 0.50                                                                 | 0.45          | 6.25            | 3.80            | 0.70     |
| Tennessee    | 0.15                                                                 | 0.30          | 4.55            | 2.80            | 0.40     |
| Texas        | 0.60                                                                 | 0.15          | 2.15            | 1.45            | 0.20     |
| North Dakota | 0.40                                                                 | 0.30          | 3.85            | 2.35            | 0.45     |
| Wyoming      | 0.40                                                                 | 0.30          | 3.85            | 2.35            | 0.45     |
| Colorado     | 0.40                                                                 | 0.30          | 3.85            | 2.35            | 0.45     |
| Utah         | 0.40                                                                 | 0.30          | 3.85            | 2.20            | 0.40     |

Source: U.S. Department of the Interior, *Final Environmental Statement, Federal Coal Management Program*, Report No. 1972(142), Bureau of Land Management, Washington, D.C., 1979.

**Table B.6. Water use factors (dust control and revegetation)**

| State or region | Water use factor<br>(acre-feet per 10 <sup>6</sup> tons of coal) |                    |
|-----------------|------------------------------------------------------------------|--------------------|
|                 | Surface mining                                                   | Underground mining |
| North Dakota    | 6.299                                                            | 3.68               |
| Wyoming         | 5.048                                                            | 3.68               |
| Colorado        | 5.048                                                            | 3.68               |
| Utah            | 6.079                                                            | 3.68               |
| Eastern states  | 4.460                                                            | 5.88               |

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Appendix C  
SUPPORTING ANALYSES

Appendix C.0  
HEALTH RISK ANALYSIS

Although actual leak rates can be determined only during operation, it can be assumed that the levels of toxic materials in actual practice will be controlled such that their concentrations in workplace air will not exceed appropriate TLVs. Thus, the restriction is

$$\frac{C_R}{TLV} < 1, \quad (1)$$

where  $C_R$  is the concentration of the toxic material in the air. The equation governing the total mass of a material in the air volume available to a worker is

$$\frac{dM_R}{dt} = pg_f - M_R\lambda_R, \quad (2)$$

where

$M_R$  = mass of material in workplace air,

$p$  = fraction leaking into workplace air,

$g_f$  = toxic material mass flow rate in the process stream,

$\lambda_R$  = turnover rate of air in the work location.

The solution to Eq. (2) is

$$M_R = \frac{pg_f}{\lambda_R} (1 - e^{-\lambda_R t}). \quad (3)$$

For sufficiently long times, such as 8 h, Eq. (3) is closely approximated by

$$M_R = \frac{pg_f}{\lambda_R}. \quad (4)$$

From Eq. (4), the leak rate that results in a buildup of materials,  $M_R$ , in the workplace air is

$$p = \frac{M_R\lambda_R}{g_f}. \quad (5)$$

Equations (1) and (5) are used to calculate allowable leak rates for each agent (assuming other agents are absent) which would present the strictest requirements in terms of leak control. Leak rates relative to CO may be calculated in order to determine whether CO is a suitable indicator compound. Therefore,  $P_i/P_{CO}$  is calculated, where  $P_i$  is the allowable leak rate for toxic material  $i$  and  $P_{CO}$  is the allowable leak rate for CO.

With  $C_R$  replaced by the TLV in the limiting case, and given that  $M_R = C_R V_R$ , where  $V_R$  is the air volume, and  $g_f = C_p v_p$ , where  $C_p$  is the concentration of the toxic material in the process stream, and  $v_p$  is the volume flow rate of the process stream, the following equation is derived:

$$\frac{P_i}{P_{CO}} = \frac{TLV_i C_{p,CO}}{TLV_{CO} C_{p,i}}. \quad (6)$$

If  $P_i/P_{CO}$  is greater than 1, then the concentration of toxic materials,  $i$ , will not exceed its TLV if the TLV of CO is not exceeded by the CO level. The magnitude of the ratio will indicate how much below or above TLV the concentration of material,  $i$ , would be, given that CO does not exceed its TLV.

Appendix C.1  
AIR QUALITY AND NOISE



## Appendix C.1.1

## AIR QUALITY

Construction impactsInput dataSource strengths

| <u>Pollutant</u> | <u>Emission (kg/year)</u> |
|------------------|---------------------------|
| TSP              | $8.9 \times 10^3$         |
| CO               | $43.7 \times 10^3$        |
| HC               | $10.7 \times 10^3$        |

Emission rates

|           |          |
|-----------|----------|
| Work day  | 8 h      |
| Work week | 5 d      |
| Work year | 52 weeks |
| Emissions | 2080 h   |

| <u>Pollutant</u> | <u>Emission rate (g/s)</u> |
|------------------|----------------------------|
| TSP              | 1.19                       |
| CO               | 5.84                       |
| HC               | 1.43                       |

Source area

$22 \times 10^3 \text{ m}^2$  (1158 m x 564 m)

Meteorological data

|                  |         |
|------------------|---------|
| Wind speed       | 4.9 m/s |
| Stability        | neutral |
| Effective height | 3 m     |

The winds blow in a given direction a maximum of 15% and toward Presidents Island. The maximum annual average concentration is thus  $3.14 \times 10^{-6} \times 0.15$ , or  $n_{x_{\max}}/Q = 0.47 \times 10^{-6}$ .

| <u>Pollutant</u> | <u>Concentration at Presidents Island</u> |
|------------------|-------------------------------------------|
| TSP              | $0.6 \text{ } \mu\text{g}/\text{m}^3$     |
| CO               | $2.8 \text{ } \mu\text{g}/\text{m}^3$     |
| HC               | $0.7 \text{ } \mu\text{g}/\text{m}^3$     |

Operational impactsFugitive emissions from coal pileFrom Sect. 2.4.2.2

Yearly emissions = 18 tons controlled

Area = 51,708 m<sup>2</sup>, or (227 m)<sup>2</sup>

Computational procedure

From Turner,<sup>1</sup>

$$\sigma_{y_0} = 227/4.3 = 53$$

For neutral stability,  $x_y$  at  $\sigma_{y_0}$  at 53 = 500 m

For  $x = 1000$  m downwind,  $\sigma_z = 60$  m

At  $x = x + x_y = 1000$  m + 500 m = 1500 m

At  $x = 1500$  m,  $\sigma_y = 150$

$$\frac{x}{Q} = \frac{1}{(\pi)(150)(60)(4.9)} \exp \left[ -\frac{1}{2} \left( \frac{3}{60} \right)^2 \right]$$

$$\frac{x}{Q} = 7.2 \times 10^{-6}$$

For Presidents Island,  $x_{\max}/Q = (7.2 \times 10^{-6}) \times (0.15) = 1.08 \times 10^{-6}$   $x_{\max} = 0.6 \mu\text{g}/\text{m}^3$

Computational procedure

From Turner,<sup>1</sup>

$$\sigma_{y_0} = \text{square side}/4.3$$

$$\sigma_{y_0} = 1158 \text{ m}/4.3 = 269$$

For neutral stability,  $x_y$  at  $\sigma_{y_0}$  of 259 m = 2.5 km

For  $x = 1000$  m downwind,  $\sigma_z = 60$

At  $x = x + x_y = 2.5$  km + 1000 m = 3500 m

At  $x = x + x_y = 3500$  m,  $\sigma_y = 340$

$$x(1000) = \frac{Q}{\pi \sigma_y \sigma_z} u \exp \left[ -\frac{1}{2} \left( \frac{H}{\sigma_z} \right)^2 \right]$$

where

$x(1000)$  = concentration at 1000 m downwind

$Q$  = source strength

$\sigma_y$  = crosswind dispersion parameter

$\sigma_z$  = vertical dispersion parameter

$u$  = average wind velocity

$H$  = effective height of emission

For various pollutants, calculate  $x/Q$

$$\frac{x(1000)}{Q} = \frac{1}{(\pi)(340)(60)(4.9)} \exp \left[ -\frac{1}{2} \left( \frac{3}{60} \right)^2 \right]$$

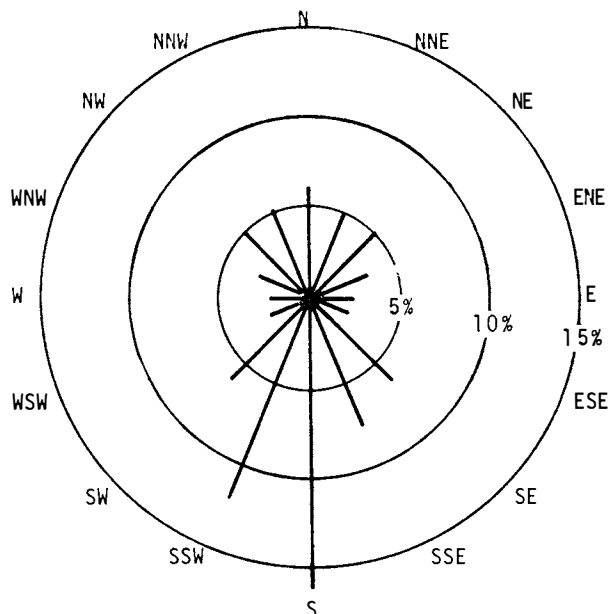
$$\frac{x(1000)}{Q} = 3.14 \times 10^{-6}$$



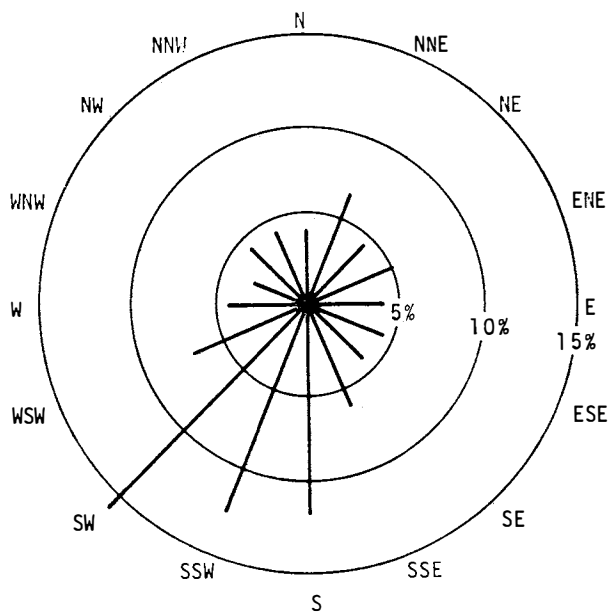
### Routine emissions

The pollutant concentrations resulting from the operation of the proposed facility were calculated by using an air quality dispersion model, CRSTER, developed by the EPA. Routine plant effluents were used as input, as were meteorological data from the Memphis, Tennessee, airport. Nonroutine emissions of  $\text{SO}_2$  were calculated by determining the simple ratio of nonroutine to routine emissions and utilizing the PTDIS<sup>2</sup> calculational procedure. This approach is conservative, but no other data on effluent characteristics are available for making a more detailed calculation.

#### C.1.1.1 Wind roses for the Memphis area



U.S. Weather Bureau - Memphis Data 1951 to 1960



TVA Allen Data - 1977



Appendix C.1.2

NOISE

This entire appendix is directly copied from the Memphis Light, Gas and Water  
Division Environmental Report, Sects. 3.5, 4.1.5, and 4.2.5.



### 3.5 AMBIENT NOISE

An assessment of ambient sound levels in the vicinity of the Memphis Industrial Fuel Gas Demonstration Plant was conducted August 11 to 14, 1978. August was selected to represent the fair weather period when outdoor activities are common. Sound level measurements were made at nine locations in the plant site vicinity. The locations are shown in Figure 3-33. Location 1, the Chucalissa Indian Village Reconstruction, is 1.9 miles southeast of the plant site and represents the nearest recreational area. This location has a direct line of sight to the plant site. Location 2 is on the levee west of the T. E. Maxson Wastewater Treatment Plant, 0.6 mile south of the site. Location 3 is at the Wilbur Johns Farming Camp, 1.1 miles south of the site, and represents the nearest permanently inhabited dwelling. Location 2 is in a direct line from the plant site to location 3 and was chosen as a means to ascertain any effects the levee may have on noise from the plant site reaching location 3 and to indicate the degree of attenuation with distance. Location 4 is in the parking area of the CB&I Nuclear Company, 1 mile northeast of the site, and is the nearest developed area on Presidents Island where a substantial number of people could be affected. Location 5 is approximately 100 feet to the east of the T. E. Maxson Wastewater Treatment Plant parking lot, 0.6 mile south-southeast of the site. This location is between the treatment plant and the Allen Generating Plant and was chosen to determine the combined noise effects of the two plants. Locations 6, 7, 8 and 9 are on higher ground (i.e., the road) at the approximate midpoints of the sides of the property boundary.

Sound measurements were made with a precision grade (American National Standards Institute, Type 1) instrument in a manner consistent with good field measurement practices. The omni-directional microphone was located approximately 4 feet above the ground when measurements were made. All measurements were made on the "slow" meter scale under calm wind conditions. Measurements were taken on the A-weighted scale,\* the C-weighted scale and the flat (unweighted

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\* Noise levels have the units of decibels (dB) re:  $20\mu\text{N}/\text{m}^2$ . The A-weighted values are designated dBA. The A-weighted scale modifies the true sound spectrum in a prescribed manner to give a response that simulates that of the human ear.

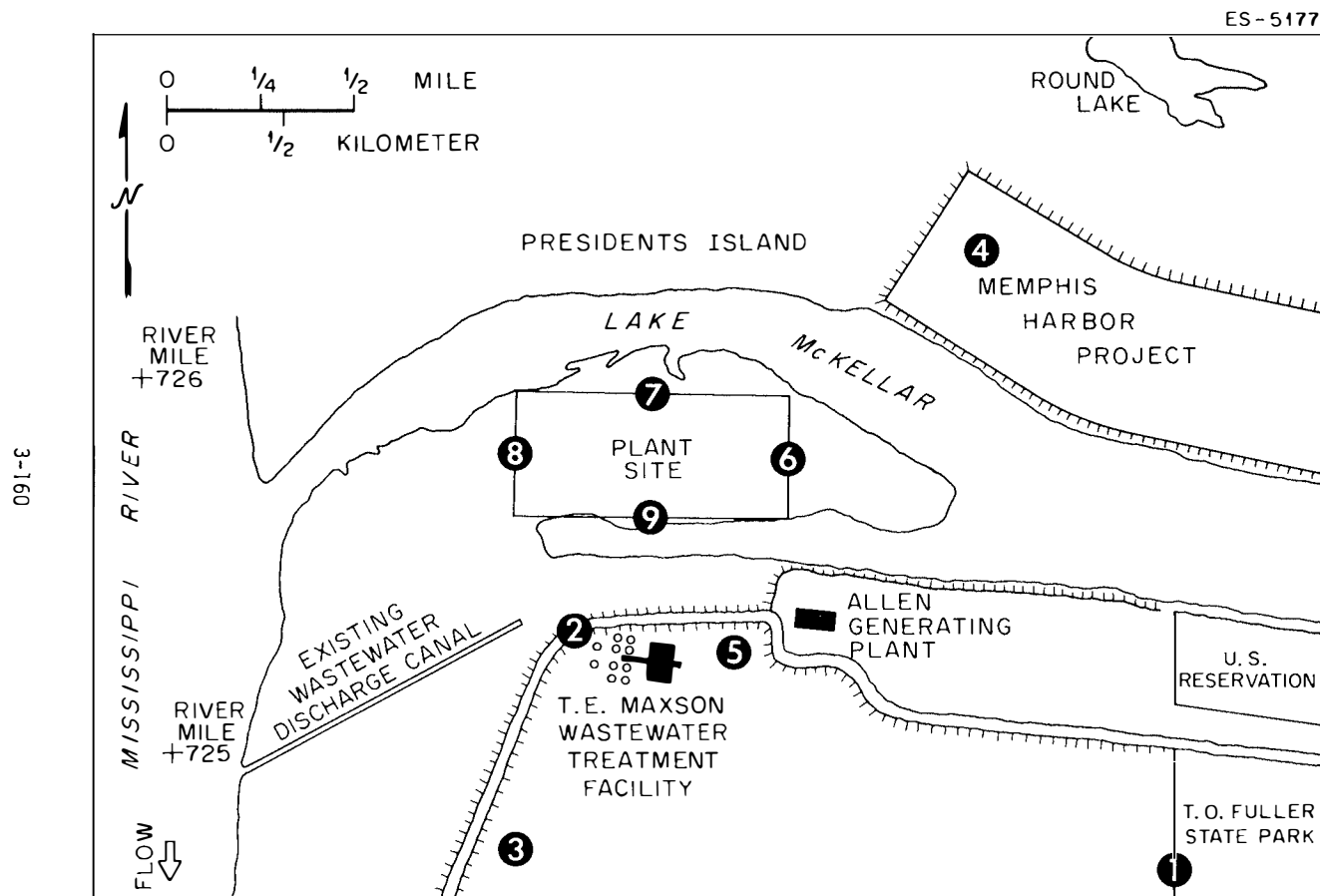


Fig. 3-33. Sound Level Measurement Locations (Modified).

or linear) scale. At each location, the A-weighted sound levels were recorded at 15-second intervals over a minimum time period of 15 minutes. At the beginning and end of each observation period, the flat and C-weighted levels were measured. Comparisons of the differences between the A-weighted and the flat and C-weighted levels were used to verify: (1) that excessive wind speeds were not present and (2) that the background noise spectrum had not changed significantly over the period of measurement.\* Measurements were taken on four occasions - once in the daytime and once in the nighttime, both during the week and on the weekend. Daytime is defined as 7:00 a.m. to 7:00 p.m., and nighttime is defined as 7:00 p.m. to 7:00 a.m. Daytime measurements were made when the average wind speed was less than 10 miles per hour, and nighttime measurements were made when the average wind speed was less than 5 miles per hour.

Average ambient noise levels measured at each location are presented in Table 3-44. These levels were determined by taking a weighted average of all measured values over the 15-minute time period. Table 3-44 also includes maximum levels of intermittent noises, the sources observed at each location and the maximum daytime and nighttime wind speeds measured at each location. These levels are included in the average ambient noise levels, but since the occurrences of these levels were of short duration, they did not contribute significantly to the average values.

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\* The A-weighted scale strongly attenuates low frequency noise; whereas, the C-weighted scale provides only modest low frequency attenuation. Hence, the differences between the A-weighted and the flat and C-weighted levels provide measure of the amount of noise present in the low frequency region. Since wind noise is predominantly a low frequency phenomenon, this comparison is an effective means to evaluate the wind speed effects on the measured noise. In general, large differences between the A-weighted and the flat and C-weighted levels are indicative of high wind speeds; small differences are indicative of low wind speeds. Differences between the flat and C-weighted scales at the beginning and end of the observation period indicate whether the frequency content of the noise signal has changed significantly.

TABLE 3-44

## AMBIENT NOISE LEVELS AND MAXIMUM WIND SPEEDS

| Location | Average Noise Levels<br>(dBA re: 20 $\mu$ N/m <sup>2</sup> ) |       |         |       | Maximum Noise Levels<br>(dBA re: 20 $\mu$ N/m <sup>2</sup> ) |                | Maximum Wind Speeds<br>(mph) |       |
|----------|--------------------------------------------------------------|-------|---------|-------|--------------------------------------------------------------|----------------|------------------------------|-------|
|          | Weekday                                                      |       | Weekend |       | Source                                                       | Level          | Day                          | Night |
|          | Day                                                          | Night | Day     | Night |                                                              |                |                              |       |
| 1        | 54                                                           | 56    | 55      | 56    | Train                                                        | 67             | 6                            | 1     |
| 2        | 53                                                           | 53    | 53      | 57    | Traffic<br>Airplane<br>Insects                               | 64<br>66<br>64 | 4                            | 1     |
| 3        | 49                                                           | 51    | 46      | 42    | Airplane<br>Animals                                          | 61<br>65       | 4                            | 5     |
| 4        | 56                                                           | 43    | 52      | 56    | Traffic                                                      | 61             | 4                            | 5     |
| 5        | 58                                                           | 60    | 59      | 53    | Airplane                                                     | 63             | 4                            | 1     |
| 6        | 59                                                           | 76    | 66      | 70    | Airplane<br>Barge<br>Insects                                 | 64<br>74<br>78 | 3                            | 4     |
| 7        | 57                                                           | 63    | 62      | 62    | Barge                                                        | 66             | 1                            | 4     |
| 8        | 56                                                           | 59    | 57      | 58    |                                                              |                | 1                            | 1     |
| 9        | 67                                                           | 58    | 62      | 57    | Traffic<br>Airplane                                          | 68<br>69       | 5                            | 1     |



### 3.5.1 NOISE GUIDELINES

No existing state or local noise regulations affect the proposed plant site. Noise guidelines have been published for use in cases where no such regulations exist; these are presented in Tables 3-45 and 3-46. These guidelines can be used to interpret the data in Table 3-44. Steady state sound level values in Table 3-45 are consistent with recommendations in both the United States and Europe.<sup>(1)</sup> If a sound is present for only a portion of the time, as in the case of passing trains, then the values in Table 3-45 may be increased by the amounts shown in Table 3-46. Table 3-47 presents a comparison between familiar sounds and their associated noise levels, measured in dBA.

### 3.5.2 DESCRIPTION OF THE EXISTING ENVIRONMENT

The background ambient noise at all locations, except location 4, consisted primarily of insect noises and a steady hum from the Allen Generating Plant. The nighttime insect noise levels on the eastern site boundary (location 6) were extremely high (averages of 76 and 70 dBA). These values probably represent about the highest expected naturally caused background noise levels at this site. The background ambient noise at location 4 originated from industrial processes at the CB&I Nuclear Company Plant. Background noises from the T. E. Maxon Wastewater Treatment Plant were discernable at locations 2 and 5. Earthmoving equipment had an effect on background daytime noise levels observed at locations 6 and 9. A passing barge raised background levels at locations 6 and 8.

Based on the guidelines in Table 3-45 and the data in Table 3-44, all nine locations can be classified as suburban-urban during the daytime, on both weekdays and weekends. The nighttime levels tend to be in the urban-industrial-heavy industrial range. However, the guidelines do not account for natural noise sources such as insects, whose noises are seasonal and are generally accepted. Hence, the nighttime levels at the site can be characterized as being in the urban range (based on observed levels not dominated by the insect

TABLE 3-45  
GUIDELINES FOR COMMUNITY NOISE LEVELS<sup>(2)</sup>

| <u>Area</u>                                                           | <u>Sound Level (dBA re: 20 <math>\mu</math>N/m<sup>2</sup>)</u> |              |              |
|-----------------------------------------------------------------------|-----------------------------------------------------------------|--------------|--------------|
|                                                                       | <u>Day*</u>                                                     | <u>Night</u> | <u>Other</u> |
| Rural (residential)                                                   | 50                                                              | 40           | 45           |
| Suburban (residential) also hospital,<br>church and similar zones     | 55                                                              | 45           | 50           |
| Urban (residential) also apartment                                    | 60                                                              | 50           | 55           |
| Urban (residential) with some commercial,<br>retail or light industry | 65                                                              | 55           | 60           |
| Predominantly industrial                                              | 70                                                              | 60           | 65           |
| Heavy industrial, few dwellings                                       | 75                                                              | 65           | 70           |

\* "Day" represents the period 0700 to 1700 hours on weekdays and "night" 2200 to 0700 hours. "Other" includes 1700 to 2200 hours and on weekends and holidays 0700 to 1700 hours.

TABLE 3-46  
COMMUNITY NOISE LEVEL LIMITS FOR NOISE PRESENT ONLY  
A PORTION OF THE TIME PERIOD UNDER CONSIDERATION<sup>(2)</sup>

| <u>Time Present (%)</u> | <u>Amount of Level Increase (dB)</u> |
|-------------------------|--------------------------------------|
| 1                       | 15                                   |
| 2                       | 15                                   |
| 3                       | 15                                   |
| 4                       | 14                                   |
| 5                       | 13                                   |
| 8                       | 11                                   |
| 10                      | 10                                   |
| 20                      | 7                                    |
| 30                      | 5.5                                  |
| 40                      | 3.9                                  |
| 50                      | 2.8                                  |
| 80                      | 1.0                                  |
| 100                     | 0                                    |

TABLE 3-47  
SOUND LEVELS AND HUMAN RESPONSE<sup>(3)</sup>

|                                  | NOISE LEVEL<br>(dBA) | Response             | Hearing Effects                           | Conversational Relationships  |
|----------------------------------|----------------------|----------------------|-------------------------------------------|-------------------------------|
| CARRIER DECK                     | 150                  |                      |                                           |                               |
| JET OPERATION                    | 140                  |                      |                                           |                               |
|                                  | 130                  | PAINFULLY LOUD       | CONTRIBUTION TO HEARING IMPAIRMENT BEGINS |                               |
|                                  |                      | LIMIT AMPLIFIED      |                                           |                               |
|                                  |                      | SPEECH               |                                           |                               |
| JET TAKEOFF<br>(200 feet)        | 120                  |                      |                                           |                               |
| DISCOTHEQUE                      |                      |                      |                                           |                               |
| AUTO HORN (3 feet)               | 110                  | MAXIMUM VOCAL EFFORT |                                           |                               |
| RIVETING MACHINE                 | 100                  |                      |                                           | SHOUTING IN EAR               |
| JET TAKEOFF<br>(2000 feet)       |                      |                      |                                           |                               |
| GARBAGE TRUCK                    |                      | VERY ANNOYING        |                                           |                               |
| N.Y. SUBWAY STATION              | 90                   | HEARING DAMAGE       |                                           | SHOUTING AT 2 FT.             |
| HEAVY TRUCK<br>(50 feet)         |                      | (8 hours)            |                                           |                               |
| PNEUMATIC DRILL<br>(50 feet)     | 80                   | ANNOYING             |                                           | VERY LOUD CONVERSATION, 2 FT. |
| ALARM CLOCK                      |                      |                      |                                           |                               |
| FREIGHT TRAIN<br>(50 feet)       | 70                   | TELEPHONE USE        |                                           | LOUD CONVERSATION, 2 FT.      |
| FREEWAY TRAFFIC<br>(50 feet)     |                      | DIFFICULT            |                                           |                               |
| AIR CONDITIONING UNIT (20 feet)  | 60                   | INTRUSIVE            |                                           | LOUD CONVERSATION, 4 FT.      |
|                                  |                      |                      |                                           |                               |
| LIGHT AUTO TRAFFIC<br>(100 feet) | 50                   | QUIET                |                                           | NORMAL CONVERSATION, 2 FT.    |
| LIVING ROOM                      |                      |                      |                                           |                               |
| BEDROOM                          | 40                   |                      |                                           |                               |
| LIBRARY                          |                      |                      |                                           |                               |
|                                  |                      |                      |                                           |                               |
| SOFT WHISPER<br>(15 feet)        | 30                   |                      |                                           |                               |
|                                  |                      |                      |                                           |                               |
| BROADCASTING STUDIO              | 20                   |                      |                                           |                               |
|                                  |                      |                      |                                           |                               |
|                                  | 10                   | JUST AUDIBLE         |                                           |                               |
|                                  |                      |                      |                                           |                               |
|                                  | 0                    | THRESHOLD OF HEARING |                                           |                               |

noises). The highest nighttime levels were found at the plant boundary locations, which are the areas least disturbed by human activity and most likely to have the greatest concentration of insects. Several of the significant background noise sources operate continuously (e.g., the Allen Generating Plant and the T. E. Maxson Wastewater Treatment Plant), producing essentially a constant noise level. As a consequence, there are smaller variations in the background noise levels between weekday and weekend, and day and night than otherwise would be expected.

#### 4.1.4.4 MOTOR VEHICLE AND CONSTRUCTION EQUIPMENT EXHAUST

Estimated motor vehicle and construction equipment emissions are presented in Table 4-1. These estimates are based upon the maximum number of each type of vehicle expected to be used, the projected operation schedule for each vehicle and emission factors for construction equipment.<sup>(2)</sup> With the exception of automobiles and pickup trucks, all construction vehicles are assumed to be diesel powered. Table 4-1 presents the estimated emissions in tons per year. As can be seen in Table 4-1, most of the emissions are a result of construction equipment. These emissions are relatively small in magnitude. No significant impact on ambient pollutant levels will result.

#### 4.1.4.5 CONSTRUCTION DEBRIS

Air impacts caused by construction debris will be negligible. Debris will be collected weekly and removed to a commercial sanitary landfill. During the storage time on site, debris will be contained by either covering or sprinkling it with water to minimize wind erosion.

#### 4.1.5 NOISE

An evaluation of noise levels associated with construction procedures at the plant site indicate that no significant impact on the surrounding environment will occur as a result of these noises. Other than at locations near the plant boundary, construction noise will be inaudible. The volume of traffic through Fuller State Park will increase because of worker and delivery traffic. As a result, the duration of noise exposure in the park will increase. However, the maximum noise levels in the park are not expected to increase over current levels.

Construction noise levels were evaluated by considering the types, number and schedule of pieces of major construction equipment anticipated to be used and the expected worker and delivery traffic flows.

Table 4-2 lists the major noise-producing equipment that will be used during construction, the number required, the period of use and maximum expected A-weighted noise levels\* for each piece of equipment at a distance of 50 feet.<sup>(1)</sup> The different equipment that will be used during the construction period indicates that the average construction noise level will vary.

A composite construction source noise level was calculated for five construction periods, the site filling period (4th quarter 1980 to 2nd quarter 1981) and each of the construction years (1981 to 1984). The levels are listed in Table 4-3. These source noise levels were calculated by using information in Table 4-2 by assuming that most of the construction equipment will be operated in a close group at the plant site center rather than being dispersed over the entire plant site. Composite noise levels at 50 feet from the center of the assumed grouping were established by summing the individual noise levels for the construction equipment on a mean square pressure basis. When sound sources are of the same relative size, as is the case with construction equipment, the mean square pressure basis for summing noise sources gives results essentially identical to summing sound powers, where the relative sizes of sound sources is considered.

Since all of the equipment will be used at least 6 hours per day, the composite levels were calculated with all the equipment operating at conditions producing the maximum expected noise levels. These levels will represent the maximum expected levels because most of the equipment will operate under full load for only portions of the time. Hence, the composite source levels listed in Table 4-3 represent worst-case estimates and do not account for the short-term (day to day) variation in the level caused by daily tasks. The composite source levels are largely controlled by the noisiest pieces of machinery. Reductions in the composite levels could be achieved by decreasing the noise levels of the loudest equipment listed in Table 4-2.

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\*All noise levels are specified in terms of the A-weighted scale (dBA re: 20  $\mu\text{N/m}^2$ ) which simulates the response of the human ear and is commonly used when discussing the relationship of sound to people.

TABLE 4-2  
CONSTRUCTION EQUIPMENT UTILIZATION AND NOISE LEVELS

| Equipment               | Time Period                  | Number Required | Daily Usage (hr) | Maximum Expected Individual Equipment Noise Level at 50 ft, dBA re: 20 $\mu$ N/m <sup>2</sup> |
|-------------------------|------------------------------|-----------------|------------------|-----------------------------------------------------------------------------------------------|
| 1/2 Ton Pickup          | 2nd Qtr 1981 to 1984         | 13              | 6                | 82                                                                                            |
| Medium Duty Tractor     | 1981 to 1984                 | 2               | 8                | 85                                                                                            |
| Heavy Duty Tractor      | 1981 to 1984                 | 1               | 8                | 95                                                                                            |
| Dredgers                | 4th Qtr 1980 to 2nd Qtr 1981 | 3               | 22               | 85                                                                                            |
| 50-ton Crawler Crane    | 4th Qtr 1980 to 2nd Qtr 1981 | 4               | 6                | 76                                                                                            |
| Bulldozers              | 4th Qtr 1980 to 2nd Qtr 1981 | 6               | 8                | 90                                                                                            |
| Graders                 | 4th Qtr 1980 to 2nd Qtr 1981 | 2               | 8                | 90                                                                                            |
| Front-End Loader        | 1981 to 1983                 | 2               | 6                | 82                                                                                            |
| 80-Ton Crawler Crane    | 1982 to 1983                 | 2               | 6                | 79                                                                                            |
| 125-Ton Crawler Crane   | 1982 to 1983                 | 2               | 6                | 84                                                                                            |
| 150-Ton Crawler Crane   | 1982 to 1983                 | 2               | 6                | 88                                                                                            |
| 200-Ton Crawler Crane   | 1982 to 1983                 | 2               | 6                | 88                                                                                            |
| 25-Ton Truck Crane      | 1981 to 1983                 | 3               | 6                | 80                                                                                            |
| 45-Ton Hydraulic Crane  | 1982 to 1983                 | 3               | 6                | 78                                                                                            |
| Cherry Picker           | 1982 to 1983                 | 20              | 8                | 75                                                                                            |
| Welding Packs           | 1982 to 1983                 | 6               | 8                | 75                                                                                            |
| 600 CFM Air Compressors | 1982 to 1983                 | 4               | 8                | 85                                                                                            |

TABLE 4-3  
COMPOSITE CONSTRUCTION EQUIPMENT SOURCE  
NOISE LEVELS BY CONSTRUCTION PERIOD

| <u>Construction<br/>Period</u>          | <u>Composite Source<br/>Noise Level at 50 ft,<br/>dBA re: 20 <math>\mu</math>N/m<sup>2</sup></u> |
|-----------------------------------------|--------------------------------------------------------------------------------------------------|
| 4th Quarter 1980 to<br>2nd Quarter 1981 | 97                                                                                               |
| 1981                                    | 98                                                                                               |
| 1982                                    | 100                                                                                              |
| 1983                                    | 100                                                                                              |
| 1984                                    | 97                                                                                               |



The composite source noise levels from IFGDP construction were projected to the nine receiver locations described in Section 3.5 and shown in Figure 4-2 by assuming hemispherical radiation of noise and correcting the levels for ground absorption and atmospheric absorption for a standard day (59°F and 70 percent relative humidity). Predicted levels at Location 1 also include a correction to account for shielding by the Allen Generating Plant. The projected construction noise levels for each of the five construction periods indicated in Table 4-3 at each location shown in Figure 4-2 are tabulated in Table 4-4. This table also includes the approximate distance from each receiver location to the plant site center and the measured average summer-season daytime ambient noise levels.

For construction period 1, the predicted noise levels at the site boundaries (Locations 6 to 9) represent the average level for site filling and grading. Actual levels can range from -3 to +5 dB around the listed average value when filling and grading operations are remote from and adjacent to the receiver locations, respectively. The noise levels at the other locations are relatively insensitive to the location of the noisy equipment on the site because these locations are significantly farther away (i.e., the effect of noise source separation or movement on the site is negligible).

A comparison of the predicted construction levels and the measured daytime ambient levels in Table 4-4 indicate that the plant construction noise will be audible only at site boundary Locations 6 through 9. The construction levels will be inaudible at Location 1, the Chucalissa Indian Village site, and all other locations except those in close proximity to the site boundary. Hence, plant construction noise is not expected to produce temporary or permanent hearing impairment in man or wildlife, even though it will have a temporary disruptive effect on wildlife use of the site.<sup>(2,3)</sup>

Another potential construction-related noise impact is the effect of noise generated by workers traveling to and from the plant site each day. Considering the work force size, estimated in Table 2-3, and an average of two persons per vehicle, there may be up to 350 vehicle trips per day to and from

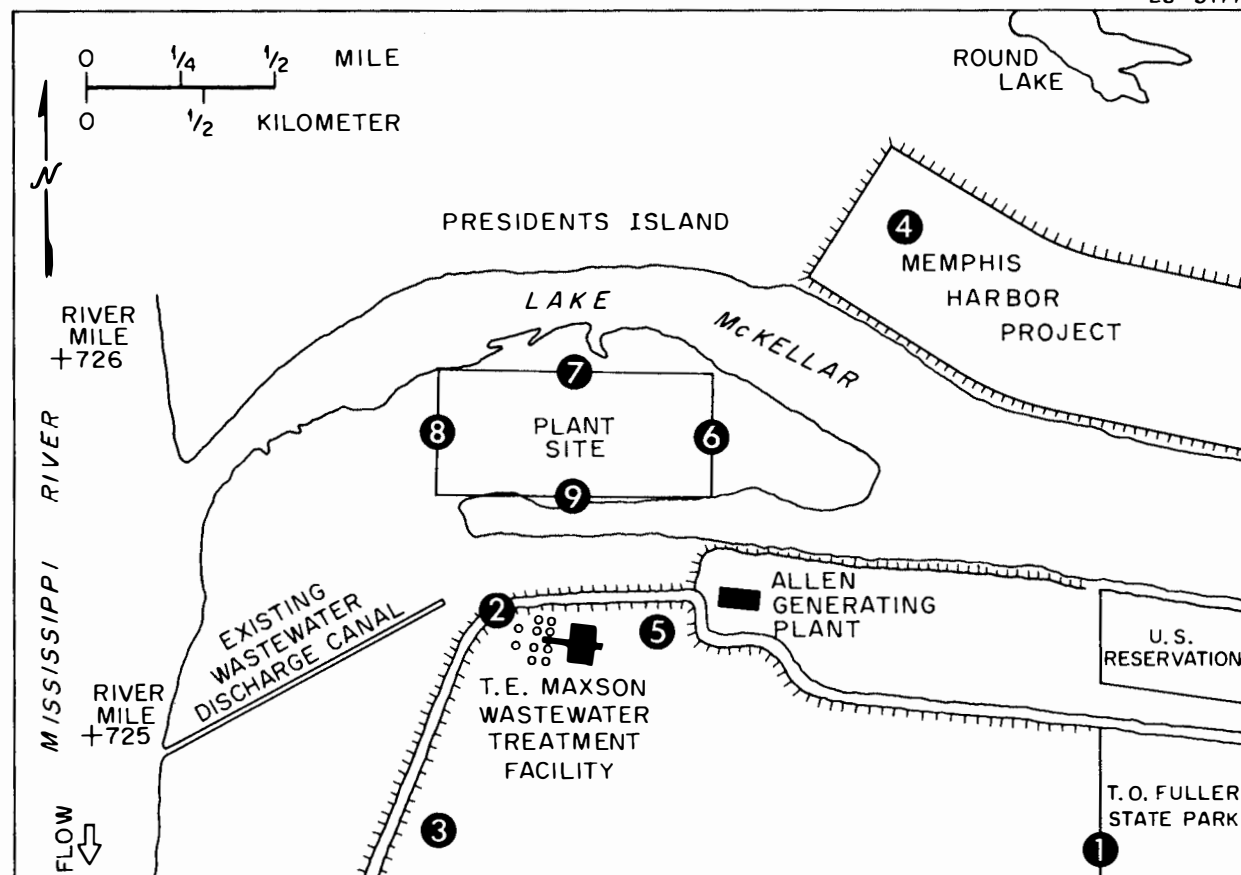


Fig. 4-2. Sound Level Measurement Locations (Modified).

TABLE 4-4  
PREDICTED CONSTRUCTION NOISE LEVELS

| Receiver Location* | Description                      | Source-Receiver Distance (ft) | Measured Average Ambient Daytime | Construction Period** Noise Level of Receiver Locations, dBA re: 20 $\mu$ N/m <sup>2</sup> |    |    |    |    |
|--------------------|----------------------------------|-------------------------------|----------------------------------|--------------------------------------------------------------------------------------------|----|----|----|----|
|                    |                                  |                               |                                  | 1                                                                                          | 2  | 3  | 4  | 5  |
| 1                  | Chucalissa Indian Village        | 10,000                        | 54                               | 23                                                                                         | 24 | 26 | 26 | 23 |
| 2                  | Top of levee                     | 3,000                         | 53                               | 53                                                                                         | 54 | 56 | 56 | 53 |
| 3                  | Farm                             | 6,000                         | 49                               | 40                                                                                         | 41 | 43 | 43 | 40 |
| 4                  | Memphis Harbor Project           | 6,000                         | 56                               | 40                                                                                         | 41 | 43 | 43 | 40 |
| 5                  | Maxson Sewage Treatment Facility | 3,100                         | 58                               | 53                                                                                         | 54 | 56 | 56 | 53 |
| 6                  | Eastern Plant Boundary           | 1,800                         | 59                               | 60                                                                                         | 61 | 63 | 63 | 60 |
| 7                  | Northern Plant Boundary          | 1,100                         | 57                               | 69                                                                                         | 70 | 72 | 72 | 69 |
| 8                  | Western Plant Boundary           | 1,800                         | 56                               | 60                                                                                         | 61 | 63 | 63 | 60 |
| 9                  | Southern Plant Boundary          | 1,100                         | 57                               | 69                                                                                         | 70 | 72 | 72 | 69 |

\* Receiver locations are shown in Figure 4-2.

\*\* Construction periods are defined in Table 4-3.

the site. This is in addition to equipment or material delivery during the day. Worker travel to and from the site will be concentrated in 45-minute periods in the morning and the evening.

Location 1, the Chucalissa Indian Village Reconstruction, and the surrounding Fuller State Park area are the only sites within 2 miles of the plant site center that may be affected by traffic noise. A traffic flow of 350 cars at speeds up to 45 miles per hour in a 45-minute period can be expected to produce intermittent noise levels of up to 65 dBA at 100 feet from the roadway.<sup>(4)</sup> Location 1 is approximately 0.25 mile from the roadway, and a buffer of trees exists between the road and the village. As a result, no significant noise impacts are expected at Location 1.

Several off-site facilities will be constructed, including an access road, a natural gas pipeline, water and wastewater pipelines and the product gas distribution system. Maximum sound levels for these types of construction activities will not exceed 80 dBA at 50 feet, and this level will occur only intermittently. Since most of this construction will take place in non-residential areas, no significant impacts are expected. Some intermittently louder levels (up to 90 dBA at 50 feet) could occur if pavement breaking is required in some areas for pipeline installation.

The nearest populated area to the region of the Mississippi River where dredging will occur is about 1 mile away. This area is located behind the levee which parallels the river. The estimated noise level produced by the three dredgers at a distance of one mile is 37 dBA. This noise level was determined by considering spherical spreading of sound, the shielding effect of the levee and ground air absorption of sound. The impact of the dredging noise will be minimal. The community noise guidelines in Table 3-45 indicate that a level of 37 dBA would be classified as representative of a rural area during both daytime and nighttime.

a chemical used as a corrosion inhibitor in the circulating water, can be estimated to have a deposition rate of  $4.5 \times 10^{-4}$  pounds per acre-day for the slightly unstable case and  $2.7 \times 10^{-4}$  pounds per acre-day for the neutral case. These levels of total suspended solids and chromate are insignificant.

#### 4.2.5 NOISE

An evaluation of noise generated during plant operation indicates that the noise impact on the surrounding areas will be negligible. At most locations away from the plant boundary, the existing ambient levels are higher than those which will result from operation of the plant. At those locations where the plant noise levels exceed the existing ambient levels, they will exceed by no more than 3 dBA.\* Such an increase is barely perceptible to the human ear and hence will produce no significant impact.

Predicted noise levels produced by plant operation were based on knowledge of plant equipment, equipment location, predicted noise levels of the equipment and the topography of the site and surrounding area.

The A-weighted radiated noise levels due to plant operation were calculated for the noise locations identified in Section 3.5.4 and shown in Figures 3-33 and 4-2. Calculation of the radiated noise levels requires a determination of the sound power produced by each noise source. The sound power levels listed in Table 4-19 for most of the major noise sources were determined from the unit horsepower or capacity rating and from data and predictive equations presented in References 1 through 6. For the remaining sources, sound power level data were not available in the literature, and the radiated sound power

---

\* See List of Abbreviations for definition.

TABLE 4-19  
MAJOR NOISE SOURCES AND THEIR ESTIMATED SOUND POWER LEVELS

| Source |                             | Noise Level,<br>dBA re: 20 $\mu$ N/m <sup>2</sup> | Sound Power Level,<br>dBA re: 10 <sup>-12</sup> watts |
|--------|-----------------------------|---------------------------------------------------|-------------------------------------------------------|
| 100C   | Cyclone Separators          | 90 @ 3 feet                                       | 110                                                   |
| 300C   | Raw Gas Compressors (2)     |                                                   | 115                                                   |
|        | Recycle Gas Compressor      | 90 @ 3 feet                                       | 107                                                   |
|        | Raw Gas Scrubbers (3)       | 90 @ 3 feet                                       | 107                                                   |
| 700C   | Air Compressors (2)         |                                                   | 118                                                   |
|        | Oxygen Compressor           |                                                   | 114                                                   |
| 1000C  | Barge Unloading System*     | 85 @ 3 feet                                       | 105                                                   |
|        | Vibrator                    |                                                   | 111                                                   |
|        | Coal Crushing/Drying Unit   |                                                   | 106                                                   |
|        | Front-End Loaders*          |                                                   | 114                                                   |
| 1500C  | Ash Disposal Trucks*        |                                                   | 117                                                   |
| 2000C  | Package Boilers (2)         |                                                   | 98                                                    |
| 3400C  | Cooling Tower               |                                                   | 112                                                   |
| 6400C  | Substation/Transformers (2) |                                                   | 102                                                   |

\* Intermittent operation

was calculated from available noise level data (presented in Table 4-19) and the estimated size of the equipment according to the equation<sup>(7)</sup>

$$W = A (10^{-12}) \text{ antilog}_{10} (L_p/10) \quad (4-2)$$

where  $W$  = sound power of the source in watts

$A$  = exposed surface area of the source in square meters

$L_p$  = A-weighted noise level 1 meter from the source

The corresponding sound power levels,  $L_w$ , which are the sound power levels expressed in dBA, are found from Equation 4-2 and are defined:

$$L_w = 10 \log_{10} (W/10^{-12} \text{ watts}) \quad (4-3)$$

These sound power levels are listed in the first column of Table 4-19. The estimated noise levels noted in Table 4-19 represent the A-weighted levels 3 feet from each source. In general, these levels are believed to be maximums and are consistent with the MLGW requirement that all vendor-supplied equipment meet OSHA requirements for 90 dBA maximum worker exposure for an 8-hour work day.

Different procedures were used to determine the predicted plant operational noise levels at the plant site boundary locations (6 to 9) and at all other locations (1 through 5). At Locations 1 to 5, away from the site boundary, the total plant radiated sound energy is assumed to emanate from the "acoustic" center of the plant. (This point closely corresponds to the geometric center of the noise sources on the plant site and has been taken as such.) The noise levels at the receiver locations (1 to 5) are then found from the equation<sup>(6,7)</sup>

$$L_{pi} = 10 \log_{10} W_t - 20 \log r_i + DI_i - \alpha_{gi} - \alpha_{mi} + 121 \quad (4-4)$$

where  $L_{pi}$  = A-weighted noise level at the receiver location  $i$   
 $W_t$  = total sound power emitted from the acoustic center in watts  
 $r_i$  = distance from the acoustic center to location "i" in feet  
 $DI_i$  = directivity correction factor to location "i" in dB  
 $\alpha_{gi}$  and  $\alpha_{mi}$  = ground and atmospheric absorption between the acoustic center and the  $i^{th}$  receiver location  
 121 = a constant

For the receiver locations (6 to 9) on the site boundary, the radiated sound level at each location was calculated separately using Equation 4-4 for each source. The resulting sound levels were summed on a mean square pressure basis to obtain the receiver sound level. This procedure must be followed for locations where the distance from the sources is about the same as the separation distance between sources.

The calculated sound levels utilizing both procedures were corrected for source directivity, source height and shielding by surrounding structures. The ground absorption correction used in Equation 4-4 conservatively assumes relatively flat terrain past the plant site boundaries and minimal vegetation. The atmospheric absorption correction used assumes standard day conditions of 59°F and 70 percent relative humidity.

The continuous noise levels predicted for operation of the plant at rated capacity at the nine receiver locations are listed in Table 4-20 along with the measured summertime average day and night ambient noise levels (from Section 3.5). These predicted levels include the corrections for hemispherical spreading of sound, ground absorption, shielding by other structures (if pertinent) and atmospheric absorption for standard day conditions.

The major continuous noise sources at the plant are the large compressors. The front-end loaders and ash disposal trucks also produce relatively high noise



levels at the receiver locations, but this equipment is used only intermittently. No high-noise-level upset conditions are expected to occur. Comparing the predicted plant operational noise levels with the measured ambient levels in Table 4-20 indicates the following:

- o The IFGDP will be inaudible at the Chucalissa Indian Village (Location 1).
- o The plant will be essentially inaudible at Locations 3, 4 and 5 and barely detectable at Location 2.
- o The noise levels at the plant site boundary will increase by 6 to 13 dB over current average daytime levels, with the maximum noise level anywhere on the boundary being approximately 70 dBA.

In relation to the community noise guidelines presented in Table 3-45 in Section 3.5, the plant boundary locations can be classed as being in the "predominantly industrial" category for daytime and the "heavy industrial" category for nighttime. At all other receiver locations, the noise produced by the plant alone would cause these locations to be rated either "rural" or "suburban" during the daytime and in the "rural" to "urban with light industry" range during the nighttime.

Overall, the actual impact of the plant operational noise on the surroundings will be negligible. In most areas away from the plant boundary, the plant will be inaudible because of the existing ambient levels produced by the Maxson Wastewater Treatment Facility, the Allen Generating Plant, as well as train and barge traffic in the area.

Traffic noise during plant operation is not expected to have any significant impact on the surroundings. The flow of traffic will be considerably less during operation than during construction as a result of a smaller work force requirement. The impact of construction traffic noise is considered to be negligible (Section 4.1.5), and the same conclusion can be reached for operational noise.

TABLE 4-20  
PREDICTED PLANT OPERATIONAL NOISE LEVELS

| Receiver<br>Location* | Description                   | Distance from<br>Source<br>(ft) | Noise Level, dBA re: 20 $\mu$ N/m <sup>2</sup> |                         |       |
|-----------------------|-------------------------------|---------------------------------|------------------------------------------------|-------------------------|-------|
|                       |                               |                                 | Predicted from<br>Plant Operation              | Measured Ambient<br>Day | Night |
| 1                     | Chucalissa Indian Village     | 10,000                          | 36                                             | 54                      | 56    |
| 2                     | Top of Levee                  | 3,000                           | 56                                             | 53                      | 53    |
| 3                     | Farm                          | 6,000                           | 46                                             | 49                      | 51    |
| 4                     | Memphis Harbor Project        | 6,000                           | 46                                             | 56                      | 43    |
| 5                     | Maxson Sewage Treatment Plant | 3,100                           | 56                                             | 58                      | 60    |
| 6                     | Eastern Plant Boundary        | 1,800                           | 62                                             | 59                      | 76    |
| 7                     | Northern Plant Boundary       | 1,100                           | 70                                             | 57                      | 63    |
| 8                     | Western Plant Boundary        | 1,800                           | 62                                             | 56                      | 59    |
| 9                     | Southern Plant Boundary       | 1,100                           | 70                                             | 67                      | 58    |

\* Receiver locations are shown in Figures 3-33 and 4-2.

## Appendix C.2

### HYDROLOGY



Appendix C.2.1

SURFACE WATER



ES-4997



DEPARTMENT OF THE ARMY  
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS  
P. O. BOX 631  
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESHR

23 November 1977

SUBJECT: Results of Model Tests of Fill Along the Mississippi River at  
Mile 725.5

District Engineer  
U. S. Army Engineer District, Memphis  
ATTN: LMMED-B  
668 Federal Office Building  
Memphis, Tennessee 38103

1. Tests were conducted on the Mississippi Basin Model (MBM) to determine the effects on the Mississippi River Project Design Flowline (PDF) of building a fill area along the Mississippi River at mile 725.5. The tests were requested by Mr. Guy Forney of your office by telephone on 25 July 1977.

Purpose of Study

2. These tests were conducted to determine the effect of dredged material deposition on upstream stages. It is proposed that the elevation of this fill be above the PDF.

The Model

3. The MBM is a fixed-bed model of the Mississippi River and its tributary system constructed to a horizontal scale of 1:2000 and a vertical scale of 1:100. These tests were conducted on the Cairo, Illinois-to-Helena, Arkansas reach of the model which had been adjusted to reproduce the 1973 Flood. A map of the test reach showing the Memphis Harbor Project, levees, the proposed fill and locations where model data were recorded is presented in Incl 1.

Test Procedures and Results

4. Steady flows simulating the crest of the PDF were introduced into the Cairo-to-Helena reach of the model without and with the proposed fill. The water surface elevation at Helena was held to 203.6 ft msl for both conditions. This is the elevation of the PDF obtained at Helena during previous model tests. Water surface elevations were recorded along the St. Francis Levee, the Ensley Levee, and on Presidents Island in the vicinity of the Memphis Harbor Project.

Fig. C.1. Letter from H. B. Simmons, Department of the Army, "Results of Model Tests of Fill Along the Mississippi River at Mile 725.5," 23 November 1977.

WESHR

23 November 1977

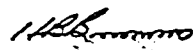
SUBJECT: Results of Model Tests of Fill Along the Mississippi River at  
Mile 725.5

5. The resulting water surface elevations, presented in Incl 2, indicate that the proposed fill raised to an elevation above the PDF would raise the PDF to a maximum of 0.7 foot along the north portion of Ensley Levee with a maximum increase of 0.2 foot on the left bank of the Mississippi River at the downstream end of Presidents Island. This increase in the PDF extended upstream to about the center of the Memphis Harbor Project. There was no increase in stages along the St. Francis Levee.

FOR THE COMMANDER AND DIRECTOR:

2 Incl  
as

CF:  
LMVED-WH

  
H. B. SIMMONS  
Engineer  
Chief, Hydraulics Laboratory



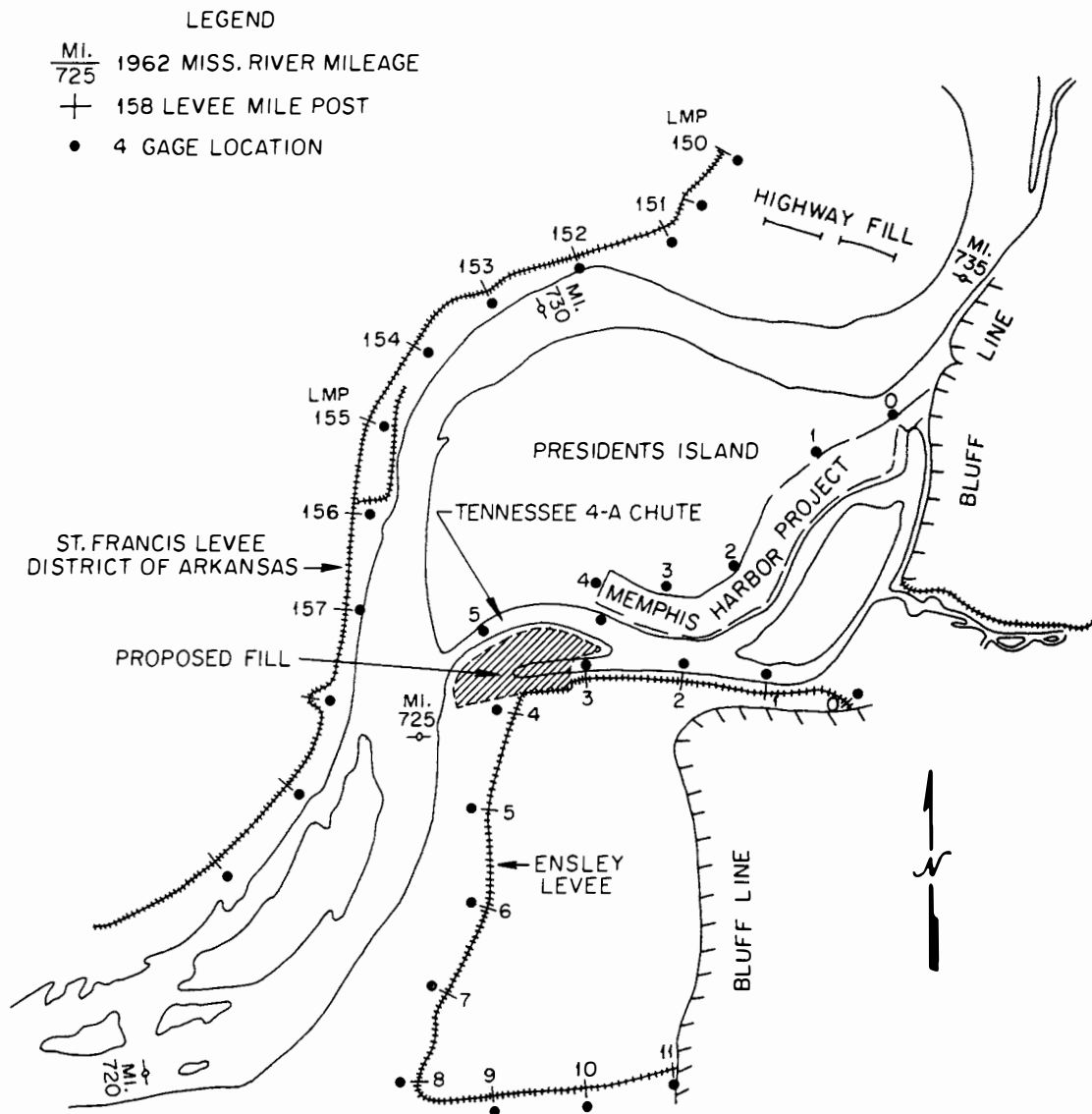


Fig. C.2. Enclosure No. 1 from H. B. Simmons 23 November 1977 letter.

ES-4994

GAGE NO. (1)  
or LMP

ELEVATION IN FEET MSL

PROPOSED FILL  
NOT INSTALLED

PROPOSED FILL  
INSTALLED

ST. FRANCIS LEVEE-DISTRICT OF ARKANSAS

|     |       |       |
|-----|-------|-------|
| 150 | 237.5 | 237.5 |
| 151 | 237.1 | 237.1 |
| 152 | 237.0 | 237.0 |
| 153 | 236.4 | 236.4 |
| 154 | 236.2 | 236.2 |
| 155 | 235.8 | 235.8 |
| 156 | 233.8 | 233.8 |
| 157 | 233.5 | 233.4 |
| 158 | 231.9 | 231.6 |
| 159 | 231.6 | 231.6 |
| 160 | 231.6 | 231.6 |

PRESIDENTS ISLAND

|     |       |       |
|-----|-------|-------|
| 0   | 240.4 | 240.4 |
| 1   | 237.0 | 237.0 |
| 2   | 236.8 | 236.9 |
| 3   | 236.5 | 236.6 |
| 4   | 234.6 | 234.8 |
| 4-A | 233.5 | 233.7 |
| 5   | 233.2 | 233.4 |

ENSLEY LEVEE

|    |       |       |
|----|-------|-------|
| 0  | 233.3 | 234.0 |
| 1  | 233.2 | 233.9 |
| 2  | 233.2 | 233.9 |
| 3  | 233.2 | 233.9 |
| 4  | 233.0 | 231.6 |
| 5  | 232.4 | 232.4 |
| 6  | 232.2 | 232.2 |
| 7  | 232.0 | 232.0 |
| 8  | 231.9 | 231.9 |
| 9  | 231.8 | 231.8 |
| 10 | 231.8 | 231.8 |
| 11 | 231.8 | 231.8 |

(1) For gage location see Inclosure 1.

Fig. C.3. Enclosure No. 2 from H. B. Simmons 23 November 1977 letter.

Appendix C.2.2  
ASH AND ASH LEACHATE COMPOSITION



## Appendix C.2.2

## ASH AND ASH LEACHATE COMPOSITION

Characterization of the chemical composition of the waste and leach testing were performed on material produced during operation of a U-gas pilot facility. Feed coal was Western Kentucky No. 9. Table C.1 shows the results of mechanical analysis of the material. The bulk of the waste consists of spherical or rounded particles ranging in size from 0.84 mm to 4.75 mm. Weight loss upon ignition is shown in Table C.2. Table C.3 shows the chemical composition of the ash for major elements and trace elements of interest in the evaluation of the potential hazard of the waste. The results of batch leaching of the waste, using five leaching procedures, are presented in Table C.4. Also listed in Table C.4 are proposed RCRA standards defining wastes as toxic, based on toxic metal content in the leachate 10 times the primary drinking water standards. In addition to batch leaching, wastes were subjected to column leach testing, in which water is passed through a column of waste and is analyzed for soluble toxic trace metals.

Testing of the waste shows that, although the material contains comparatively high levels of barium and chromium, the solubility of RCRA-designated elements in the leach tests was well below the concentrations defined as hazardous. The concentrations of potentially hazardous trace metals in the leachate were below primary drinking water standards under all leach conditions used except the 0.1 N nitric acid extraction, which is a more severe leach condition than is expected in the natural environment. Barium and chromium exceeded the drinking water standards in the nitric acid extract.

Additional bottom ash testing was performed by Energy Impact Associates by using the EPA extraction procedure and two modified ASTM procedures. The ASTM method was modified to begin extraction at pH 7 and 8, which is the range of surface water and groundwater pH at the site. Details of the testing methods used by EIA are available in their report.<sup>3</sup> The results of chemical testing of inorganic parameters in the leachate are presented in Table C.5. Levels of potentially hazardous inorganic substances were below hazardous concentrations designated by RCRA.

Table C.1. Sieve analysis of U-gas solid waste produced at near-atmospheric-pressure conditions

| Particle size range (mm) | Ash sample <sup>a</sup> (%) |       |       |       |       | Average |
|--------------------------|-----------------------------|-------|-------|-------|-------|---------|
|                          | 1                           | 2     | 3     | 4     | 5     |         |
| >4.75                    | 1.27                        | 1.02  | 0.36  | 0.36  | 1.02  | 0.81    |
| <4.75 to >2.0            | 18.14                       | 15.82 | 16.75 | 17.13 | 19.11 | 17.39   |
| <2.0 to >0.84            | 78.03                       | 80.54 | 80.16 | 80.39 | 77.89 | 79.40   |
| <0.84 to >0.5            | 1.54                        | 1.98  | 1.93  | 1.46  | 1.45  | 1.67    |
| <0.5 to >0.25            | 0.41                        | 0.29  | 0.29  | 0.24  | 0.10  | 0.27    |
| <0.25 to >0.125          | 0.13                        | 0.02  | 0.03  | 0.03  | 0.02  | 0.05    |
| <0.125 to >0.053         | 0.11                        | 0.04  | 0.06  | 0.05  | 0.05  | 0.06    |
| <0.053                   | 0.36                        | 0.31  | 0.42  | 0.34  | 0.37  | 0.36    |

<sup>a</sup>One grab sample removed from each of the five 5-gal containers shipped to ORNL by IGT.

Source: Letter from W. J. Boegley to Peter Lui, Chicago DOE, Apr. 9, 1979.

**Table C.2. Moisture content and weight loss on ignition at various temperatures for atmospheric pressure U-gas waste**

| Temperature (°C) | Sample weight loss (% w/w) |      | Mean |
|------------------|----------------------------|------|------|
|                  | 1                          | 2    |      |
| 110              | 0.03                       | 0.03 | 0.03 |
| 300              | 1.15                       | 0.31 | 0.73 |
| 500              | 3.90                       | 3.16 | 3.53 |
| 800              | 5.27                       | 4.48 | 4.88 |
| 1000             | 4.28 <sup>a</sup>          | 3.34 | 3.81 |

<sup>a</sup>Oxidation of FeO to Fe<sub>2</sub>O<sub>3</sub> is a possible explanation of weight gain between 800 and 1000°C.

Source: Letter from W. J. Boegley to Peter Lui, Chicago DOE, Apr. 9, 1979.

**Table C.3. Neutron activation analysis of selected elements present in U-gas agglomerates**

| Element      | Agglomerate <sup>a</sup> |
|--------------|--------------------------|
| Aluminum, %  | 9.40                     |
| Arsenic      | 2.45                     |
| Barium       | 334                      |
| Calcium, %   | 8.76                     |
| Cesium       | 4.60                     |
| Chromium     | 422                      |
| Cobalt       | 23                       |
| Iron, %      | 13.80                    |
| Magnesium    | 1.45                     |
| Manganese    | 1602                     |
| Molybdenum   | 45                       |
| Potassium, % | 1.13                     |
| Sodium       | 2630                     |
| Strontium    | 670                      |
| Thorium      | 11.0                     |
| Titanium     | 3354                     |
| Vanadium     | 420                      |
| Uranium      | 10.24                    |

<sup>a</sup>Concentration ppm unless otherwise noted.

Source: Letter from W. J. Boegley to Peter Lui, Chicago DOE, Apr. 9, 1979.

Table C.4. Atomic absorption analysis of leachates derived from various batch leaching protocols (ppm)

| Element  | EPA<br>EP | ASTM<br>H <sub>2</sub> O | ASTM<br>pH 4.5 | 0.1 N<br>HNO <sub>3</sub> | 0.1 N<br>NH <sub>4</sub> OH | RCRA<br>standards <sup>a</sup> |
|----------|-----------|--------------------------|----------------|---------------------------|-----------------------------|--------------------------------|
| Arsenic  | <0.001    | <0.001                   | <0.001         | 0.011                     | <0.002                      | 5.0                            |
| Barium   | 0.02      | 0.01                     | 0.06           | 2.8                       | 0.02                        | 100.0                          |
| Cadmium  | <0.001    | <0.001                   | <0.001         | <0.001                    | <0.001                      | 1.0                            |
| Chromium | <0.005    | <0.005                   | 0.006          | 0.07                      | 0.005                       | 5.0                            |
| Copper   | 0.01      | <0.01                    | <0.01          | <0.01                     | <0.01                       | <i>b</i>                       |
| Lead     | <0.01     | <0.01                    | <0.01          | <0.01                     | <0.01                       | 5.0                            |
| Mercury  | <0.001    | <0.001                   | <0.001         | <0.001                    | <0.001                      | 0.2                            |
| Nickel   | 0.03      | <0.005                   | 0.055          | 1.4                       | <0.005                      | <i>b</i>                       |
| Selenium | <0.001    | <0.001                   | <0.001         | <0.001                    | <0.007                      | 1.0                            |
| Silver   | <0.002    | <0.002                   | <0.002         | <0.002                    | <0.002                      | 5.0                            |
| Zinc     | 0.013     | <0.001                   | 0.066          | 0.359                     | <0.001                      | <i>b</i>                       |

<sup>a</sup> RCRA standards (May 19, 1980) are 100 times the EPA Interim Primary Drinking Water Standards.

<sup>b</sup> No standards have been established for copper, nickel, and zinc.

Source: Letter from W. J. Boegley to Peter Lui, Chicago DOE, Apr. 9, 1979.

Table C.5. Chemical quality of leachate produced by the ASTM and EPA methods

Concentrations in mg/liter except pH and odor

| Parameters                             | ASTM pH 7 |          | ASTM pH 8 |         | EPA EP  |          | RCRA standards <sup>a</sup> |
|----------------------------------------|-----------|----------|-----------|---------|---------|----------|-----------------------------|
|                                        | 1-A       | 1-B      | 2-A       | 2-B     | 3-A     | 3-B      |                             |
| Physical                               |           |          |           |         |         |          |                             |
| pH units                               | 10.6      | 10.7     | 10.6      | 10.7    | 4.8     | 4.9      |                             |
| Total dissolved solids                 | 170.0     | 130.0    | 100.0     | 130.0   | 190.0   | 180.0    |                             |
| Total alkalinity, as CaCO <sub>3</sub> | 94.0      | 95.0     | 94.0      | 100.0   | 41.0    | 53.0     |                             |
| Total hardness, as CaCO <sub>3</sub>   | 53.0      | 78.0     | 81.0      | 100.0   | 26.0    | 30.0     |                             |
| Odor (T.O.N.)                          | 1         | 1        | 1         | 1       | 1       | 1        |                             |
| Nutrients                              |           |          |           |         |         |          |                             |
| Ammonia nitrogen                       | 0.06      | 0.08     | 0.14      | 0.41    | 0.18    | 0.03     |                             |
| Nitrate nitrogen                       | 0.31      | 0.31     | 0.29      | 0.41    | <0.01   | 0.75     |                             |
| Phosphorus, total                      | 0.31      | 0.11     | 0.04      | 0.02    | 0.57    | 0.031    |                             |
| Organics                               |           |          |           |         |         |          |                             |
| Chemical oxygen demand                 | 28.0      | 21.0     | 2.0       | 7.0     | 241.0   | <i>b</i> |                             |
| Total organic carbon                   | 8.8       | 5.7      | 2.0       | <0.4    | 93.0    | 90.0     |                             |
| Phenols                                | <0.01     | <0.01    | <0.01     | <0.01   | 0.020   | 0.012    |                             |
| Oil and grease                         | 2.0       | <1.0     | <1.0      | <1.0    | <1.0    | <1.0     |                             |
| Cyanide                                | <0.01     | <0.01    | <0.01     | <0.01   | <0.01   | <0.01    |                             |
| Major anions                           |           |          |           |         |         |          |                             |
| Chloride                               | 1.6       | 2.2      | 3.9       | 7.7     | 0.20    | 2.1      |                             |
| Fluoride, free                         | <0.02     | <0.02    | <0.02     | <0.02   | <0.02   | <0.02    |                             |
| Sulfate                                | <i>b</i>  | <i>b</i> | 7.0       | 13.0    | 2.0     | 2.0      |                             |
| Major cations                          |           |          |           |         |         |          |                             |
| Calcium                                | 60.0      | 60.0     | 60.0      | 70.0    | 19.0    | 10.0     |                             |
| Magnesium                              | 0.45      | 0.35     | 0.42      | 0.32    | 0.15    | 0.12     |                             |
| Sodium                                 | 1.4       | 1.4      | 6.8       | 5.8     | 36.0    | 20.0     |                             |
| Potassium                              | 2.4       | 2.6      | 3.8       | 4.5     | 1.6     | 1.6      |                             |
| Trace elements                         |           |          |           |         |         |          |                             |
| Antimony                               | 0.0008    | 0.0008   | 0.002     | 0.002   | 0.0005  | <0.0004  | <i>c</i>                    |
| Arsenic                                | 0.032     | 0.028    | 0.007     | 0.011   | <0.002  | <0.0007  | 5.0                         |
| Barium                                 | <0.06     | <0.06    | <0.02     | <0.07   | <0.03   | <0.25    | 100.0                       |
| Beryllium                              | <0.002    | <0.002   | <0.002    | <0.002  | <0.002  | <0.002   | <i>c</i>                    |
| Cadmium                                | <0.003    | <0.003   | <0.003    | <0.003  | <0.003  | <0.003   | 1.0                         |
| Chromium                               | <0.005    | 0.006    | <0.005    | <0.005  | 0.006   | 0.005    | 5.0                         |
| Chromium (Cr <sup>+6</sup> )           | <0.010    | <0.010   | <0.010    | <0.010  | <0.01   | <0.01    | <i>c</i>                    |
| Copper                                 | 0.015     | 0.020    | 0.005     | 0.005   | 0.11    | 0.005    | <i>c</i>                    |
| Iron                                   | 0.063     | 0.030    | 0.057     | 0.030   | 0.038   | 0.040    | <i>c</i>                    |
| Lead                                   | <0.010    | <0.010   | 0.010     | <0.010  | 0.050   | <0.010   | 5.0                         |
| Manganese                              | 0.006     | 0.005    | 0.008     | 0.006   | 0.010   | <0.005   | <i>c</i>                    |
| Mercury                                | <0.0002   | <0.0001  | <0.0008   | <0.0008 | <0.0002 | <0.0002  | 0.2                         |
| Nickel                                 | <0.010    | <0.010   | <0.010    | <0.010  | 0.010   | 0.010    | <i>c</i>                    |
| Selenium                               | <0.002    | <0.002   | <0.002    | <0.002  | <0.002  | <0.008   | 1.0                         |
| Silver                                 | <0.002    | <0.002   | 0.004     | <0.002  | <0.002  | <0.002   | 5.0                         |
| Thallium                               | <0.005    | <0.005   | <0.005    | <0.005  | <0.006  | <0.006   | <i>c</i>                    |
| Zinc                                   | 0.15      | 0.014    | 0.37      | 0.005   | 0.050   | 0.20     | <i>c</i>                    |

<sup>a</sup> RCRA standards (May 19, 1980) are 100 times the EPA Interim Primary Drinking Water Standards.

<sup>b</sup> Insufficient sample to be determined accurately.

<sup>c</sup> Standards being promulgated.

Source: J. W. Bodamer and H. K. Roffman, *Leaching Studies on IGT U-Gas<sup>®</sup> Gasifier Ash*, prepared by Energy Impact Associates for Foster Wheeler Energy Corporation, Pittsburgh, Pa., August 1979.



Appendix C.2.3

VENDOR-SUPPLIED INFORMATION ON CHROMATE DESTRUCT SLUDGE



andco 2005 walden avenue/p.o. box 988/buffalo, new york 14240/phone 716-681-7400/telex 91-547



S L U D G E FROM THE

ANDCO CHROMATE REMOVAL PROCESS

IS NON-HAZARDOUS

Gentlemen:

We have good news for industrial users of chromates as a cooling water corrosion inhibitor. The sludge generated from the treatment of blowdown by the Andco Chromate Removal Process is not classed as a hazardous waste by the EPA. It can now be easily disposed of at relatively low cost.

The new EPA regulations for the disposal of hazardous waste as required by the Resource Conservation and Recovery Act (RCRA) establish criteria to determine whether a solid waste is hazardous.

In the case of sludge generated by the Andco Process in treating cooling tower blowdown, the sludge has only to pass the EPA Toxicity Test \* to be considered non-hazardous.

The EPA Toxicity Test is a 24-hour extraction procedure at pH 5 using acetic acid. If the leachate contains less than 5 ppm, the sludge is considered non-hazardous.

Sludge samples were obtained from four (4) geographically scattered Andco customers and evaluated by independent testing laboratories. The respective leachates contained the following chrome levels:

| <u>Plant</u> | <u>Total Chrome</u> |
|--------------|---------------------|
| A            | .05 ppm             |
| B            | .07 ppm             |
| C            | .01 ppm             |
| D            | .05 ppm             |

This shows that in addition to being classed as a non-hazardous solid waste by the EPA, the leachate would usually meet the chrome limits (0.05 ppm) of the National Drinking Water Standard.

We have asked the EPA how this specifically affects sludge disposal. They state that, since our sludge is not considered hazardous, disposal in non-secure landfills, municipal garbage dumps, or even on-site would be permissible. Such disposal is, of course, subject to local and state regulations in force.



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This finding should allow Andco customers to:

1. Minimize sludge disposal costs since secure landfill is not required.
2. Reduce hauling charges to isolated secure landfills.
3. Eliminate the paperwork required when handling "hazardous" solid wastes.
4. Continue chrome usage by keeping the cost of blowdown treatment to a minimum.

If you should require further detail, please feel free to call me at (716) 681-7400.

Very truly yours,

ANDCO ENVIRONMENTAL PROCESSES, INC.

Joseph G. Duffey, P.E.  
President

\* Federal Register, Vol. 45, No. 98, May 19, 1980

RPR/eb

Appendix C.3  
WATER QUALITY



## Appendix C.3.1

## SEDIMENT QUALITY

During the monitoring program, sediment samples from Lake McKellar and the Mississippi River were analyzed to assess their quality. Sample sites are shown in Fig. C.4; samples were collected on October 18, 1978. Sediment samples were subjected to elutriate testing to determine the solubility of potentially toxic materials. An acid digestion was also performed on the sediment. The laboratory and analytical procedures employed are those recommended in Standard Methods,<sup>4</sup> EPA Methods,<sup>5</sup> and EPA Protocol.<sup>6</sup> The U.S. Army Corps of Engineers procedure<sup>7</sup> was used in the elutriate test.

Elutriate testing was developed by the Corps of Engineers to assess the impact of dredging on natural waters. In the elutriate test, one part of sediment is mixed with four parts (volume/volume) of water, shaken for 30 min, allowed to settle for 1 h, and centrifuged and filtered to separate solids from the water. Filtered river water was used in the test. Chemical analysis of the water reflects the composition of water that has been in contact with the sediment during the dredging and filling operations. In addition to data obtained during site monitoring, some data on sediment quality were available from published literature. A summary of published data is presented in Table C.6. Detection limits for sediment analyses are listed in Table C.7. Results of sediment and elutriate analyses performed during site monitoring are presented in Tables C.8-C.11.

Bottom sediment was characterized by using the classification scheme based on sediment chemistry proposed by Prater and Anderson.<sup>8</sup> Results of classification of sediments by this method are shown in Table C.12. Sediment quality is generally better in the Mississippi River than in Lake McKellar, which is probably a function of the flushing action of the river.

Of the polycyclic aromatic hydrocarbons investigated, only naphthalene was detected in MRL sediments, while benzo(a)pyrene, chrysene, anthracene, fluorene, pyrene, and fluoranthene were detected in sediments from LM1. The levels of these compounds were between 3 and 19 times the detection limit of 0.005 ppm (Table C.9).

Comparison of nutrients and organic components of sediment from LM1 and MRL shows that Lake McKellar has elevated levels of nutrients, has high BOD and COD, and has high organic carbon compared with the river. Significant levels of heavy metals are present in sediment from both the river and the lake. The metal content of Lake McKellar sediment was generally much greater than that in the river sediment; however, elutriates from both sediments are similar in quality and show low solubility of metals under the test conditions.

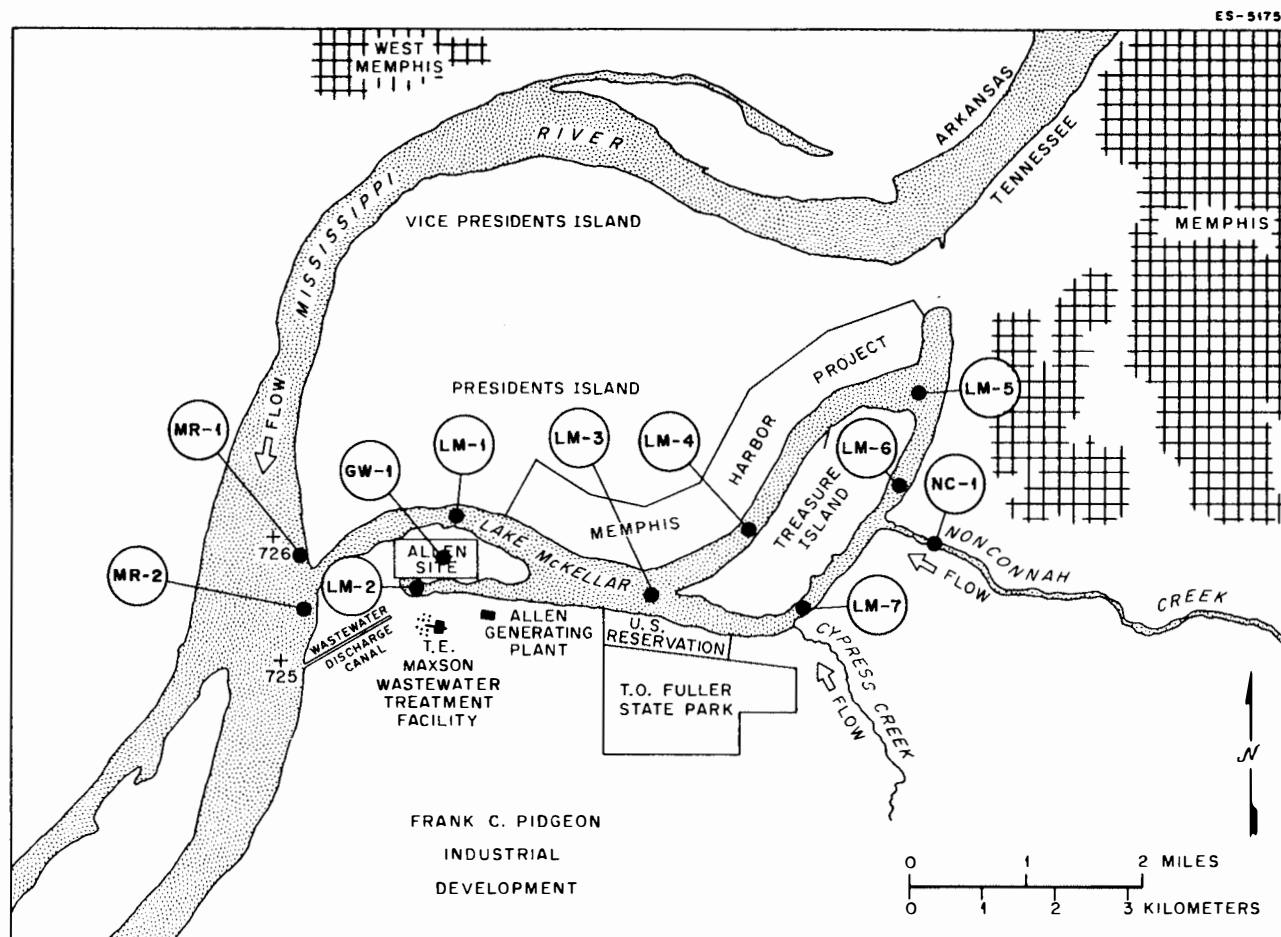


Fig. C.4. Water quality sampling locations during the 1978-79 surveys. Source: Modified from ER, Fig. 3A-2, p. 3A-23.



Table C.6. Literature review of sediment chemistry data near the proposed site

|                            | USGS<br>data for<br>West Memphis<br>(1973) | COM/limnetics<br>data for<br>Mississippi River<br>(1977) | Memphis and Shelby<br>County Health Department data (1975) |                       |                       | Corps of Engineers<br>data<br>(1977) | Corps of Engineers data<br>for Nonconnah Creek (1975) |                       |
|----------------------------|--------------------------------------------|----------------------------------------------------------|------------------------------------------------------------|-----------------------|-----------------------|--------------------------------------|-------------------------------------------------------|-----------------------|
|                            |                                            |                                                          | Mc3 <sup>a</sup>                                           | Mc4 <sup>a</sup>      | N-1 <sup>a</sup>      |                                      | Highway 51-S                                          | Hornlake Road         |
|                            | Number of<br>cases: 1                      | Number of<br>cases: 3                                    | Number of<br>cases: 1                                      | Number of<br>cases: 1 | Number of<br>cases: 1 | Number of<br>cases: 1                | Number of<br>cases: 1                                 | Number of<br>cases: 1 |
| Organics                   |                                            |                                                          |                                                            |                       |                       |                                      |                                                       |                       |
| Total organic carbon, %    | b                                          | b                                                        | 0.73                                                       | 1.33                  | 0.29                  | b                                    | 0.0008                                                | 0.001                 |
| Cyanide, mg/kg             | b                                          | b                                                        | b                                                          | b                     | b                     | b                                    | 0.06                                                  | 0.03                  |
| Nutrients, mg/kg           |                                            |                                                          | b                                                          | b                     | b                     |                                      |                                                       |                       |
| Kjeldahl nitrogen          | b                                          | b                                                        | b                                                          | b                     | b                     | b                                    | 0.007                                                 | 0.006                 |
| Nitrite and nitrate, total | 3.0                                        | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Total phosphorous          | b                                          | b                                                        | b                                                          | b                     | b                     | b                                    | 0.0096                                                | 0.006                 |
| Metals, mg/kg              |                                            |                                                          | b                                                          | b                     | b                     |                                      |                                                       |                       |
| Arsenic                    | 0.001                                      | <0.04                                                    | b                                                          | b                     | b                     | b                                    | 0.0008                                                | 0.0013                |
| Cadmium                    | 0.0                                        | 1.7                                                      | b                                                          | b                     | b                     | b                                    | 0.0003                                                | 0.0004                |
| Chromium                   | 0.01                                       | 19.9                                                     | 14.3 <sup>c</sup>                                          | 11.3 <sup>c</sup>     | 12.7 <sup>c</sup>     | b                                    | 0.0001                                                | 0.0002                |
| Cobalt                     | <2.0                                       | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Copper                     | 0.0                                        | 12.2                                                     | b                                                          | b                     | b                     | b                                    | 0.0006                                                | 0.0004                |
| Iron                       | 0.85                                       | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Lead                       | <5.0                                       | 6.5                                                      | 24.0 <sup>c</sup>                                          | 8.0 <sup>c</sup>      | 28.0 <sup>c</sup>     | b                                    | 0.0002                                                | 0.001                 |
| Manganese                  | 0.026                                      | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Mercury                    | 0.0                                        | 0.054                                                    | 0.05 <sup>c</sup>                                          | 0.030 <sup>c</sup>    | 0.047 <sup>c</sup>    | b                                    | 0.0004                                                | 0.00033               |
| Selenium                   | 0.0                                        | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Zinc                       | 0.006                                      | 58.6                                                     | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Pesticides, ppm            |                                            |                                                          | b                                                          | b                     | b                     |                                      |                                                       |                       |
| Lindane                    | b                                          | <0.5                                                     | b                                                          | b                     | b                     | d                                    | b                                                     | b                     |
| Heptachlor                 | b                                          | <0.5                                                     | b                                                          | b                     | b                     | d                                    | b                                                     | b                     |
| Aldrin                     | b                                          | <0.5                                                     | b                                                          | b                     | b                     | d                                    | b                                                     | b                     |
| Heptachlor epoxide         | b                                          | <0.5                                                     | b                                                          | b                     | b                     | d                                    | b                                                     | b                     |
| Dieldrin                   | b                                          | <0.5                                                     | b                                                          | b                     | b                     | 0.00187                              | b                                                     | b                     |
| Endrin                     | b                                          | <0.5                                                     | b                                                          | b                     | b                     | d                                    | b                                                     | b                     |
| Chlordane                  | b                                          | <0.5                                                     | 0.640                                                      | 0.010                 | 0.032                 | 0.000826                             | b                                                     | b                     |
| DDE                        | b                                          | <0.5                                                     | 0.023                                                      | 0.018                 | 0.030                 | 0.002304                             | b                                                     | b                     |
| DOD, TDE                   | b                                          | <0.5                                                     | 0.087                                                      | 0.062                 | 0.056                 | 0.001565                             | b                                                     | b                     |
| DDT                        | b                                          | <0.5                                                     | 0.026                                                      | b                     | 0.036                 | 0.002089                             | b                                                     | b                     |
| Demeton                    | b                                          | b                                                        | 0.035                                                      | b                     | b                     | b                                    | b                                                     | b                     |
| BHC                        | b                                          | b                                                        | b                                                          | b                     | 0.013                 | b                                    | b                                                     | b                     |
| Atrazine                   | b                                          | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Diazinon                   | b                                          | b                                                        | b                                                          | b                     | b                     | b                                    | b                                                     | b                     |
| Dieldrin                   | b                                          | b                                                        | 0.023                                                      | 0.010                 | 0.032                 | 0.00187                              | b                                                     | b                     |
| Methyloxychlor             | b                                          | b                                                        | b                                                          | b                     | b                     | 0.018435                             | b                                                     | b                     |
| Toxaphene                  | b                                          | b                                                        | b                                                          | b                     | b                     | 0.018435                             | b                                                     | b                     |
| PCB, AR 1254               | b                                          | b                                                        | b                                                          | b                     | b                     | 0.001304                             | b                                                     | b                     |
| Organophosphates           | b                                          | b                                                        | b                                                          | b                     | b                     | d                                    | d                                                     | d                     |

<sup>a</sup>See Fig. 3A-1, ER, for station location.<sup>b</sup>Data not available.<sup>c</sup>Originally reported as mg/liter and converted to mg/kg on the assumption of unitary density.<sup>d</sup>Concentration less than detection limit.

Source: ER, pp. 3A-51 and 3A-52.

Table C.7. Chemical parameters measured, detection limits, reporting units, and sampling locations for sediment samples collected on October 18, 1978

| Parameters                                        | Detection limits   |                                  | Reporting units    |                                  | Parameters determined |                     | Filtered water | Sampling stations |      |
|---------------------------------------------------|--------------------|----------------------------------|--------------------|----------------------------------|-----------------------|---------------------|----------------|-------------------|------|
|                                                   | Sediment chemistry | Elutriate chemistry <sup>a</sup> | Sediment chemistry | Elutriate chemistry <sup>a</sup> | Sediment chemistry    | Elutriate chemistry |                | MR-1              | LM-1 |
| Physical                                          |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| pH, units                                         | <i>b</i>           | 0.1                              |                    | units                            | X                     | X                   | X              | X                 | X    |
| Total solids                                      | <i>b</i>           |                                  | mg/g               |                                  | X                     |                     |                | X                 | X    |
| Total volatile residue                            | <i>b</i>           |                                  | mg/g               |                                  | X                     |                     |                | X                 | X    |
| Total dissolved solids                            | <i>b</i>           | 1.0                              |                    | mg/liter                         |                       | X                   |                | X                 | X    |
| Oil and grease                                    | <i>b</i>           | 0.05                             | mg/g               | mg/liter                         | X                     | X                   |                | X                 | X    |
| Nutrients                                         |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| Total kjeldahl nitrogen                           | <i>b</i>           |                                  | mg/g               |                                  | X                     |                     |                | X                 | X    |
| Ammonia nitrogen                                  | <i>b</i>           | 0.01                             | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Phosphorus, total                                 | <i>b</i>           | 0.01                             | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Orthophosphate                                    | <i>b</i>           |                                  |                    | mg/liter                         |                       | X                   | X              | X                 | X    |
| Organics                                          |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| BOD (5 day)                                       | <i>b</i>           | 1.0                              | mg/kg              | mg/liter                         | X                     | X                   |                | X                 | X    |
| COD                                               | <i>b</i>           | 1.0                              | mg/kg              | mg/liter                         | X                     | X                   |                | X                 | X    |
| TOC                                               | <i>b</i>           | 1.0                              | %                  | mg/liter                         | X                     | X                   |                | X                 | X    |
| Phenols                                           | <i>b</i>           | 0.001                            | mg/g               | mg/liter                         | X                     | X                   |                | X                 | X    |
| Major anions                                      |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| Cyanide, total                                    | <i>b</i>           | 0.005                            | mg/g               | mg/liter                         | X                     | X                   |                | X                 | X    |
| Major cations                                     |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| Iron, total                                       | <i>b</i>           |                                  | mg/g               |                                  | X                     |                     |                | X                 | X    |
| Trace metals                                      |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| Arsenic                                           | <i>b</i>           |                                  | mg/g               |                                  | X                     |                     |                | X                 | X    |
| Cadmium                                           | <i>b</i>           | 0.001                            | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Chromium                                          | <i>b</i>           |                                  | mg/g               |                                  | X                     |                     |                | X                 | X    |
| Copper                                            | <i>b</i>           | 0.01                             | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Lead                                              | <i>b</i>           | 0.01                             | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Manganese                                         | <i>b</i>           | 0.01                             | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Mercury                                           | <i>b</i>           | 0.0002                           | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Zinc                                              | <i>b</i>           | 0.01                             | mg/g               | mg/liter                         | X                     | X                   | X              | X                 | X    |
| Polynuclear aromatic hydrocarbons                 |                    |                                  |                    |                                  |                       |                     |                |                   |      |
| Benzo[a]anthracene (1,2-benzanthracene)           | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Benzo[a]pyrene (3,4-benzopyrene)                  | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| 3,4-benzofluoranthene                             | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Benzo[k]fluoranthene (11,12-benzofluoranthene)    | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Chrysene                                          | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Acenaphthylene                                    | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Anthracene                                        | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Benzo[ghi]perylene (1,12-benzoperylene)           | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Fluorene                                          | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Phenanthrene                                      | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Dibenzo[a,h]anthracene (1,2,5,6-dibenzanthracene) | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)    | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Pyrene                                            | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Naphthalene                                       | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |
| Fluoranthene                                      | 0.005              | 0.01                             | ppm                | ppm                              | X                     | X                   |                | X                 | X    |

<sup>a</sup>Detection limits and reporting units for filtered water are equivalent to those for elutriate chemistry.

<sup>b</sup>Detection limits depend on the constituents of the solid sample matrix. In all cases except cyanide, which had a consistent detection limit of 0.0002 mg/g, concentrations were above detection limits.

Source: ER, p. 3A-53.

**Table C.8. Chemistry of sediment collected from the Mississippi River and Lake McKellar by EIA on October 18, 1978**

| Parameter <sup>a</sup>  | Station <sup>b</sup> |          |                    |          |                  |         |                    |         |
|-------------------------|----------------------|----------|--------------------|----------|------------------|---------|--------------------|---------|
|                         | MR1                  |          |                    |          | LM1              |         |                    |         |
|                         | Number of values     | Mean     | Standard deviation | Maximum  | Number of values | Mean    | Standard deviation | Maximum |
| <b>Physical</b>         |                      |          |                    |          |                  |         |                    |         |
| Total solids            | 2                    | 0.9429   | 0.0158             | 0.9541   | 2                | 0.4493  | 0.0319             | 0.4719  |
| Total volatile residue  | 2                    | 0.0036   | 0.0                | 0.0036   | 2                | 0.077   | 0.003              | 0.079   |
| Oil and grease          | 2                    | 0.081    | 0.084              | 0.041    | 2                | 0.7     | 0.4                | 1.0     |
| <b>Nutrients</b>        |                      |          |                    |          |                  |         |                    |         |
| Total kjeldahl nitrogen | 2                    | 0.105    | 0.021              | 0.120    | 2                | 1.71    | 0.19               | 1.84    |
| Ammonia nitrogen        | 2                    | 0.041    | 0.009              | 0.048    | 2                | 0.210   | 0.0                | 0.210   |
| Phosphorus, total       | 2                    | 0.072    | 0.018              | 0.085    | 2                | 0.285   | 0.042              | 0.315   |
| <b>Organics</b>         |                      |          |                    |          |                  |         |                    |         |
| BOD, 5 d, mg/kg         | 2                    | 565.0    | 63.6               | 610.0    | 2                | 4100.0  | 1414.2             | 5100.0  |
| COD, mg/kg              | 2                    | 1780.0   | 42.4               | 1810.0   | 2                | 3155.0  | 403.1              | 3440    |
| TOC, %                  | 2                    | 0.146    | 0.105              | 0.220    | 2                | 0.685   | 0.077              | 0.74    |
| Phenols                 | 2                    | 0.000079 | 0.000012           | 0.000087 |                  | 0.0027  | 0.0004             | 0.0003  |
| <b>Major anions</b>     |                      |          |                    |          |                  |         |                    |         |
| Cyanide, total          | 2                    | <0.0002  | c                  | <0.0002  | 2                | <0.0002 | c                  | <0.0002 |
| <b>Major cations</b>    |                      |          |                    |          |                  |         |                    |         |
| Iron, total             | 2                    | 3.29     | 0.23               | 3.46     | 2                | 20.80   | 0.14               | 20.90   |
| <b>Other metals</b>     |                      |          |                    |          |                  |         |                    |         |
| Arsenic                 | 2                    | 0.006    | 0.0                | 0.006    | 2                | 0.053   | 0.001              | 0.054   |
| Cadmium                 | 2                    | 0.0001   | 0.0                | 0.0001   | 2                | 0.0009  | 0.0                | 0.0009  |
| Chromium                | 2                    | 0.0027   | 0.0001             | 0.0028   | 2                | 0.0160  | 0.0004             | 0.0164  |
| Copper                  | 2                    | 0.0015   | 0.0002             | 0.0016   | 2                | 0.0206  | 0.0001             | 0.0207  |
| Lead                    | 2                    | 0.0033   | 0.0004             | 0.0035   | 2                | 0.0323  | 0.0004             | 0.0325  |
| Manganese               | 2                    | 0.0625   | 0.0064             | 0.0670   | 2                | 0.945   | 0.106              | 1.020   |
| Mercury                 | 2                    | 0.0015   | 0.0007             | 0.0002   | 2                | 0.0009  | 0.0002             | 0.0011  |
| Zinc                    | 2                    | 0.015    | 0.001              | 0.016    |                  | 0.016   | 0.001              | 0.106   |

<sup>a</sup> Reporting units in milligrams per gram unless otherwise noted.

<sup>b</sup> See Fig. 3A-2, ER, for location of sampling stations.

<sup>c</sup> Cannot be calculated because of the occurrence of nondetectable concentrations.

Source: ER, p. 3A-54.

**Table C.9. Concentrations of polycyclic aromatic hydrocarbon<sup>a</sup> in MR1 and LM1 sediment**

| Parameter              | MR1 <sup>b</sup>     |        |         | LM1 <sup>b</sup>     |        |         |
|------------------------|----------------------|--------|---------|----------------------|--------|---------|
|                        | Number of replicates | Mean   | Maximum | Number of replicates | Mean   | Maximum |
| Benzo[a]anthracene     | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Benzo[a]pyrene         | 6                    | <0.005 | <0.005  | 6                    | 0.038  | 0.083   |
| 3,4-benzo fluoranthene | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Benzo[k]fluoranthene   | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Chrysene               | 6                    | <0.005 | <0.005  | 6                    | 0.029  | 0.063   |
| Acenaphthylene         | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Anthracene             | 6                    | <0.005 | <0.005  | 6                    | 0.073  | 0.087   |
| Benzo[ghi]perylene     | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Fluorene               | 6                    | <0.005 | <0.005  | 6                    | 0.004  | 0.023   |
| Phenanthrene           | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Dibenzo[a,b]anthracene | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Indeno[1,2,3-cd]pyrene | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Pyrene                 | 6                    | <0.005 | <0.005  | 6                    | 0.049  | 0.097   |
| Naphthalene            | 6                    | <0.005 | <0.005  | 6                    | <0.005 | <0.005  |
| Fluoranthene           | 6                    | <0.019 | <0.058  | 6                    | 0.035  | 0.073   |

<sup>a</sup> Parts per million on a dry weight basis.

<sup>b</sup> Refer to Fig. 3A-2, ER, for location of sampling stations.

Source: ER, p. 3A-55.

Table C.10. Elutriate chemistry for sediment collected by EIA on October 18, 1978

| Parameter <sup>a</sup> | Stations <sup>b</sup> |         |                    |         |                  |        |                    |         |
|------------------------|-----------------------|---------|--------------------|---------|------------------|--------|--------------------|---------|
|                        | MR1                   |         |                    |         | LM1              |        |                    |         |
|                        | Number of values      | Mean    | Standard deviation | Maximum | Number of values | Mean   | Standard deviation | Maximum |
| Physical               |                       |         |                    |         |                  |        |                    |         |
| pH, units              |                       |         |                    |         |                  |        |                    |         |
| Total dissolved solids | 6                     | 259.8   | 28.3               | 292.0   | 6                | 236.2  | 20.5               | 264.0   |
| Oil and grease         | 6                     | 0.28    | 0.19               | 0.50    | 6                | 0.18   | 0.13               | 0.30    |
| Nutrients              |                       |         |                    |         |                  |        |                    |         |
| Ammonia nitrogen       | 6                     | 3.15    | 3.43               | 7.80    | 6                | 0.83   | 0.47               | 1.49    |
| Phosphorus, total      | 6                     | 0.074   | 0.031              | 0.136   | 6                | 0.051  | 0.087              | 0.229   |
| Orthophosphate         | 6                     | 0.042   | 0.013              | 0.068   | 6                | 0.010  | 0.006              | 0.018   |
| Organics               |                       |         |                    |         |                  |        |                    |         |
| BOD, 5 d, mg/kg        | 6                     | 1.25    | c                  | 2.00    | 6                | 5.17   | 3.43               | 12.00   |
| COD, mg/kg             | 6                     | 8.5     | 3.2                | 12.0    | 6                | 28.2   | 5.9                | 38.0    |
| TOC, %                 | 6                     | 20.3    | 2.3                | 23.0    | 6                | 18.0   | 2.4                | 21.0    |
| Phenols                | 6                     | 0.006   | 0.001              | 0.009   | 6                | 0.005  | 0.002              | 0.009   |
| Major anions           |                       |         |                    |         |                  |        |                    |         |
| Cyanide, total         | 6                     | <0.005  | c                  | <0.005  | 6                | <0.005 | c                  | <0.005  |
| Other metals           |                       |         |                    |         |                  |        |                    |         |
| Cadmium                | 6                     | 0.001   | c                  | 0.001   | 6                | 0.0016 | c                  | 0.004   |
| Copper                 | 6                     | 0.007   | 0.001              | 0.008   | 6                | 0.008  | 0.001              | 0.009   |
| Lead                   | 6                     | 0.012   | c                  | 0.012   | 6                | 0.010  | c                  | 0.011   |
| Manganese              | 6                     | 0.028   | 0.009              | 0.044   | 6                | 2.170  | 0.431              | 2.790   |
| Mercury                | 6                     | <0.0002 | c                  | <0.0002 | 6                | 0.0003 | c                  | 0.0009  |
| Zinc                   | 6                     | 0.014   | 0.001              | 0.015   | 6                | 0.010  | 0.006              | 0.018   |

<sup>a</sup>All reporting units in mg/liter unless otherwise noted.<sup>b</sup>See Fig. 3A-2, ER, for location of sampling stations.<sup>c</sup>Cannot be calculated because of the occurrence of nondetectable concentrations.

Source: ER, p. 3A-56.

Table C.11. Water chemistry of filtered site water used in elutriate test of Mississippi River and Lake McKellar sediment

| Parameter <sup>a</sup> | Station          |        |                  |        |
|------------------------|------------------|--------|------------------|--------|
|                        | MR1              |        | LM1              |        |
|                        | Number of values | Mean   | Number of values | Mean   |
| pH, units              | 2                | 7.15   | 2                | 7.5    |
| Ammonia nitrogen       | 2                | 0.145  | 2                | 0.445  |
| Orthophosphate         | 2                | 0.102  | 2                | 0.070  |
| Cadmium, total         | 2                | <0.001 | 2                | <0.001 |
| Copper, total          | 2                | 0.009  | 2                | 0.011  |
| Lead, total            | 2                | <0.01  | 2                | <0.01  |
| Manganese, total       | 2                | <0.063 | 2                | 0.59   |
| Mercury, total         | 2                | <0.003 | 2                | <0.002 |
| Zinc, total            | 2                | 0.042  | 2                | 0.042  |

<sup>a</sup>mg/liter unless otherwise noted.

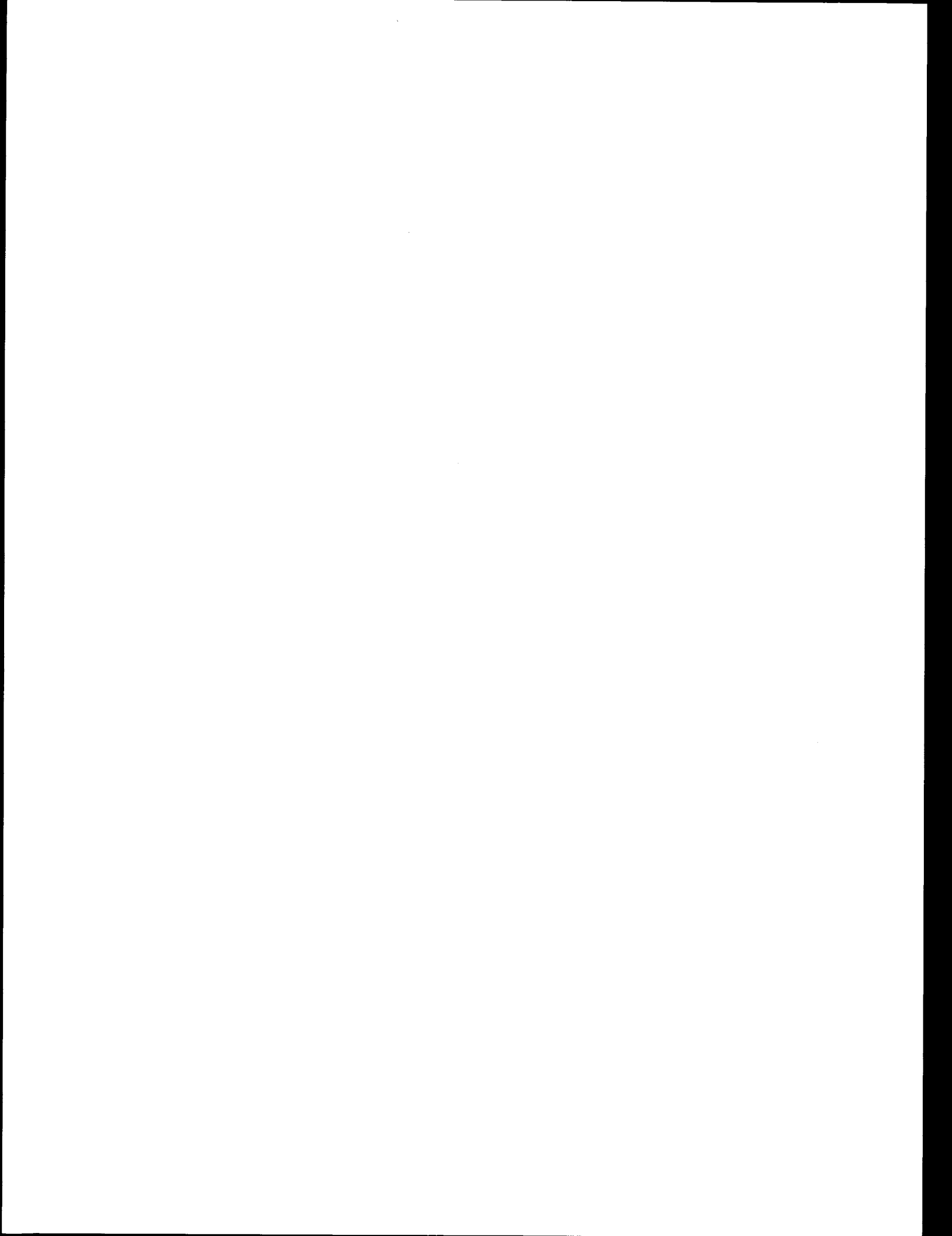
Table C.12. Classification of Memphis sediment by Prater/Anderson method

| Parameter               | MR1 <sup>a</sup>   |                                | LM1 <sup>b</sup>   |                                |
|-------------------------|--------------------|--------------------------------|--------------------|--------------------------------|
|                         | Mean concentration | Prater/Anderson classification | Mean concentration | Prater/Anderson classification |
| Oil and grease          | 0.081 mg/g         | Nonpolluted                    | 0.7 mg/g           | Nonpolluted                    |
| Total kjeldahl nitrogen | 0.105 mg/g         | Nonpolluted                    | 1.71 mg/g          | Moderately polluted            |
| Ammonia nitrogen        | 0.041 mg/g         | Nonpolluted                    | 0.21 mg/g          | Heavily polluted               |
| Phosphorus, total       | 0.072 mg/g         | Nonpolluted                    | 0.285 mg/g         | Nonpolluted                    |
| Chemical oxygen demand  | 1780 mg/kg         | Nonpolluted                    | 3155 mg/kg         | Nonpolluted                    |
| Cyanide                 | <0.002 mg/g        | Nonpolluted                    | <0.002 mg/g        | Nonpolluted                    |
| Iron                    | 3.29 mg/g          | Nonpolluted                    | 20.8 mg/g          | Moderately polluted            |
| Arsenic                 | 0.006 mg/g         | Moderately polluted            | 0.053 mg/g         | Moderately polluted            |
| Chromium                | 0.0027 mg/g        | Nonpolluted                    | 0.016 mg/g         | Nonpolluted                    |
| Copper                  | 0.0015 mg/g        | Nonpolluted                    | 0.0206 mg/g        | Nonpolluted                    |
| Lead                    | 0.0033 mg/g        | Nonpolluted                    | 0.0323 mg/g        | Nonpolluted                    |
| Manganese               | 0.0625 mg/g        | Nonpolluted                    | 0.945 mg/g         | Heavily polluted               |
| Mercury                 | 0.00015 mg/g       | Nonpolluted                    | 0.0009 mg/g        | Nonpolluted                    |
| Zinc                    | 0.015 mg/g         | Nonpolluted                    | 0.016 mg/g         | Nonpolluted                    |

<sup>a</sup>For this station, 93% of parameter classifications were listed as nonpolluted, 7% as moderately polluted, and 0% as heavily polluted.

<sup>b</sup>For this station 64% of parameter classifications were listed as nonpolluted, 21% as moderately polluted, and 15% as heavily polluted.

Source: ER, p. 3A-59.



Appendix C.3.2  
COAL PILE LEACHATE TESTING

## Appendix C.3.2

## COAL PILE LEACHATE TESTING

Field leach testing of five proposed feedstock coals has been performed at the Oak Ridge National Laboratory (personal communication from E. Davis, ORNL Environmental Sciences Division, to R. H. Ketelle, August 1979). Coal samples were placed in lysimeters and were exposed to natural rainfall events during a three-month period. Leachate samples were collected during and after each rainfall event and were analyzed for potentially hazardous metal content.

Results of field leaching tests performed on the Kentucky No. 9 and Illinois No. 6 coals are presented in Table C.13. Mean concentrations of each parameter were compared with primary and secondary drinking water standards of the U.S. Environmental Protection Agency.<sup>9,10</sup> Leachate from both coals exceeds the primary drinking water standards for the elements arsenic, cadmium, chromium, and selenium. Leachate from both coals also exceeds secondary drinking water standards for pH, iron, and sulfate content. The amounts by which measured parameters exceed the standards are shown in Table C.14. It is clear from these data that special handling of coal pile leachate is required to avoid contamination of surface water and groundwater.

**Table C.13. Summary of data collected from Illinois No. 6 coal in field lysimeter 1**

| Parameter                              | Number of observations | Mean   | Standard deviation | Minimum | Maximum | Mean exceeds DW standards by |
|----------------------------------------|------------------------|--------|--------------------|---------|---------|------------------------------|
| Runoff, % rainfall                     | 6                      | 73     | 6.7                | 65      | 83      |                              |
| Percent transmission before filter     | 11                     | 80.1   | 20.8               | 19.1    | 94.2    |                              |
| Percent transmission after filter      | 11                     | 88.6   | 6.2                | 81.9    | 97.9    |                              |
| pH                                     | 11                     | 2.2    | 0.1                | 2.1     | 2.4     | 4.3                          |
| Acidity, mg/liter as CaCO <sub>3</sub> | 6                      | 21,200 | 7,270              | 6,500   | 25,400  |                              |
| Electrical conductivity, $\mu$ mhos/cm | 11                     | 15,200 | 5,640              | 6,500   | 21,700  |                              |
| Sulfate, mg/liter                      | 11                     | 21,500 | 10,900             | 5,850   | 37,200  | 86X                          |
| Iron, mg/liter                         | 11                     | 7,710  | 3,870              | 2,090   | 12,000  | 25,700X                      |
| Arsenic, $\mu$ g/liter                 | 5                      | 147    | 90.8               | 9.4     | 258     | 2.94X                        |
| Barium, mg/liter                       | 5                      | 0.2    | a                  | a       | a       | 0                            |
| Cadmium, $\mu$ g/liter                 | 5                      | 268    | 165                | 21      | 444     | 26.8X                        |
| Chromium, $\mu$ g/liter                | 5                      | 438    | 234                | 21      | 560     | 8.7X                         |
| Lead, $\mu$ g/liter                    | 5                      | 14     | 5.6                | 7.2     | 21      | 0                            |
| Selenium, $\mu$ g/liter                | 5                      | 438    | 370                | 19      | 908     | 43.8X                        |
| Silver, $\mu$ g/liter                  | 5                      | 0.35   | 0.31               | <0.05   | 0.81    | 0                            |
| Mercury, $\mu$ g/liter                 | 5                      | 0.12   | 0.12               | 0.03    | 0.30    | 0                            |

<sup>a</sup>Barium concentration <0.2 mg/liter for all samples.



Table C.14. Summary of data collected from Kentucky No. 9 coal in field lysimeter 3

| Parameter                              | Number of observations | Mean   | Standard deviation | Minimum  | Maximum  | Mean exceeds DW standards by |
|----------------------------------------|------------------------|--------|--------------------|----------|----------|------------------------------|
| Runoff, % rainfall                     | 8                      | 71     | 29.5               | 65       | 100      |                              |
| Percent transmission before filter     | 20                     | 32.5   | 21.6               | 0.9      | 86.3     |                              |
| Percent transmission after filter      | 19                     | 48.0   | 21.6               | 13.3     | 87.1     |                              |
| pH                                     | 20                     | 2.1    | 0.2                | 1.8      | 2.5      | 4.4                          |
| Acidity, mg/liter as CaCO <sub>3</sub> | 15                     | 33,100 | 22,400             | 7,760    | 78,200   |                              |
| Electrical conductivity, $\mu$ mhos/cm | 20                     | 10,500 | 4,650              | 4,480    | 20,000   |                              |
| Sulfate, mg/liter                      | 20                     | 27,300 | 18,100             | 5,820    | 72,600   | 109X                         |
| Iron, mg/liter                         | 20                     | 9,850  | 7,250              | 1,780    | 26,200   | 32,833X                      |
| Arsenic, $\mu$ g/liter                 | 8                      | 9,050  | 6,130              | 2,040    | 17,500   | 181X                         |
| Barium, mg/liter                       | 8                      | <0.2   | <i>a</i>           | <i>a</i> | <i>a</i> | 0                            |
| Cadmium, $\mu$ g/liter                 | 8                      | 166    | 106                | 47       | 386      | 16.6X                        |
| Chromium, $\mu$ g/liter                | 8                      | 724    | 296                | 330      | 1,220    | 14.4X                        |
| Lead, $\mu$ g/liter                    | 8                      | 12     | 10                 | 7.2      | 35       | 0                            |
| Selenium, $\mu$ g/liter                | 8                      | 829    | 1,000              | 56       | 3,000    | 82.9X                        |
| Silver, $\mu$ g/liter                  | 8                      | 0.05   | <i>b</i>           | <i>b</i> | <i>b</i> |                              |
| Mercury, $\mu$ g/liter                 | 8                      | 0.20   | 0.20               | 0.05     | 0.60     | 0                            |

<sup>a</sup> Barium concentration <0.2 mg/liter for all samples.

<sup>b</sup> Silver concentration <0.05 g/liter for all samples.



Appendix C.4  
AQUATIC ECOLOGY



## Appendix C.4

## AQUATIC ECOLOGY

Table 3.5 presents the existing water quality criteria applicable to the Mississippi River at Memphis. However, these standards and criteria do not include all water quality constituents and are subject to periodic revision. This appendix provides additional information and discussion regarding water quality constituents and their impacts on aquatic ecosystems.

Water quality criteria for 65 toxic pollutants have been issued as draft criteria by the Environmental Protection Agency (EPA), but no final criteria have yet been adopted. Once finalized, these criteria (summarized in Table C.15) will serve as a basis for setting standards. Among the list of 65 toxic pollutants for which EPA is developing criteria are PNAs. However, except for the three individual PNAs in Table C.15, EPA has found its data insufficient for estimating PNA criteria for the protection of freshwater aquatic life.

**Table C.15. Draft water quality criteria for potentially toxic pollutants<sup>a</sup>**

| Constituent                       | Freshwater aquatic life <sup>b</sup> |                            | Human health |
|-----------------------------------|--------------------------------------|----------------------------|--------------|
|                                   | 24-h average                         | Not to exceed              |              |
| Trace elements                    |                                      |                            |              |
| Arsenic                           | 57                                   | 130                        | 0            |
| Cadmium                           | $\exp[0.87 \ln(h) - 4.38]$           | $\exp[1.30 \ln(h) - 3.92]$ | 10           |
| Chromium, trivalent               | $\exp[0.83 \ln(h) + 2.94]$           | $\exp[0.83 \ln(h) + 3.72]$ | 50           |
| Chromium, hexavalent              | 10                                   | 110                        | 0            |
| Copper                            | $\exp[0.65 \ln(h) - 1.94]$           | $\exp[0.88 \ln(h) - 1.03]$ | 1000         |
| Lead                              | $\exp[1.51 \ln(h) - 3.37]$           | $\exp[1.51 \ln(h) - 1.39]$ | 50           |
| Mercury                           | 0.064                                | 3.2                        | 0.2          |
| Nickel                            | $\exp[1.01 \ln(h) - 1.02]$           | $\exp[0.47 \ln(h) - 4.19]$ | 50           |
| Selenium                          | 9.7                                  | 22                         | 10           |
| Zinc                              | $\exp[0.67 \ln(h) + 0.87]$           | $\exp[0.64 \ln(h) + 2.46]$ | 5000         |
| Industrial wastes                 |                                      |                            |              |
| Cyanide                           | 1.4                                  | 38                         | 200          |
| Phenol                            | 600                                  | 3400                       | 3400         |
| 2-4 Dimethylphenol                | 38                                   | 86                         | <sup>c</sup> |
| Polynuclear aromatic hydrocarbons |                                      |                            |              |
| Naphthalene                       | <sup>c</sup>                         | <sup>c</sup>               | 143          |
| Fluoranthene                      | 250                                  | 560                        | 200          |
| Acenaphthene                      | 110                                  | 240                        | 20           |

<sup>a</sup>Pollutants measured in  $\mu\text{g/liter}$ .

<sup>b</sup>Hardness given as h.

<sup>c</sup>Not derived because of insufficient data.

Source: U.S. Environmental Protection Agency, "Water Quality Criteria" *Fed. Regist.* **44**(52): 15926-15981 (1979); **44**(144): 43660-43697, 1979; and **44**(191): 56628-56657 (1979).

Although no draft criteria have been established for PNAs, basic compounds, or individual phenolic compounds, Table C.16 indicates the estimated permissible concentrations (EPCs) established for some of these compounds. Concern over the release of PNAs into the aquatic environment stems primarily from the demonstrated carcinogenic and cocarcinogenic activity of several PNA compounds.<sup>1</sup> Given the lack of water quality criteria for PNAs, this appendix presents information useful in evaluating the impacts of PNAs on aquatic environments.

Polynuclear aromatic hydrocarbons (Fig. C.5) are a series of fused-ring aromatic compounds produced both in the natural environment and in high-temperature industrial processes such as

**Table C.16. Estimated permissible concentrations (EPCs) for polynuclear aromatic hydrocarbon compounds, basic compounds, and phenolic compounds in the SAC fluid or wastewater**

| Constituent                      | EPC<br>( $\mu\text{g/liter}$ ) | Basis |
|----------------------------------|--------------------------------|-------|
| <b>PNAs</b>                      |                                |       |
| Naphthalene                      | 50                             | a     |
| Acenaphthene                     | None                           |       |
| Fluorene                         | None                           |       |
| Phenanthrene                     | 280                            | b     |
| Anthracene                       | 2000                           | c     |
| Fluoranthene                     | 800                            | b     |
| Pyrene                           | 8333                           | c     |
| Benz[a]anthracene                | 4                              | b     |
| Chrysene                         | 79.4                           | c     |
| Benzo[b]fluoranthene             | 31.5                           | c     |
| Benzo[k]fluoranthene             | 58                             | c     |
| Benzo[a]pyrene                   | 20                             | b     |
| Benzo[e]pyrene                   | 109                            | c     |
| Dibenz[a,h]anthracene            | 4                              | b     |
| Benzo[gh,i]perylene              | None                           |       |
| Indeno[1,2,3-cd]pyrene           | 58.5                           | c     |
| Biphenyl                         | 13.8                           | b     |
| Tetralin (tetrahydronaphthalene) | 500                            | a     |
| <b>Basic Compounds</b>           |                                |       |
| Aniline                          | 262                            | b     |
| Methyl aniline                   | 304                            | b     |
| Dimethyl aniline                 | 345                            | b     |
| -Naphthylamine                   | 20                             | c     |
| -Naphthylamine                   | 6                              | c     |
| Pyridine                         | 207                            | b     |
| Methyl pyridine                  | 310                            | b     |
| Quinoline and isoquinoline       | 140                            | b     |
| Methylquinoline                  | 492                            | b     |
| Acridine                         | 800                            | b     |
| <b>Phenolics</b>                 |                                |       |
| Cresols                          | 50                             | a     |
| Phenylphenols                    | 810                            | c     |
| Alkyl cresols                    | 212                            | b     |
| Catechol                         | 280                            | b     |
| Indanols                         | 1300                           | b     |

<sup>a</sup>EPC, based ecological effects.

<sup>b</sup>EPC, based on health effects.

<sup>c</sup>EPC for zero threshold pollutants (suspected or potential carcinogens), based on health effects.

Source: J. G. Cleland, and G. L. Kingsbury, "Multi-media Environmental Goals for Environmental Assessment," EPA-600/7-77-136b, U.S. Environmental Protection Agency, Research Triangle Park, N.C., 1977.

petroleum refining, coal coking, and coal liquefaction. The characteristics of PNA are very much influenced by the compound's molecular weight and the number of rings in its structure. The solubility of PNAs is generally very low and decreases with increasing molecular weight. This low solubility limits the concentrations of PNAs in aqueous solution, but it also results in a tendency of PNAs to adsorb to suspended particulate matter and become concentrated in bottom sediments and the fatty tissues of organisms.

Herbes et al.<sup>2</sup> reviewed the fate of PNAs in aquatic environments. The persistence of these compounds in surface waters is controlled by such mechanisms as volatilization, photolysis, sorption, sedimentation, bioaccumulation, and metabolism by aquatic organisms. A large number of bacteria commonly found in aquatic ecosystems actively metabolize aromatic hydrocarbons into organic acids as their food source.<sup>3</sup> The half-life (time in which concentrations are reduced by 1/2) of PNA compounds is largely a function of their specific chemical structure.<sup>2</sup> Volatilization is relatively more important for PNAs of lower molecular weight (two- and three-ringed compounds, such as naphthalene), but photolysis and sediment sorption are more important for larger PNAs (those with three or more rings, such as anthracene and pyrene). As is true of the water solubility of PNAs, transport and transformation processes for PNAs will change as a function of environmental parameters such as temperature, turbidity, water

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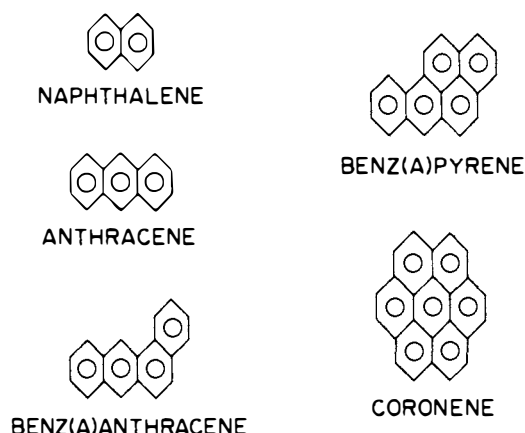


Fig. C.5. Representative PNA compounds. Source: Fig. 4, Herbes, S. E., G. R. Southworth, I. L. Shaeffer, W. H. Griest, M. P. Maskarinec. 1980. Critical pathways of polycyclic aromatic hydrocarbons in aquatic environments, pp. 113-128 in: H. Witschi (ed.), *The Scientific Basis of Toxicity Assessment*. Elsevier/North Holland Biomedical Press.

velocity, depth, sunlight, and wind speed (Table C.17). Estimates of the half-life of benzoanthracene (a four-ringed PNA) vary from 10 h in a clear, fast-flowing river to about 10 days in a turbid, slow-moving river.<sup>2</sup> Southworth<sup>4</sup> estimated the half-life for anthracene in fast, clear streams to be about 1.4 h. In microcosm studies to measure the fate of <sup>14</sup>C-labeled anthracene (a three-ringed PNA), in simulated pond ecosystems, Giddings et al.<sup>5</sup> found that after six days, about 10% of an initial single dosage remained in the water column. After 84 days of this microcosm experiment, 32% of the original anthracene was present in the sediments, and none was detectable in the water column.

Table C.17. Qualitative effects of environmental parameters on rates of transport processes

| Parameter      | Change resulting from increase in parameter <sup>a</sup> |                |               |                       |
|----------------|----------------------------------------------------------|----------------|---------------|-----------------------|
|                | Photolysis                                               | Volatilization | Sedimentation | Microbial degradation |
| Temperature    | b                                                        | + or -         | -             | +                     |
| Turbidity      | -                                                        | -              | +             | b                     |
| Water velocity | b                                                        | +              | -             | b                     |
| Depth          | -                                                        | -              | -             | -                     |
| Sunlight       | +                                                        | b              | b             | b                     |
| Wind speed     | b                                                        | +              | b             | b                     |

<sup>a</sup>+ indicates an increase; - indicates a decrease.

<sup>b</sup>No significant effect.

Source: Herbes, S. E., G. R. Southworth, D. L. Shaeffer, W. H. Griest, and M. P. Maskarinec, 1980. Table 6 from "Critical Pathways of Polycyclic Aromatic Hydrocarbons in Aquatic Environments," pp. 113-128 in H. Witschi (ed), *The Scientific Basis of Toxicity Assessment*, Elsevier/North-Holland Biomedical Press.

The acute toxicity of PNAs is limited by their water solubility. Gehrs<sup>6</sup> presented theoretical data which suggest that for a PNA with a molecular weight greater than 150, water solubility would be less than the acute toxicity levels for fish (Fig. C.6). Only a limited amount of data are available for specific PNAs.

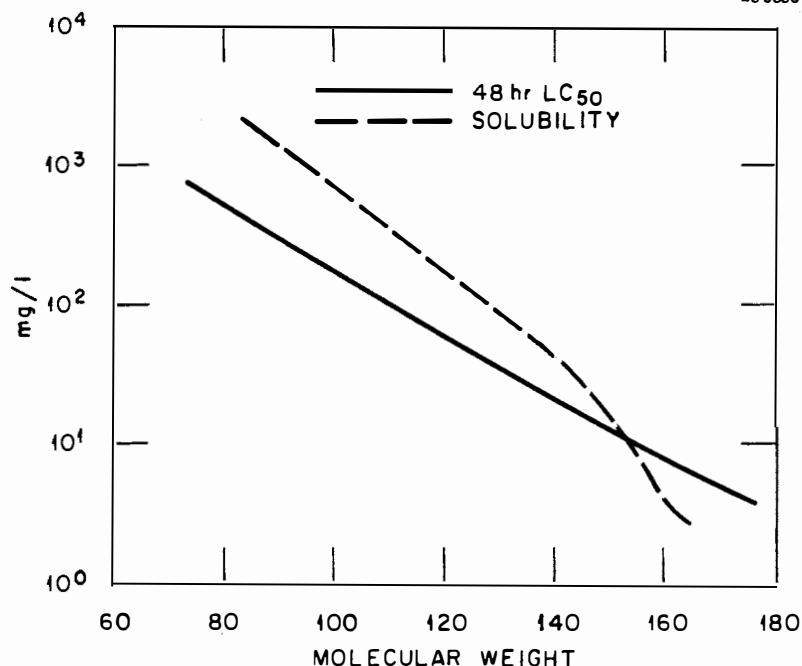


Fig. C.6. Theoretical solubility and LC<sub>50</sub> values plotted against molecular weights for a series of aromatic hydrocarbons. Source: Fig. 5, Gehrs, C. W. 1977. Environmental implications of coal conversion technologies: organic contaminants, \_\_: 157-175, in: Thorp and Gibbon (eds.). Energy and Environmental Stress in Aquatic Systems, CONF-77114, U.S. Department of Energy, Oak Ridge, TN.

The trends that have been observed in bioconcentration of PNAs are opposite to those observed for acute toxicity. As Fig. C.7 shows bioconcentration increases as PNAs increase in size and nonpolarity, as measured by the n-octanol/water partition coefficient.<sup>7</sup> The ranges of bioconcentration of PNAs in *Daphnia* are 10,000x for benzo[a]anthracene (4-ring PNAs) to 100x for naphthalene (2-ring PNAs). Bioaccumulation of PNAs by *Pimephales promelas* (fathead minnows) occurs to a generally lesser degree (George Southworth, ORNL, personal communication to Michael Sale, ORNL, November 1980). For instance, the equilibrium concentrations of anthracene in the tissues of *Pimephales* and *Daphnia* were, respectively, 500x and 1200x aqueous concentrations.



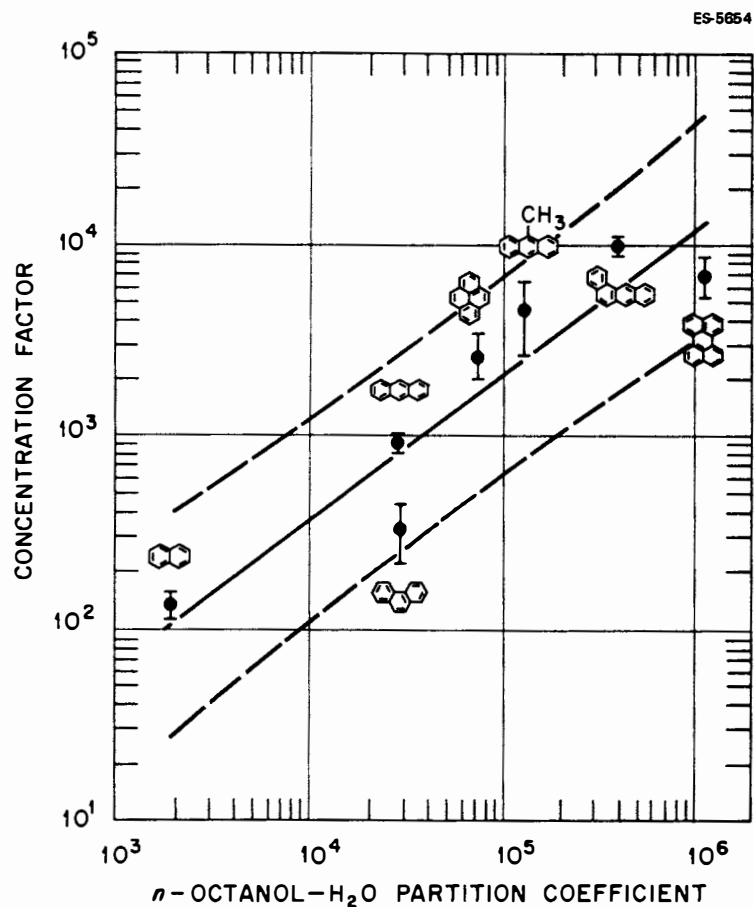


Fig. C.7. Log concentration factor (24 h) vs log *n*-octanol-water partition coefficient (calculated from Leo, 1975) for several PAH in *Daphnia pulex* at 25°C. Dashed lines delineate 95% prediction interval. Source: Fig. 2, Southworth, G. R., J. J. Beauchamp, and P. K. Schnieder. 1978. Bioaccumulation potential of polycyclic aromatic hydrocarbons in *Daphnia Pulex*, *Water Res.* 12: 973-977.

## REFERENCES FOR APPENDIX C.4

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3. R. H. Ross, "Environmental Interactions," Chapter 6 in *Environmental, Health, and Control Aspects of Coal Conversion*, vol. 2, H. M. Braunstein, E. D. Copenhaver, and H. A. Pfuderer, Eds., ORNL/EIS-95, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1977.
4. G. R. Southworth, "Transport and Transformation of Anthracene in Natural Waters, pp. 359-361 in *Aquatic Toxicology*, L. L. Marking and R. A. Kimerle, Eds., ASTM-STP 667, Amer. Soc. Testing & Materials, Philadelphia, Penn., 1979.
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7. G. R. Southworth, J. J. Beauchamp, and P. K. Schneider, "Bioaccumulation Potential of Polycyclic Aromatic Hydrocarbons in *Daphnia Pulex*," *Water Res.* 12: 973-977 (1978).
8. D. R. Branson, W. B. Neely, and G. E. Blan, "Predicting a Bioconcentration Potential of Organic Chemicals in Fish from Partition Coefficients," pp. 99-117 in *Structural-Activity Correlations in Studies of Toxicity and Bioconcentration with Aquatic Organisms*, G. D. Veith and D. E. Konasweich, Eds., International Joint Commission, Ontario, Canada, 1975.

Appendix C.5

LIQUEFACTION POTENTIAL OF SITE MATERIALS



## Appendix C.5

## LIQUEFACTION POTENTIAL OF SITE MATERIALS

Liquefaction is a type of soil failure in which internal pore pressure exceeds confining pressure and results in flotation of grains, loss of bearing capacity, and, in severe cases, flow of the soil. Conditions required for liquefaction to occur are saturation of the soil, soil texture of well-sorted fine to very fine sand, loose packing of grains, and vibration of sufficient magnitude for a period adequate to initiate failure.<sup>11</sup>

Sediment samples were collected at regular intervals in exploratory borings, and selected samples were subjected to physical testing and particle-size classification. The bulk of the materials tested fall into two categories: (1) fine to medium slightly gravelly sands and (2) clayey silts. Figure C.8 is a composite plot of grain-size distributions for gravelly sands occurring within 20 m (65 ft) of the surface. Sandy alluvium at the site falls in the range of size distributions indicated by the stippled area. Mechanical analyses were performed on composite sediment samples from possible dredge borrow areas at the mouth of Lake McKellar and near the east bank of the Mississippi River. Size distributions of these samples are given in Table C.18. These distributions, if plotted, would lie near the coarse edge of the stippled field in Fig. C.8.

Figure C.9 shows the range of grain-size distributions for sands that have liquefied under actual earthquake conditions and those that liquefied under laboratory conditions. Comparison of Figs. C.8 and C.9 indicates that fine sands on the site lie in the range of liquefiable sands.

Suitable sandy borrow material was covered by 9 m (29 ft) of silt at the mouth of Lake McKellar; however, only 2 m (6 ft) of silt covered the sand in the Mississippi River. The river sands are somewhat coarser than those that have failed in case histories of liquefaction (Fig. C.9).

In general, liquefaction occurs in sands having relative densities of less than about 70%.<sup>11</sup> Direct measurements of soil density are not available for site soils; however, the relative density can be approximated when the standard penetration resistance is known.<sup>12</sup> Approximate relative densities obtained from penetration tests range from less than 25% to 70% for sands on the site that fit the size requirement of liquefiable materials.

The grain size and density of the existing soils would indicate the possibility of liquefaction or seismically induced settlement if a seismic event of sufficient magnitude were to occur.

Such a failure would likely affect certain lenses of weak materials at relatively shallow depth. Placement of a substantial fill on the site would cause compaction of some of the existing material and would increase confining pressure in the soil. Both of these would tend to reduce the potential for liquefaction; however, settlement could remain a potential problem if gradual compaction occurred over a long period of time. Careful control of site preparation activities and subsurface testing after compaction of the fill are necessary to minimize this potential hazard.

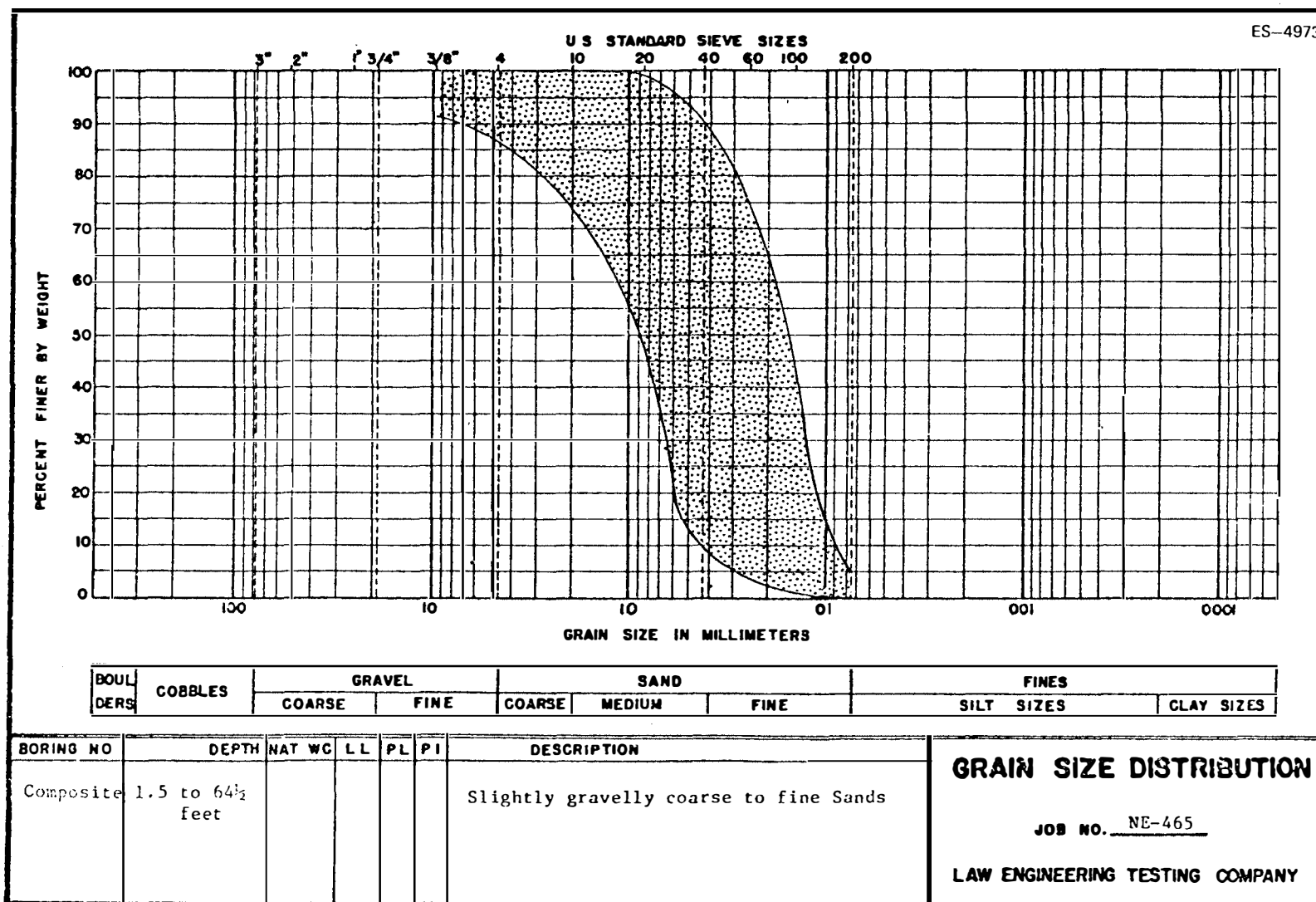


Fig. C.8. Grain-size distribution. Source: *Preliminary Report of Subsurface Investigation, MLGW Coal Gasification Plant*, prepared by Law Engineering Testing Company, 1979.

**Table C.18. Size distributions of composite sediment samples from the mouth of Lake McKellar and near the east bank of the Mississippi River**

| Size<br>(mm) |                  | Composite passing sieve<br>(%)    |                                       |
|--------------|------------------|-----------------------------------|---------------------------------------|
|              |                  | Location                          |                                       |
|              |                  | Lake McKellar (WB-1) <sup>a</sup> | Mississippi River (WB-2) <sup>b</sup> |
| 16           | 0.6 <sup>c</sup> | 100.0                             | 100.0                                 |
| 13           | 0.5 <sup>c</sup> | 95.1                              | 96.6                                  |
| 5            | 4 <sup>d</sup>   | 94.7                              | 95.4                                  |
| 2            | 10 <sup>d</sup>  | 93.2                              | 94.0                                  |
| 0.8          | 20 <sup>d</sup>  | 84.7                              | 84.6                                  |
| 0.4          | 40 <sup>d</sup>  | 45.4                              | 41.1                                  |
| 0.25         | 60 <sup>d</sup>  | 22.4                              | 13.5                                  |
| 0.15         | 100 <sup>d</sup> | 8.3                               | 6.0                                   |
| 0.074        | 200 <sup>d</sup> | 4.9                               | 3.7                                   |

<sup>a</sup>Composite collected from depths of 8.8 to 17.2 m (29 to 56.5 ft).

<sup>b</sup>Composite collected from depths of 2 to 12.3 m (6 to 40.5 ft).

<sup>c</sup>Inches.

<sup>d</sup>U.S. standard sieve size.

Source: Data included in letter from A. J. Krause, Energy Impact Associates, to R. H. Ketelle and R. D. Roop, Nov. 15, 1979.

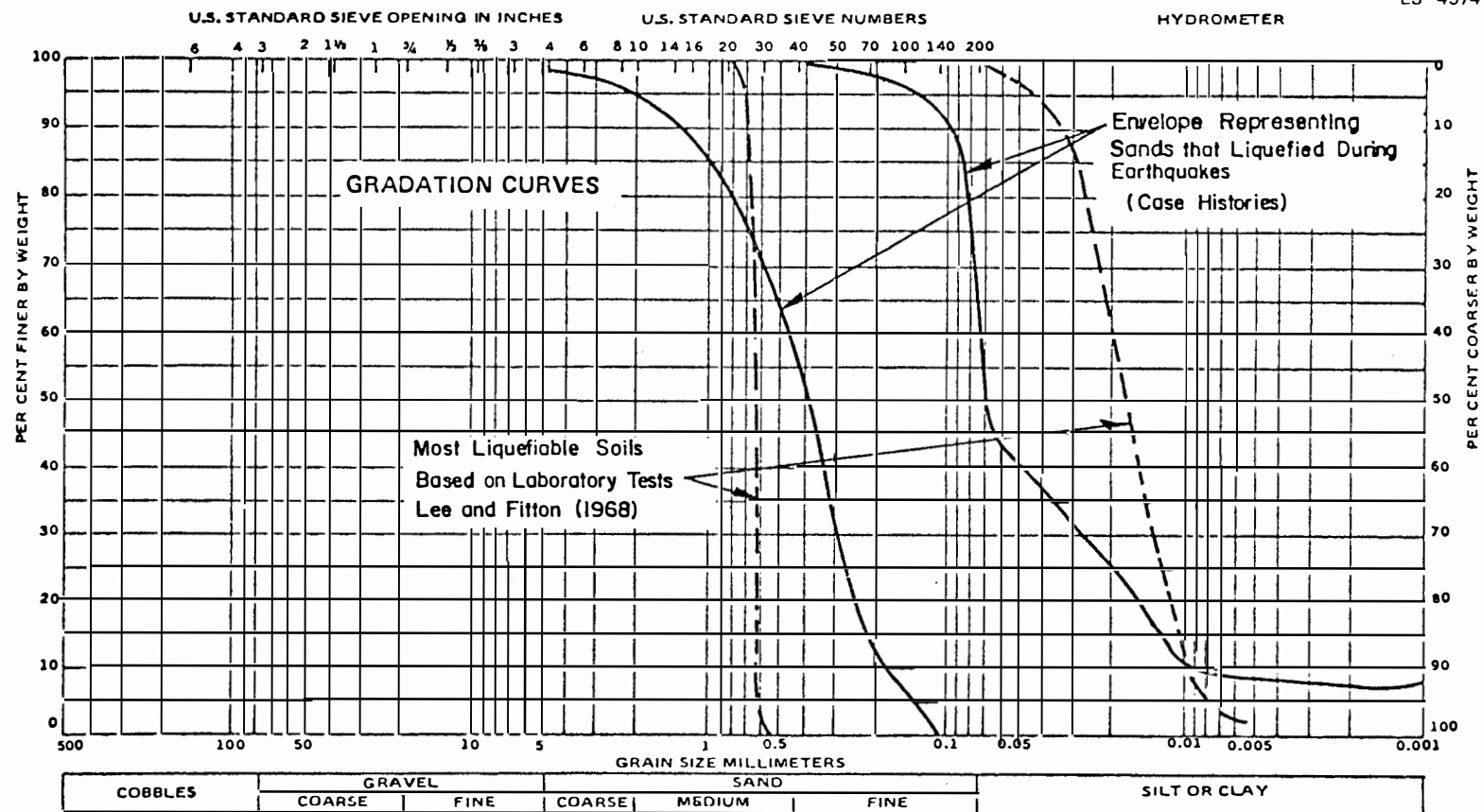


Fig. C.9. Grain-size distributions. Source: ATEC Associates of Kentucky, *Preliminary Geotechnical Engineering Study for 2000 ST/P SRC Project* for Wheelabrator Clean Fuel Corporation, Louisville, Ky., 1977.



Appendix C.6  
TERRESTRIAL ECOLOGY



## Appendix C.6

## TERRESTRIAL ECOLOGY

Negative effects of air pollutants on plants include reduced growth and reproduction due to various physiological changes caused directly by the pollutants, increased susceptibility of plants to parasites and diseases, and mortality of individual plants. The many species of plants are generally divided into three levels of sensitivity to air pollutants: sensitive, intermediate, and tolerant. Under conditions of low dosage levels, vegetation and soils may function as important sinks for airborne contaminants without adverse effects. Under intermediate dosage, subtle adverse effects (e.g., reduced growth) may occur, particularly in sensitive plant species. Exposure to high dosage may induce acute morbidity or mortality in sensitive and intermediate plants. Effects of air pollutants on natural ecosystems in different areas have ranged from virtual elimination of vegetation to subtle changes, including slight reductions of species diversity due to the loss of one or a few sensitive species and reduced productivity of certain species. In forest ecosystems, certain plant species could become less abundant due to the effect of air pollutants on the species' competitive interactions.<sup>13</sup> Such species could be important to wildlife. Current ambient levels of air pollutants in many areas of the eastern United States adversely affect plant productivity.<sup>14</sup> Estimates of annual national economic losses caused by effects on crops and ornamental plants have ranged from \$135 million<sup>15</sup> to \$500 million.<sup>16</sup> If all plant species and other factors are considered, annual loss estimates would exceed a billion dollars.<sup>16</sup> Increased air pollution from industrial development will increase this impact.

Although sulfur dioxide, nitrogen dioxide, carbon monoxide, and other gases and particulates will be emitted during plant operation under normal operating conditions, applicable EPA air quality standards will not be violated, but this does not guarantee the absence of subtle effects (Sect. 4.1.7). During short periods, unplanned nonroutine emissions could release greater quantities of sulfur dioxide, dust, and hydrocarbons into the atmosphere than during normal operation. Although plant species vary in their sensitivity to sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter, vegetation near the site will likely experience few directly observable effects from any of these pollutants, with the possible exception of sulfur dioxide, assuming standards are not violated.

Sulfur dioxide

At the specific locality where pollutant concentrations will be maximum as determined by wind direction (about 2 km northeast of the facility), the normal operation of the plant is expected to increase ambient ground-level concentrations of  $\text{SO}_2$  by  $69 \mu\text{g}/\text{m}^3$  (see Table 4.3) for the 3-h maximum,  $24 \mu\text{g}/\text{m}^3$  for the 24-h maximum, and  $2 \mu\text{g}/\text{m}^3$  for the annual average (Sect. 4.1.1.2). These concentrations compare with current ambient levels of 523, 214, and  $34 \mu\text{g}/\text{m}^3$ , respectively (Table 3.1). Various published studies indicate that the increased concentrations of  $\text{SO}_2$  near the facility would have significant adverse effects only on the most sensitive plant species. Even without the plant, very sensitive species could be affected by the current ambient levels of  $\text{SO}_2$ . Four-hour  $\text{SO}_2$  concentrations that caused leaf injury to 22 different agricultural crops ranged from  $629 \mu\text{g}/\text{m}^3$  to  $1834 \mu\text{g}/\text{m}^3$  (ref. 17, Table 5-6). In the presence of ozone or nitrogen dioxide, 4-h  $\text{SO}_2$  concentrations that resulted in foliar injury in ten agricultural crops ranged upward from  $262 \mu\text{g}/\text{m}^3$  (ref. 17, Table 5-7). For sensitive plants, it has been projected that 4-h  $\text{SO}_2$  concentrations required to produce threshold injury are from 262 to  $2620 \mu\text{g}/\text{m}^3$  (ref. 17, Table 5-8). Similarly, for intermediate plants, the concentrations required are 1310 to  $13,100 \mu\text{g}/\text{m}^3$ . For sensitive woody plants in the southeastern United States, it has been estimated that 3-h  $\text{SO}_2$  concentrations required to produce threshold injury are from 786 to  $1572 \mu\text{g}/\text{m}^3$  (ref. 18, Table 16). Therefore these various studies indicate that, at least over short time periods,  $\text{SO}_2$  emissions from the proposed facility should have no significant impacts on most plant species. Effects of chronic low-level exposure are more difficult to assess than those of short-term exposure, because few long-term studies have been done, resulting in an absence of sufficient data. Most field studies near polluting industries have not been able to separate the effects of acute and chronic exposures. In one long-term study, white pine (a sensitive species) continued to increase in volume over a ten-year period when concentrations of  $\text{SO}_2$  averaged  $21 \mu\text{g}/\text{m}^3$  during each six-month growing season (ref. 17, Table 5-2).

Soybean, which is grown in the area, is considered a sensitive species (ref. 17, Table 5-9). Therefore soybeans grown in areas of maximum SO<sub>2</sub> concentrations near the plant could experience reduced productivity.

During abnormal operating conditions, SO<sub>2</sub> concentrations off site could exceed 522 µg/m<sup>3</sup> (ambient plus plant increase) for a few hours (Sect. 4.1.1.2), which could seriously affect the growth of sensitive plant species.

#### Nitrogen oxides

Nitrogen dioxide's threshold of injury to vegetation appears to be several times as high as that of sulfur dioxide.<sup>16</sup> Nitrogen dioxide concentrations in the ambient air rarely reach phytotoxic levels. When NO<sub>2</sub> concentrations are high, other pollutants are usually present; resulting plant injury is therefore most commonly from pollutant combinations, rather than from exposure to NO<sub>2</sub> alone.<sup>14</sup> Nitrogen oxides cause very little injury to trees and shrubs, except occasionally when they are adjacent to large point sources.<sup>18</sup>

Normal plant operation is expected to increase the ambient annual average NO<sub>x</sub> concentration of 30 µg/m<sup>3</sup> (Table 3.1) by a maximum of 2 µg/m<sup>3</sup> (Sect. 4.1.1.2). Because this increase represents only 2% of the national ambient air quality standard and 7% of ambient levels, there should be no significant impacts on vegetation from nitrogen oxide emissions.

#### Carbon monoxide

Carbon monoxide has a relatively short life, or residence time, in the atmosphere and is not recognized as a pollutant having serious effects on vegetation. Because the predicted maximum concentrations resulting from facility operation represent less than 1.0% of the air quality standard (Sect. 4.1.1.2), no significant impacts are anticipated.

#### Hydrocarbons

During normal operations, most hydrocarbons are expected to be consumed by the plant flare (Sect. 4.1.1.2). The air quality standard of 160 µg/m<sup>3</sup> for a 3-h period should be easily met during normal operation.

#### Peroxyacetyl nitrate

Peroxyacetyl nitrate (PAN) is formed almost exclusively from the photochemical reaction of unsaturated hydrocarbons with oxides of nitrogen<sup>14</sup> and is a regional, rather than a site-specific, problem. PAN is a suspected phytotoxicant on vegetables and has been an important problem in the Los Angeles basin.<sup>18</sup> Woody plants, however, are apparently very tolerant of PAN. Because of the low predicted concentrations of NO<sub>2</sub> and low emissions of hydrocarbons from normal plant operation, no amounts of PAN should be produced that would significantly affect vegetation.

#### Particulates and trace metals

Highly concentrated airborne particulates can affect vegetation by clogging stomata (thus interfering with plant respiration) and by reducing light intensity. Nonvolatile trace metals contained in particulates, volatile trace metals condensed on the surfaces of particulates, and trace metals in vapors can be deposited on the surfaces of vegetation and on the soil, resulting in toxic effects on vegetation and animals. However, two reports have indicated that trace metal emissions during the next several years will not have serious effects on the biota.<sup>19,20</sup> Both reports emphasize that knowledge of source terms and effects on the biota is lacking and that further research is needed. Based on data from conventional coal combustion studies for power plants, Turner and Strojjan concluded that atmospheric releases of trace elements do not present acute ecological problems.<sup>21</sup> However, the effects of chronic exposure of ecosystems to low-level releases over a long period of time are not well known. Thus short-term effects to vegetation and wildlife are not expected to occur, but data are insufficient to predict what long-term effects, if any, will occur as a result of the MLGW plant.

During facility operation, particulates containing trace metals will be released by coal handling and storage facilities and by coal-conversion-related processes, including coal combustion for steam production. Particles from coal handling and storage will settle primarily within 100 m of the facility (Sect. 4.1.1.2) and should therefore have no significant effect on vegetation surrounding the site. Normal plant operation (excluding coal handling and storage) is expected to increase the ambient annual average particulate concentration of 58 µg/m<sup>3</sup> (Table 3.1) by

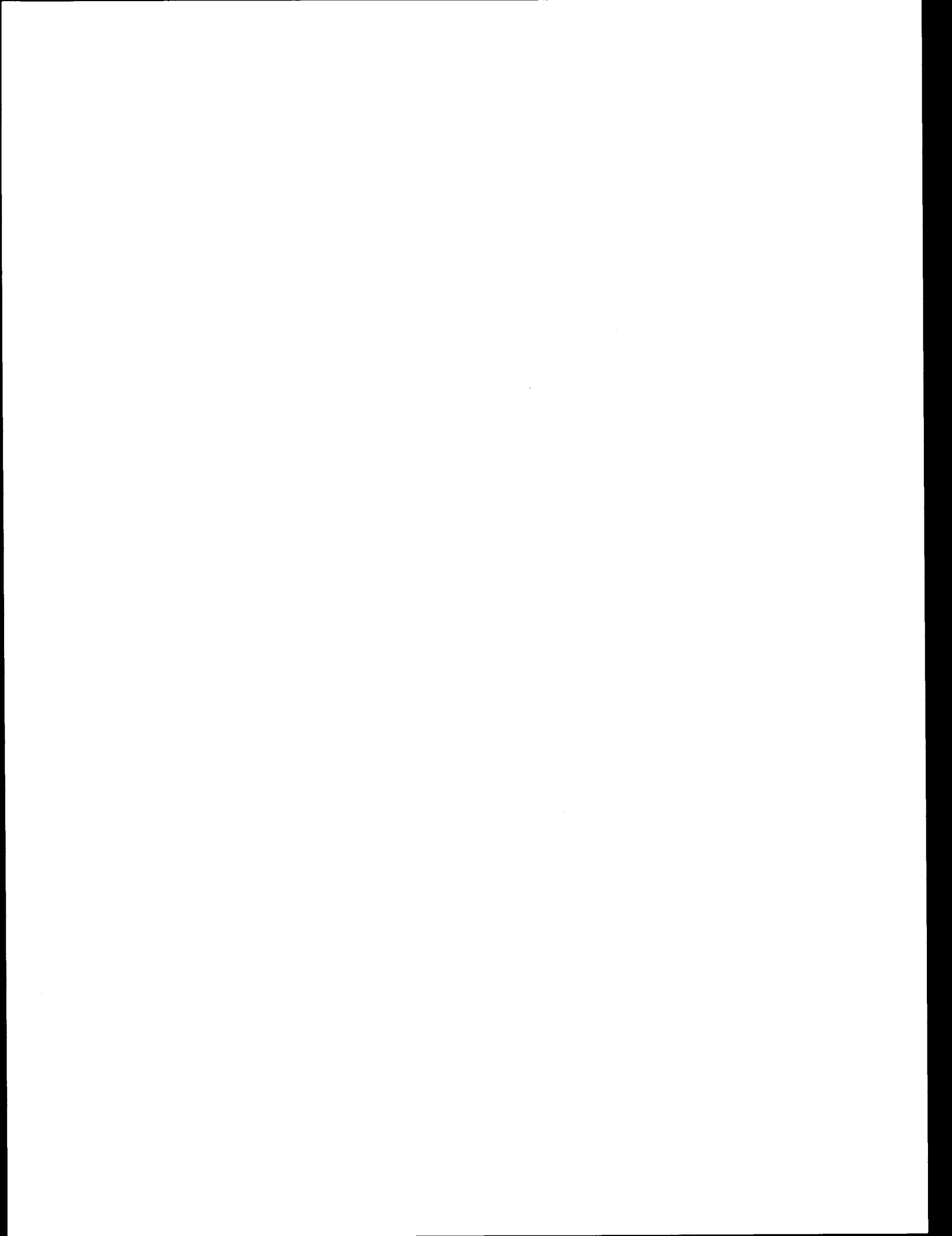
0.2  $\mu\text{g}/\text{m}^3$  (Sect. 4.1.1.2). This concentration represents less than 0.4% of the secondary air quality standard, which indicates that there should be no significant impacts on vegetation or animals resulting from particulates.

#### Cooling tower impacts

During operation of the plant, small releases of cooling tower water, termed "drift" (about 18 gpm based on design parameters stated in the ER, Sect. 2.4.5.14) will occur. Because the cooling tower circulating water contains small amounts of chromium and zinc (ER, Sect. 2.4.4.1, Table 2-18) as corrosion inhibitors and biocides, water droplets leaving the cooling tower will contain small amounts of these materials. The environmental effects on the flora and fauna due to droplet "drift" from chromated cooling towers are relatively well known as the result of work on cooling towers at the Oak Ridge Gaseous Diffusion Plant.<sup>22-25</sup> Taylor et al. demonstrated that, even though some crop species such as tobacco were sensitive to chromium, native plant species such as fescue did not develop symptoms of toxicity.<sup>22</sup> The effects observed for tobacco (reduced growth rate and chlorotic spots) were the result of leaf surface contamination and were most pronounced within 300 m of the tower.<sup>25</sup> The soil was not a significant pathway to the biota. Therefore no cumulative effects to plants or animals resulting from chromium in the soil are expected. Cotton rats captured downwind of the Oak Ridge Gaseous Diffusion Plant cooling towers showed low assimilation and rapid loss of hexavalent chromium.<sup>25</sup> Taylor and Parr concluded there was little bioaccumulation.<sup>25</sup> Based on these findings, no harmful effects to wildlife are expected from the chromium in the drift at the proposed site. Chromium concentrations reached background levels at 1400 m from the Oak Ridge Gaseous Diffusion Plant. This plant has two large towers (60 cells combined capacity).<sup>23</sup> The proposed plant by comparison will have one tower with five cells. Therefore, the area affected is expected to be substantially smaller, and effects on vegetation should be minor.

The amount of salts deposited on vegetation in drifting water droplets is considered inconsequential, based on numerous studies.<sup>26</sup> Also, the amount of rainfall in the Memphis area is high, and salts would be readily washed from vegetation. Consequently, salt-deposition effects are expected to be inconsequential.

However, the potential impacts on the biota of using process wastewater as makeup water for the cooling tower cannot be accurately assessed, given the uncertain chemical characteristics of the priority organics of this water. A complex set of organics, trace elements, dissolved solids, and other constituents would be present in the cooling tower makeup water. These constituents, which would be heated during certain plant processes and could form chemical species such as chloroform, chlorophenols, etc., would be emitted during cooling tower operations. Careful monitoring of the treated process water will be carried out prior to the use of process wastewater for cooling tower makeup. Whether process wastewater will be used as cooling tower makeup will be decided during the final design stage.



Appendix C.7  
STATUS OF LICENSES, PERMITS, AND APPROVALS





## Appendix C.7

## STATUS OF LICENSES, PERMITS, AND APPROVALS

Permits required by MLGW in order to begin construction and operation of the proposed facility are of four different types: air permits, water permits, solid waste permits, and possible Toxic Substances Control Act Registration. The current status of the schedule for obtaining these permits is shown in Table C.19. In each case the regulatory environment is somewhat changeable, so that plans based on current requirements may be modified as these requirements change. Because the MLGW facility would be the first gasifier of its type to be constructed under current environmental laws and regulations, the review process for these permits may be quite extensive.

Air permits

The Prevention of Significant Deterioration (PSD) Permit, the Permit to Construct, and the Permit to Operate are administered wholly or in part through the Memphis and Shelby County Health Department (MSCHD). They will be denied or approved on the basis of the project's impacts on air quality.

The PSD permit actually is issued on the authority of the Federal Clean Air Act and amendments by the U.S. Environmental Protection Agency (EPA) on the recommendation of the Tennessee Department of Public Health. The agency with primary reviewing authority, however, is the MSCHD. MLGW and its industrial associates must supply information to these agencies on the proposed design, the construction schedule, proposed emission reduction systems, baseline air quality, air quality modeling studies, and probable impacts.

The Permit to Construct is issued by MSCHD on the authority of the Tennessee Air Quality Act. Review of the permit application serves new-source review requirements and determines applicable new-source performance standards set by EPA. Much of the information on process emissions (both stack and nonstack) and the proposed design required for the PSD permit also is needed for the Permit to Construct.

The Permit to Operate or Operating Certificate also would be issued by MSCHD on the authority of the Tennessee Air Quality Act. It would initially require no new information on emissions from the proposed design but eventually would be subject to compliance inspection and possible sampling of stack emissions. Application for the permit may be made following initial startup of the facility.

Water permits

Three types of approvals relating to water will be required: a National Pollutant Discharge Elimination System (NPDES) Permit, approval of the engineering report and preliminary plans, and Department of the Army Sect. 404 and Sect. 10 permits and Sect. 401 certification.

The NPDES permit program is authorized by the Federal Water Pollution Control Act (and amendments), with review responsibilities delegated by EPA to the Tennessee Department of Public Health (TDPH). MLGW will be required to supply TDPH with a detailed description of the facility, of wastewater discharges, and the implementation schedule. Since performance standards have not been promulgated for new-source coal gasification plants, TDPH will compare these data with the effluent limitations it develops. The permit will be issued if the effluents from the proposed facility are within these limitations.

TDPH also has the authority to approve or disapprove the engineering report and preliminary plans under Tennessee Regulations for Plan Submittal and Approval. The results of waste and wastewater analyses as well as detailed plans of the wastewater treatment facilities must be submitted for the approval of TDPH. Such approval constitutes TDPH permission to construct the wastewater treatment facilities. These detailed plans and the composition of effluents will depend to a large extent on the effluent limitations established by TDPH under the NPDES permit program.

Table C.19. Status of project permits and approvals

| Permitting agency                       | Permit                                                       | Date application submitted | Date permit expected |
|-----------------------------------------|--------------------------------------------------------------|----------------------------|----------------------|
| <b>Federal agency</b>                   |                                                              |                            |                      |
| U.S. Army Corps of Engineers            | Sect. 10 and 404 permits for construction in navigable river | August 1980                | After EIS approval   |
| <b>State agency</b>                     |                                                              |                            |                      |
| Tennessee Department of Public Health   | NPDES <sup>a</sup> permit for effluent discharge to river    | July 1981                  | January 1982         |
|                                         | Solid Waste Disposal permit                                  | July 1981                  | January 1982         |
|                                         | Sect. 401 water quality certification                        | August 1980                | After EIS approval   |
| <b>Shelby County agency</b>             |                                                              |                            |                      |
| Memphis-Shelby County Health Department | Prevention of Significant Deterioration                      | August 1980                | April 1981           |
|                                         | Permit to Construct                                          | August 1980                | April 1981           |
|                                         | Permit to Operate                                            | 1983                       | 1984                 |

<sup>a</sup> National Pollutant Discharge Elimination System.

A single application to the Memphis District of the U.S. Army Corps of Engineers will permit a review for all approvals required under Sects. 401 and 404 of the Federal Water Pollution Control Act (as amended) and Sect. 10 of the Rivers and Harbors Act. The Sect. 404 and Sect. 10 permits will be necessary in order to fill and dike the Allen site as proposed by MLGW. This approval can not be granted until a Final EIS has been completed. The Sect. 401 Certification requires state approval, and this authority also resides in TDPH.

#### Solid waste permits

Permission to handle and dispose of solid wastes currently is within the jurisdiction of TDPH under the authority of the Tennessee Solid Waste Disposal Act. Federal regulations implementing the Resource Conservation and Recovery Act (RCRA), which will govern the disposal of solid wastes, were published on May 19, 1980. These regulations assign to TDPH lead responsibility in this area.

TDPH will require a feasibility study, a site investigation, and detailed construction and operation plans for the solid waste processing and disposal facilities associated with the plant. TDPH approval of these plans constitutes permission to begin construction of the facilities. TDPH also requires a Registration for Operation of a Solid Waste Processing or Disposal Facility and will issue this registration after a postconstruction compliance inspection of the facilities. Issuance of the registration constitutes permission to begin disposal. Simple onsite storage of solid waste, on the other hand, does not require registration.

#### Registration of toxic substances

The regulations implementing the Toxic Substances Control Act (TSCA) require that premanufacture notification (PMN) with supportive information be given to EPA prior to the production of toxic materials. EPA has indicated that a PMN will be required for the product gas.

Appendix C.8

FLOODPLAIN-WETLAND DETERMINATION AND PRELIMINARY STATEMENT OF FINDINGS



Appendix C.8.1

FLOODPLAIN-WETLAND DETERMINATION

**IDENTIFICATION AND EVALUATION OF ALTERNATIVES  
TO  
THE LOCATION OF A PROPOSED FEDERAL ACTION  
IN THE FLOODPLAIN**

**MEMPHIS LIGHT, GAS AND WATER DIVISION  
Industrial Fuel Gas Demonstration Project**

April 1980

**U. S. DEPARTMENT OF ENERGY**

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## I. PURPOSE

A Medium-Btu Industrial Fuel Gas Demonstration Plant is being proposed for construction and operation in Shelby County, Tennessee, by Memphis Light, Gas and Water Division (MLGW) on a cost-shared basis with the Department of Energy. MLGW is a municipal utility that distributes electricity, gas and water in Shelby County, Tennessee. The proposed 134-acre site for this plant is located in a 100-year floodplain and contains land which has been designated as wetlands by the U. S. Corps of Engineers and U.S. Fish and Wildlife Service. In order to comply with Executive Order 11988, "Floodplain Management," and Executive Order 11990, "Protection of Wetlands," this report identifies and evaluates the alternatives to this proposed action. These alternatives include: (1) Alternative Sites; (2) Alternative Actions; and, (3) No Action.

## II. PROJECT AND SITE BACKGROUND

### A. Project Background

In 1976, the Department of Energy (DOE), which at the time was the Energy Research and Development Administration (ERDA), announced it would co-sponsor a series of coal gasification demonstration plants to assist the development of practical second generation technology for converting coal into gaseous fuel as a means of encouraging the country's energy self-sufficiency. A request for proposal, RFP No. E(49-18)-2043, was issued, and five firms, including MLGW, responded with proposals in May 1976.

In January 1977, MLGW and the W.R. Grace & Co were selected in accordance with the criteria presented in the RFP to undertake conceptual and preliminary design efforts (Phase I) which could lead to the construction and operation of a demonstration plant for converting high sulfur coal to low/medium Btu gas for industrial applications. Subsequently, contracts were executed with the W.R. Grace & Co and MLGW on August 23 and August 30, 1977, respectively. Each project was structured in three phases: Phase I - Development and Conceptual Design, Phase II - Final Design, Procurement and Construction, and Phase III - Operation. At the end of Phase I, a competitive evaluation was to be conducted with a single project authorized to proceed into Phases II and III. The Phase I effort was completed for both projects in December 1979. Prior to commencement of the competitive evaluation, each contractor was required to indicate its willingness to proceed to Phase II if selected as a result of the evaluation. W.R. Grace & Co took the position that they would not proceed to Phase II of the contract even if they were selected. Thus the Grace position had the effect of

removing the Grace Project from consideration in the competitive selection and eliminating that project as a viable alternative. MLGW, on the other hand, expressed willingness to proceed to Phase II.

The overall need for the Memphis project is based both on DOE's objectives to demonstrate the technical, economic, and environmental feasibility of producing synthetic gas from coal for industrial applications and on MLGW's desire to alleviate the long term natural gas supply shortage which MLGW has projected for industrial customers in the Memphis area.

#### B. Site Background

The initial identification of the proposed site for the MLGW project has its origin in the ERDA RFP No. E(49-18)-2043, issued in January, 1976, in which it was stated that "Offerors are free to select the process, plant location, plant size, and the coal to be processed in exchange for cost sharing." Furthermore, site related parameters were to be evaluated as weighted criteria in the selection evaluation. As a result, MLGW selected and specified the Allen Site in their response to the RFP submitted in May 1976. This site, known as the Allen Site due to its proximity to TVA's Allen Power Generating Plant, was also specified in the resulting DOE/MLGW contract as the plant location.

Since the Allen Site is located in a 100-year floodplain and contains wetlands, it is required by Executive Orders 11988 and 11990, Water Resources Council Guidelines 43 FR 6030 and DOE Regulations 10 CFR 1022 that a determination be made by DOE as to whether there is a practicable alternative for siting in the floodplain/wetlands. The test of what is practicable depends on the specific situation and includes consideration of many factors, such as environment, cost, technology and implementation time.

### III. SITING CONSTRAINTS AND CRITERIA

In the identification of alternative sites, it is recognized that there are basic constraints which candidate sites must satisfy to qualify for consideration. For the MLGW Project, five site constraints were identified which led to the location of five candidate sites. For the qualified candidate sites, the determination of practicability was related to considering specific siting criteria. The following sections discuss these constraints and criteria.



A. Siting Constraints

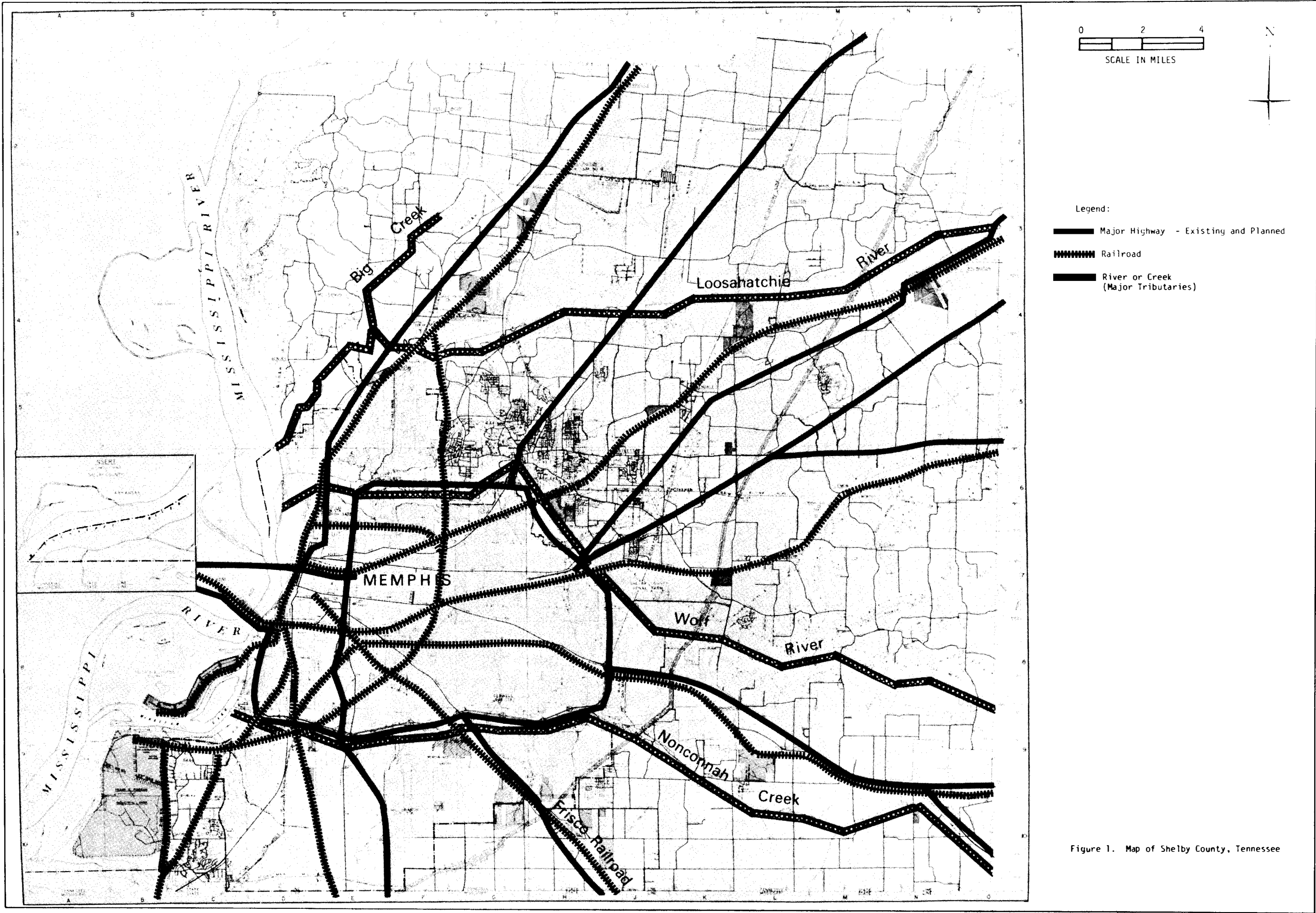
1. Statute Requirements - Land outside of Shelby County is not available for siting the plant since, as a municipal utility, MLGW is governed by Chapter 381 of the Private Acts of 1939. This Act details the limitations which the State of Tennessee imposes upon MLGW. One of these limitations is that all construction by MLGW must be in Shelby County. Deviation from this restriction would require the passage of legislation by the Tennessee Legislature and signature into law by the Governor. Even after enactment of the legislation, MLGW would still have to negotiate a franchise with the area outside the county for operation of a utility system. Such actions would be inordinately time consuming and are judged non-practicable, especially considering other constraints. Therefore, the region of interest for site selection was restricted to the county.

Figure 1 presents a map of Shelby County and shows the location of major highways, railroad lines, and tributary streams (Loosahatchie River, Wolf River, Nonconnah Creek, listed in a north-to-south direction) that flow into the Mississippi River.

2. Zoning, Land-Use - Land in Shelby County presently zoned and used for residential, commercial, or public purposes is not available for siting the plant because of existing land use policy. This constraint includes parks, designated recreation or conservation areas, airports, military installations, and the location of public institutions. In addition, the Corps of Engineers has indicated that certain land within the existing dike line, established by levees along the Mississippi River, cannot be used for the plant site.

Figure 2 shows (in black) the major areas of the county excluded by this constraint. In addition to these areas, there are numerous rural or small residential areas scattered throughout the county not portrayed by the level of detail in this figure. These would also be unsuitable because of present zoning. All potential plant sites have to be carefully assessed for proximity to these exclusion areas.

Figure 2 also shows the location of major regions in the county zoned for industrial use. The proposed Industrial





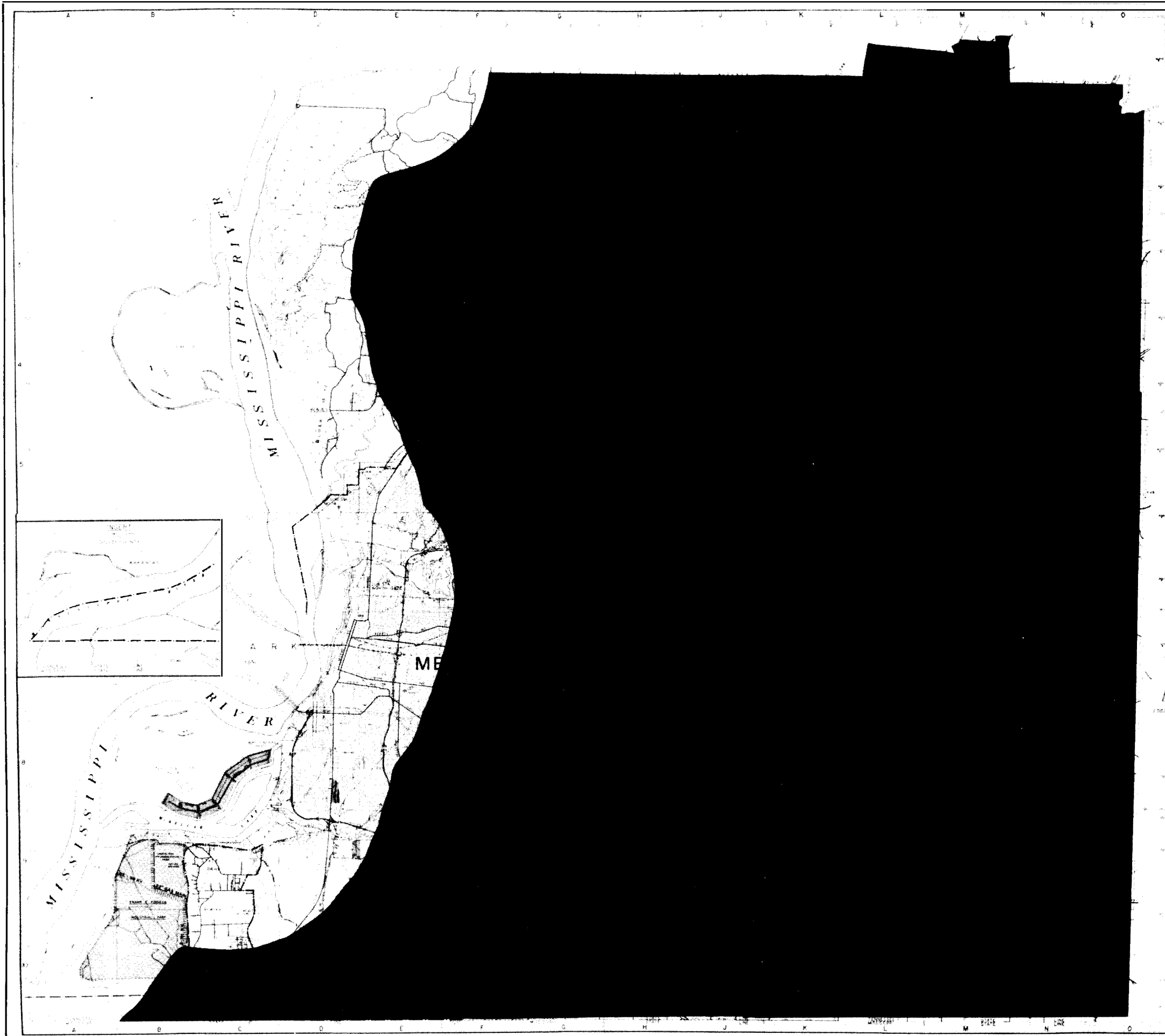
Fuel Gas Plant requires an area zoned for heavy industry (M-3). Such locations, meeting plant area requirements, are prime candidate sites since no re-zoning is required.

Also available, upon rezoning, are those areas presently zoned for medium and light industry (M-2 and M-1, respectively) or agriculture (Ag). However, while it is theoretically possible to rezone any of these latter three areas to M-3, the effort increases substantially as the present zoning varies from M-3 because of the land use development policy in the county. This policy encourages new heavy industrial development in the southwestern portion of the county, making any rezoning east of the Frisco Railroad (see Figure 1) very difficult. Rezoning of any area for the plant would be subject to the combined approval of the Zoning Board, Land Use Control Board, County Commissioners, and City Council.

3. Barge vs. Rail Delivery of Coal - Based on an economic evaluation of alternative transportation costs for coal, which is presented below, only those regions in the county accessible to barge transport are possible locations for the plant. Figure 3 shows the land area in Shelby County within 3 miles of navigable waters. This is the maximum practical distance away from navigable waters that the plant can be located in the county and still obtain barged coal by use of a conveyor system. This is due to the technical complexity and environmental impacts associated with routing a conveyor system through and around occupied industrial developments, existing structures, or urban areas (homes, office buildings, etc.). The practical length for a conveyor system in most of the county is much less than 3 miles. The significance of the 3 mile distance is that it allows access to all of the Pidgeon Industrial Park in the southwestern portion of the county, which is still unoccupied.

Three possible means of coal delivery were considered:

- a. Truck Delivery - Due to quantity of coal (1.1 million tons per year), long distance from mines (approximately 400 miles), and frequency of required truck traffic (i.e., one truck every 3 minutes), this option was eliminated without detailed economic analysis.
- b. Barge Delivery - Coal transported via the Ohio and/or



0 2 4  
SCALE IN MILES



Legend:

Land Area Beyond 3 Miles of  
Navigable Water

Figure 3. Shelby County Land Area Within  
Three Miles of Navigable Water

Mississippi Rivers to the site.

- c. Rail Delivery - Coal transported by single car or unit trains to the plant site.

Since barge and rail delivery are the only viable means of transporting coal to the plant, given below is a comparison which shows the net transportation cost difference between barge and rail deliveries to Memphis. These costs are in 1980 dollars.

|                                                                              | <u>Barge</u>                                                                                                 | <u>Rail</u>                                                                                                               |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Source                                                                       | Henderson, Ky. <sup>(1)</sup>                                                                                | Henderson, Ky. <sup>(1)</sup>                                                                                             |
| Destination                                                                  | Memphis<br>(Shelby County)                                                                                   | Memphis<br>(Shelby County)                                                                                                |
| Transportation<br>Cost per Ton<br>of Coal Delivered                          | \$2.50-\$3.00 <sup>(2)</sup><br><br>(Use \$2.75)                                                             | \$13.14 Single <sup>(3)</sup><br>Rate Net Haul<br><br>\$10.00 (Minimum) <sup>(4)</sup><br>for Unit Train<br>(Use \$11.50) |
| Annual Transporta-<br>tion Cost for 1.1MM<br>Tons Per Year                   | \$3.025MM                                                                                                    | \$12.65MM                                                                                                                 |
| Difference in Trans-<br>portation Cost<br>(Per Year)                         | Base Case                                                                                                    | + \$9.625MM                                                                                                               |
| (20 Year Project)                                                            | Base Case                                                                                                    | + \$192.5MM                                                                                                               |
| Impact of Transpor-<br>tation Costs on<br>Product Gas Cost<br>(\$per MM Btu) | Base Case                                                                                                    | + \$0.58 <sup>(5)</sup>                                                                                                   |
| % Increase in<br>Product Gas Cost                                            | Base Case                                                                                                    | + 11.1%                                                                                                                   |
| Notes (1)                                                                    | - Henderson, Ky. is centrally located<br>within the Kentucky No. 9 coal<br>supply region (Southern Illinois, |                                                                                                                           |



- Indiana, and Kentucky). Henderson is a representative supply point for the contract design coal.
- (2) Source - Ohio River Company rates, March 1980.
  - (3) Source - Louisville-Nashville Railroad Single Rate Net Haul, 1980.
  - (4) Source - Island Creek Coal Company, 1980 (Railroads negotiate unit train rates at time of order. This figure is based on Island Creek's experience in selling to other clients).
  - (5) Source - Economic Analysis of Demonstration Plant (Deliverable #39). Base Case can vary. \$5.23 per MM Btu was used. Coal price sensitivity showed that an increase of \$1 per ton in coal price (or in transportation cost) will change gas cost about \$0.06 per MM Btu.

Barring effects of changes in Government regulations and policies, the cost difference between barge and rail transportation is expected to widen in the future due to the fact that the rail industry is more labor and capital intensive.

Capital cost considerations result in a negligible difference between a facility served by rail versus one served by barge, since the barge un-loading system, dock facility, and conveyor system costs are offset by the cost of the rail spur, transfer area, and coal un-loading facility.

Recognizing that the intent of the demonstration program is to demonstrate the technical, economic, and environmental viability of converting high sulfur coal to a medium-Btu gas suitable for industrial applications so that industry will, on their own initiative, proceed with construction of similar-type plants, thereby reducing the U.S. dependence on foreign crude. Consideration must be given therefore to how the differential in transportation cost will impact the economics relating to the project. Based upon the best information available at this time, it is projected that the revenue generated by the sale of product gas, on a 90% load factor basis, will be approximately \$86.3MM per year. This is based on a projected gas

cost to customers of \$5.23/million Btu's, a price that in 1985 is expected to be competitive with natural gas and/or industrial #2 fuel oil. Offsetting these revenues are the following cost factors:

|                                                     |                          |
|-----------------------------------------------------|--------------------------|
| Plant Operating costs                               | \$54.0MM per year        |
| Debt retirement of MLGW bond issues                 | \$11.0MM per year        |
| Repayment of the Government capital cost investment | \$13.2MM per year        |
| MLGW payment in lieu of taxes                       | <u>\$ 6.0MM per year</u> |
| TOTAL                                               | \$84.2MM per year        |

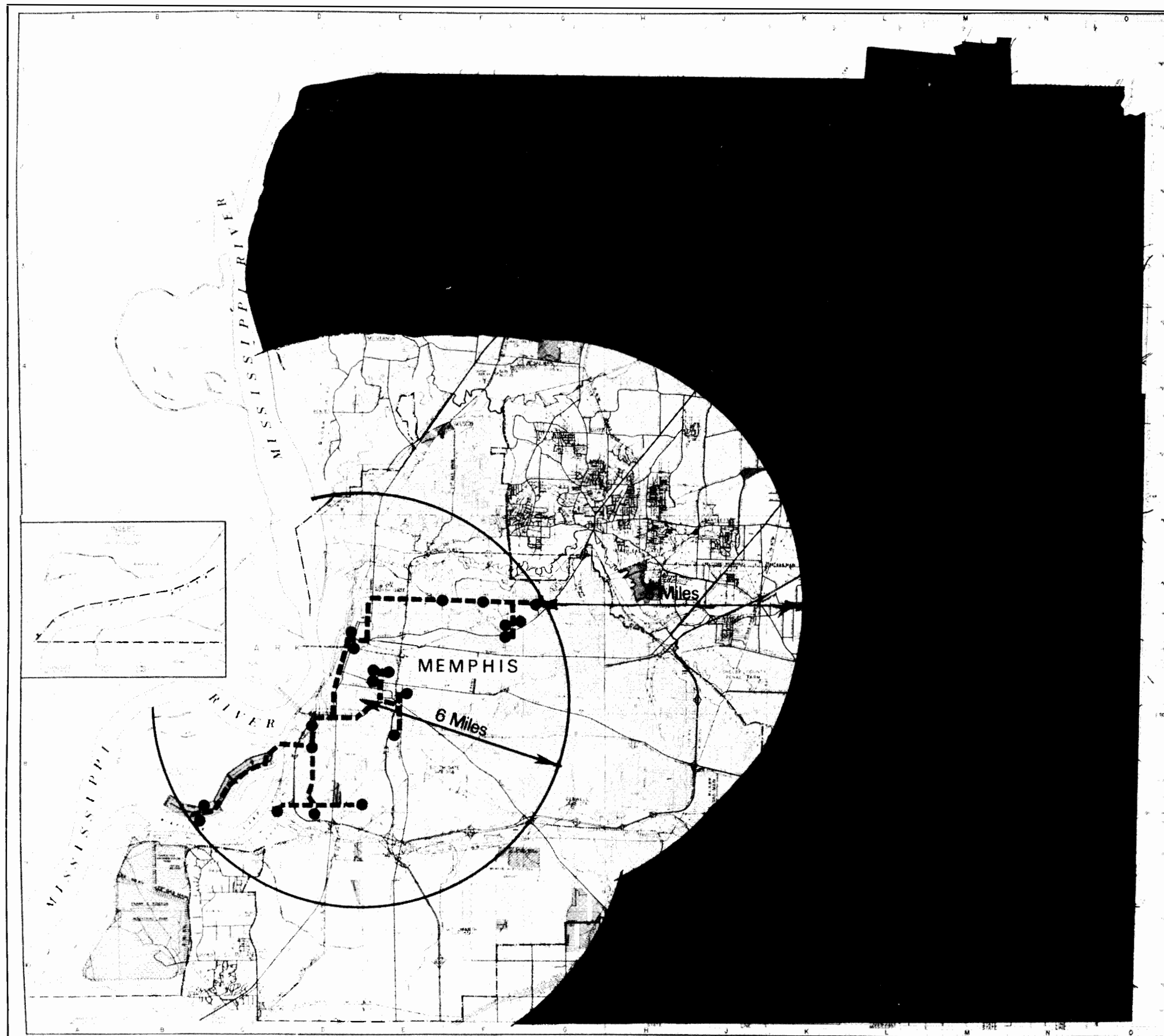
The above costs are also based on escalated factors for feed stocks, operating labor costs, and maintenance costs escalated in a manner consistent with that used for product revenues.

Since MLGW is a non-profit municipal utility the above economic analysis demonstrates that the project is economically feasible. If the product gas cost increases by approximately 11% as a result of using rail instead of barge transportation, the operating cost will increase by approximately \$10MM as shown previously and exceed the revenue of the product gas sales. Such a differential would make the project economically non-viable, thus negating the intended purpose of the program.

4. Proximity to Fuel Gas Users - The capital costs of the fuel gas transmission and distribution system establish a constraint on the maximum distance which the plant can be located from potential fuel gas customers. These costs must be repaid by revenue generated by the plant, which becomes more difficult as the pipeline distance increases. An analysis of the estimated revenue available to retire a debt issue associated with construction of the transmission and distribution system leads to the conclusion that the plant must be located within about 8 miles from the nearest potential customer. Figure 4 shows the land area excluded for the plant by this constraint, while the basis for the constraint is discussed below.

An MLGW market survey identified and located twenty (20) prospective customers for the plant output. These customers were identified and located by a two-stage





## Legend:

- Approximate Location of Potential IFG Customer
- Proposed IFG Distribution System
- Land Area Not Practicable for Location of Proposed Industrial Fuel Gas Transmission System

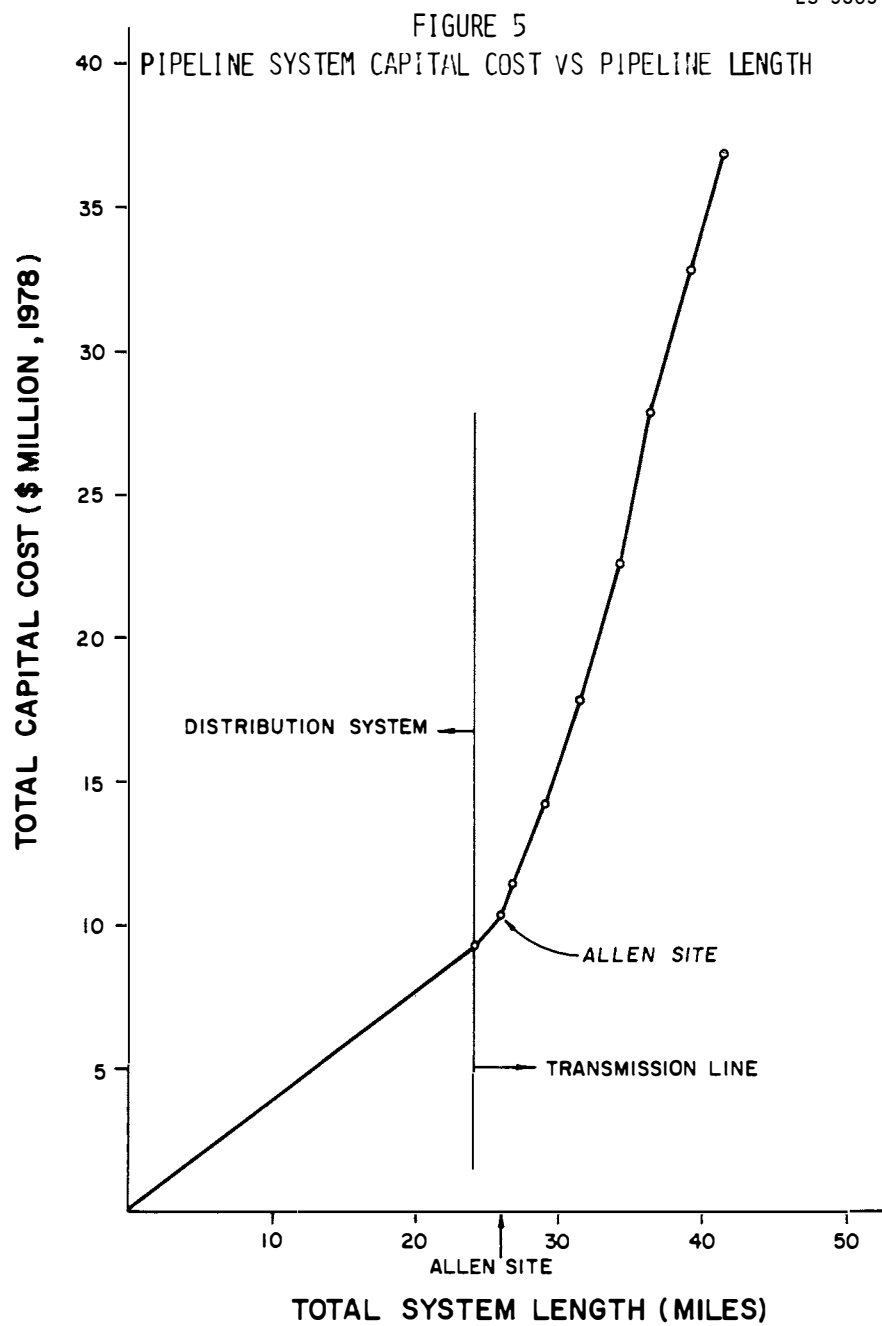
Figure 4. Shelby County Land Area Practicable for Location of the Proposed Industrial Fuel Gas Transmission System

survey. The first survey was conducted by evaluating all industrial customers in Shelby County against the following factors: customer's fuel demand, daily and seasonal load pattern, and application (e.g., space heating, steam production, feedstock, and others). From this survey, forty-four customers were initially identified as potential users of the industrial fuel gas. A second survey was then conducted which evaluated these forty-four customers against the additional factors of: feasibility of retrofitting, minimum fuel usage, safety of utilization, and constancy of load demand. This survey narrowed the list to twenty prospective customers. The locations of these twenty prospective customers and the pipeline distribution system for interconnecting them are shown in Figure 4. Since the locations of the prospective customers are fixed, the distribution system is therefore also fixed and will be independent of the gas plant location. This distribution system consists generally of smaller sized pipe. A larger sized transmission pipeline from the plant is required to connect with this distribution system. The size of the transmission pipeline increases with distance of the plant from the distribution system to compensate for pressure drop. The following discussion is given for the two systems:

- a. Distribution System - This system, which connects the various customers at an estimated cost of \$9.3 million (in 1979 dollars), is required to be sized such that the gas can be supplied at any point along the system (at approximately 150 psi) and still maintain the required pipeline pressure necessary for servicing all customers. The length of piping for the distribution system is approximately 24 miles regardless of where the plant is located. As shown in Figure 4, the main pipelines for this system will generally be located within a six mile radius.
- b. Transmission System - This system is required to connect the plant to the nearest customer on the distribution system at the required pressure. The maximum practical distance from plant site to distribution system was determined as follows:

The pipe size for the transmission pipeline is related to the length of the pipeline. The largest available size used in the industry is a 48" line. For this size pipe, a practical limit to maintain the desired

ES-5305



supply pressure in the distribution system is approximately fifteen miles. A pipeline length greater than that would require a compressor booster station. The capital investment for such a station (including 2 compressors, buildings, etc.) has been estimated to be between \$8-10MM. The use of a booster station is not desirable because in addition to the economic penalty, it poses an unknown operational safety problem. Booster stations have moving parts and seals which are subject to failures and leaks. There has been little or no experience in this country in the handling of this type of fuel gas through a booster station. Because of this concern, the use of a booster station is not contemplated. Therefore, the length of the transmission pipeline, without a booster station, is the limiting factor for the distance the plant can be located from the potential customers.

Figure 5 and Table 1 summarize how the total pipeline capital costs increase with pipeline length for the distribution and transmission systems. The maximum transmission system cost must be established considering those factors that will keep the plant economically viable. Obviously, it is advantageous to minimize the length of the transmission system and locate the plant as near as possible to the distribution system. However, a maximum practicable distance still needs to be established for flexibility and latitude in the choice of candidate sites, and this is accomplished below.

Referring to Constraint No. 3 above, the annual revenues to be generated by the plant are about \$86.3 million versus annual costs of \$84.2 million. This provides approximately \$2 million of operating capital to offset other cost increments, such as transmission system costs. Therefore, the maximum annual payment for debt service on the transmission system should not exceed \$2 million, which represents a bond issue value of approximately \$17 million, taking into account retirement of principal, interest charges, service charges, and necessary reserves. Construction of the transmission system would be completed in the 1985 time period. Therefore, the construction cost in 1985 cannot exceed \$17 million. An equivalent value in 1979 dollars would be approximately \$9 million, based upon the same factors used for escalating the 1979

cost estimate to "out-year" dollars in preparing the economic assessment. From Figure 5 and Table 1, a \$9 million cost in 1979 dollars (\$17 million in 1985 dollars) represents a transmission line length of about 8 miles to the nearest customer in the distribution system. It should be recognized that this 8 mile length is not necessarily a straight line distance because of the right-of-ways that have to be followed. Accordingly, the 8 mile constraint distance depicted in Figure 4 is a maximum established by arc distances from the nearest customer.

TABLE 1

Total System Capital Costs (\$ Million, 1978)

| Miles of<br>Transmission<br>System | Transmission<br>Pipe Size | Transmission<br>System Cost | Distribution<br>System Cost | Total<br>Cost |
|------------------------------------|---------------------------|-----------------------------|-----------------------------|---------------|
| 0.0                                | NA                        | \$ 0.0 MM                   | \$ 9.3 MM                   | \$9.3 MM      |
| 2.5                                | 34"                       | 2.2                         | 9.3                         | 11.4          |
| 5.0                                | 38"                       | 4.9                         | 9.3                         | 14.2          |
| 7.5                                | 42"                       | 8.6                         | 9.3                         | 17.9          |
| 15.0                               | 48"                       | 23.7                        | 9.3                         | 34.0          |

5. Minimum Site Area of 100 Acres - A contiguous area of at least 100 acres in size, with dimensions suitable for the Fuel Gas Plant configuration, was determined to be necessary. This area was established from an idealized plant configuration containing the following essential components:

| <u>AREA</u>       | <u>ACREAGE</u> |
|-------------------|----------------|
| Process Units     | 13             |
| Coal/Coke Storage | 7              |
| Waste Treatment   | 4              |
| Maint./Admin.     | 5              |
| Ash Storage       | 39             |
| Perimeter Buffer  | 16             |
| Roads             | 9              |
| Miscellaneous     | 7              |
| TOTAL*            | 100            |

- \* No allowance for levees, barge channel widening, irregular site shape, added buffer, etc.

An additional aspect of this constraint is that the prospective plant area must be land that is presently unoccupied by existing facilities or structures and available for development by this project. This excludes from consideration occupied industrial sites and land already designated for development by other projects. Figure 6 shows (in black) land area in Shelby County unavailable for siting the plant as a result of combining the land use constraints from Figure 2 with the site area constraint requiring a minimum of 100 available acres.

B. Overlay of Constraints

Figure 7 shows (in black) the land area in Shelby County excluded for the plant by consideration of siting constraints in conjunction with each other. Also shown (in white or gray) are those regions not excluded by the constraints. Of these regions, the following three are not suitable for siting the plant: 1) the Loosahatchie River floodplain, 2) the Wolf River floodplain, and 3) a small, isolated region located north of the others. Construction of the plant in the floodplain and wetlands areas near the mouths of the Loosahatchie and Wolf Rivers is unacceptable since such development would interfere with the natural flow characteristics between these tributaries and the Mississippi River during periods of flooding and would increase nearby flood elevations. Therefore, no candidate site was placed in these particular floodplains. A candidate plant site was also not placed in the northernmost region because of its proximity to Shelby Forest State Park, its increased distance away from the Mississippi River compared with the North Site, the need to cross a road with the coal conveyor system, and the fact that the coal unloading facilities would have to be located in high quality wetlands near the river. Moreover, this region does not offer any compensating advantages compared with the North Site.

Consequently, five candidate sites were chosen in the remaining regions not excluded by the constraints. They are depicted on Figure 7 and were determined to be the best choices for the detailed evaluation of practicability for the project. They are identified by name below and further described in Section IV.

1. Site A is the Allen Site located on a peninsula in McKellar Lake.
2. Site B is the Pidgeon Site located in the northern portion of Pidgeon Industrial Park on the Mississippi River side.

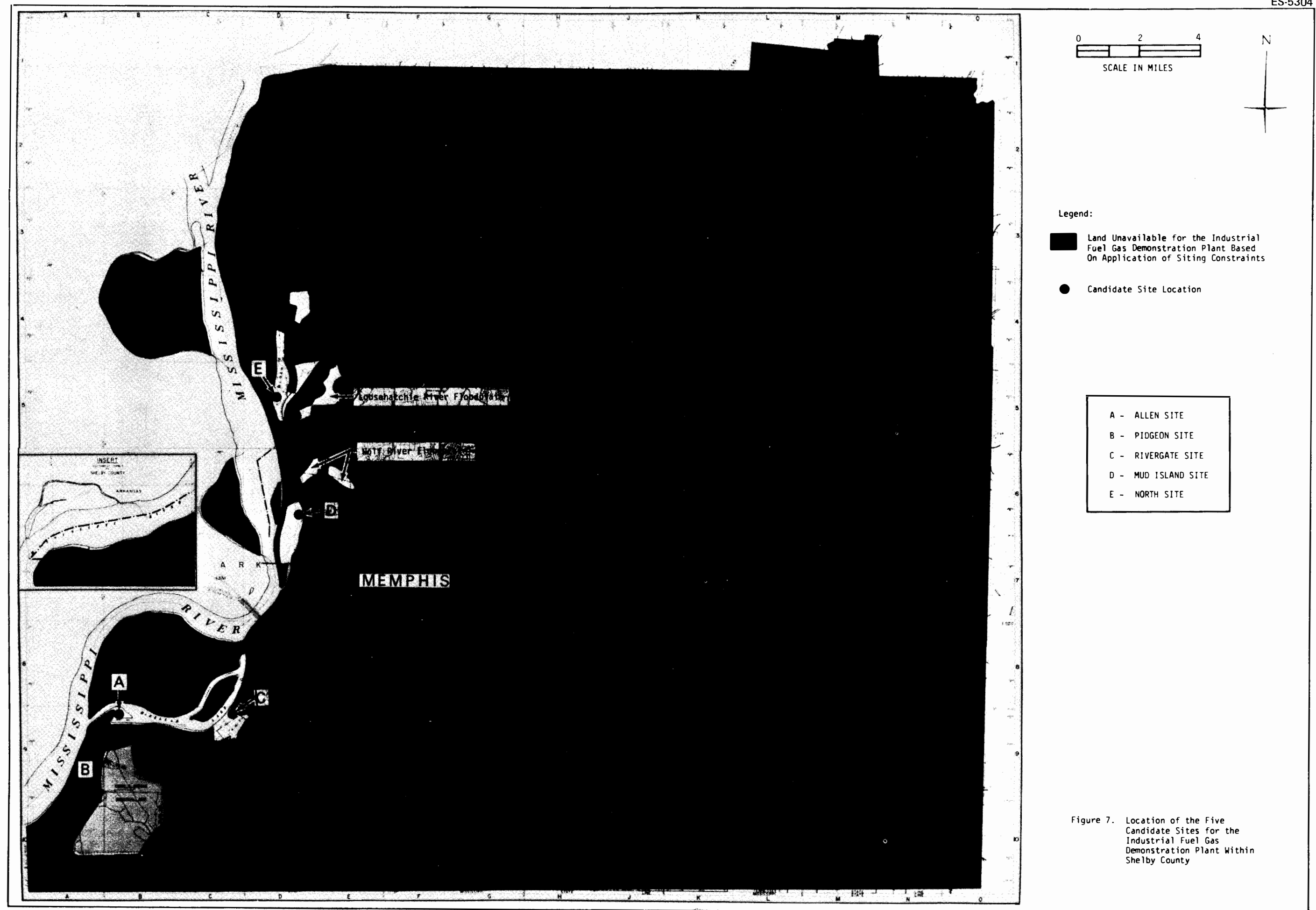


Legend:

Land Unavailable for the  
Industrial Fuel Gas Demon-  
stration Plant

Lightly shaded areas represent industrial  
sites, wholly or partially occupied.

Figure 6. Shelby County Land Area  
Unavailable for Siting the  
Industrial Fuel Gas Demon-  
stration Plant Due to  
Minimum Plant Area Requirement





3. Site C is the Rivergate Site located on McKellar Lake adjacent to Nonconnah Creek in the Rivergate Industrial Port Development.
4. Site D is the Mud Island Site located on the northern portion of Mud Island adjacent to the Wolf River Lagoon.
5. Site E is the North Site located on the bluffs above the Mississippi River, as close as possible to the river.

C. Siting Criteria

The criteria used in determining the practicability of each of the above sites are consistent with Water Resources Council guidelines 43 FR 6030 published on February 6, 1978. The guidelines stated that, at a minimum, site practicability shall be addressed in light of natural, social, economic, and legal considerations. In the context of this project, these considerations are further expanded by the following criteria:

1. Schedule - The ability of each alternative site to meet program/project schedules for contractual obligations, permit applications, site preparation, foundation requirements, public acceptance, and long lead-time activities.
2. Cost - The ability of each alternative site to avoid incurring prohibitive costs as a result of special requirements, such as the construction of new railways, auxiliary facilities, extensive site development; or significant increases in operating costs caused by factors unique to that site.
3. Environmental - The ability of each alternative site to satisfy environmental regulations or avoid adverse environmental impacts which cannot be mitigated. These include considerations in the areas of water quality, aquatic ecology, air quality, terrestrial ecology, land use, socio-economics, and noise.
4. Engineering/Technical - The ability of each alternative site to avoid high technical risks and an inordinately large number of technical problems.

IV. ALTERNATIVE SITES

In this section, a brief description is given for each of the five

candidate sites. For informational purposes, a map showing the approximate locations of both the "100-Year" floodline and the "Project Design" floodline for Shelby County near the Mississippi River is presented in Figure 8. The map also identifies wetlands near these five sites as determined from aerial photographs by the Corps of Engineers. The "100-Year" floodline is at elevation 225 feet msl (mean sea level), while the "Project Design" floodline is at elevation 233 feet msl. The latter elevation is that recommended by the Corps of Engineers as a minimum for projects in the area. The "500-Year" floodline is undefined for this region of the river. Based on the criteria shown earlier, a determination of each site's practicability is then presented with discussion.

#### A. Description of Alternative Sites

The five alternative sites can be classified according to whether they are (1) located outside the 100-year floodplain and do not impact surrounding wetlands (if they exist) (NF/NW); (2) located outside the 100-year floodplain but will impact surrounding wetlands (NF/W); (3) located within the 100-year floodplain but will not impact surrounding wetlands (F/NW); (4) located within the 100-year floodplain and will impact wetlands (F/W).

##### 1. Non-floodplain/Non-wetlands (NF/NW)

###### a. Rivergate Site

The Rivergate Site is located south of Nonconnah Creek near the Delta Refining Company refinery and one mile northwest of the Fuller State Park. The current elevation of the site (approximately 230 feet msl) is in excess of the 100-year flood level, and there are no wetlands currently located on the site. However, the site is 3 feet below the Corps of Engineers' recommendation for project design flood elevation and would require a levee or additional fill if used. The site is privately owned and zoned for heavy industry (M-3). The land is part of the Rivergate Industrial Port Development, a 425 acre area designed for locating up to 60 small industrial plants. The land is presently unoccupied but has already been leveled and prepared with road, rail and barge access.

The site has been built up to its current elevation (from an initial elevation of 200 to 210 feet msl) over a former tailings pond and wetlands area by



periodic dredging of Lake McKellar and Nonconnah Creek. The dredge material was discharged on the site at different locations over a number of years and placed without any major compaction effort and without stripping the site of the existing unsuitable material. The site has the potential for using either barge or rail facilities.

2. Non-Floodplain/Wetlands (NF/W)

a. Mud Island Site

Mud Island is a peninsula located immediately northwest of downtown Memphis. It is bounded on the west by the Mississippi River, east and south by the Wolf River Lagoon, and on the north by the Wolf River. The site is located on the northern portion of the peninsula adjacent to the only road which traverses the length of the peninsula. The site, while located above the 100-year floodplain, contains several small wetlands areas. The site, owned by several parties, is zoned for light industrial use (M-1). The site contains open spaces and a variety of vegetation and trees, but is not presently being used for economically productive purposes. The City of Memphis is currently developing the southern portion of Mud Island as a recreation area as part of a policy to maintain an attractive western approach to the city center. The site would use barge facilities in the Wolf River Lagoon for handling the delivery of coal to the plant.

3. Floodplain/Non-Wetlands (F/NW)

None of the alternative sites fit into this category.

4. Floodplain/Wetlands (F/W)

a. North Site

The North Site is located approximately 8.7 miles north of downtown Memphis near the residential area of Benjestown. The plant portion of the site would be located on bluffs out of the 100-year floodplain, but the barge unloading facility, coal conveyor system, and service roads would be located adjacent to the river in both floodplain and wetlands areas

surrounding these bluffs. It is estimated that about 20 acres of these wetlands would be directly or indirectly affected by construction and operation of these facilities. The site area is privately owned by various parties and currently zoned agricultural. The wetlands are considered by the Corps of Engineers to be of high ecological value because of the wide diversity of wildlife, vegetation, and habitat in the vicinity. Use of the site would require that a bridge be built over the Loosahatchie River and that major road improvements be made to provide improved access to the site.

b. Pidgeon Site

The Pidgeon Site is located in the northwest section of the 4,000 acre Pidgeon Industrial Park. Pidgeon Park is bounded on the north, west and south by a levee having an approximate elevation of 237 feet msl. The site elevation is below the 100-year flood level and is subject to infiltration of Mississippi River water during flood stage. To the west of the levee, where barge unloading facilities would be located in the Mississippi River, are large, high quality wetlands consisting of a mature bottomland forest. The site is owned by the Memphis and Shelby County Port Commission and is zoned for heavy industry (M-3). The northern and eastern-most portions of the Park are not available for locating the plant because of existing facilities (i.e., Maxson Wastewater Facility and Allen Generating Station) and existing development plans to reserve several 100-150 acre industrial subdivisions in the Park beginning in 1981 for small sized companies. The southern section of the park is currently under a three year contract for agricultural use.

c. Allen Site

The Allen Site is located approximately 8 miles southwest of downtown Memphis on a peninsula located near the confluence of the Mississippi River and Lake McKellar and across a barge turning basin from TVA's Allen Generating Plant. The 134-acre site is presently in the 100-year floodplain. The vegetation and wildlife on the site have been extensively surveyed and analyzed with the results of these surveys docu-

mented in a site Environmental Report. The site includes approximately 70 acres of wetlands considered to be of low-to-medium ecological value by the Corps of Engineers and U.S. Fish and Wildlife Service. The wetlands are primarily a periodically flooded successional bottomland forest dominated by black willow. Predominant understory species include common sedge, rice cut grass, green ash, sugarberry, button bush, and swamp privet. The food value of the wetlands for wildlife is limited, and no permanent aquatic habitats or fish community are supported. These wetlands are located approximately in the central portion of the site extending to the eastern perimeter. The Corps of Engineers, in a Federal action approved by EPA, is currently depositing Lake McKellar dredge spoils on a portion of the site and will continue to do so pending site development. This action is already affecting the wetlands area. The site is owned by MLGW and zoned for heavy industry (M-3) but is not presently in productive use. The site can utilize barge unloading facilities for the delivery of coal by using the existing barge-turning basin near the TVA Allen Generating Station.

**B. Determination of Practicability of Alternative Sites**

The following presents the discussion and rationale for the determination of practicability of each alternative site:

**1. Non-floodplain/Non-wetlands (NF/NW)**

**a. Rivergate Site**

Use of this site for the Fuel Gas Plant will require extensive rework of the previous hydraulic fill material to provide the soil bearing capacity necessary for supporting the heavy structures of the plant and avoiding soil liquefaction effects during a major seismic event. This work constitutes a major environmental, cost, and schedule impact.

The site was raised to its present elevation of 230 feet msl by intermittently placing hydraulic fill on the site over a several year period. No quality control was performed on the type of material (sand, silt, and dredged clay) or on its placement. Nevertheless, the site, as it exists today, can adequately

support the development of small-sized industrial plants for which it was intended.

An extensive soil exploration program has been conducted by the owner the Rivergate Site on the 130 acre area where the plant would be built. This program included over 100 soil borings with standard penetration tests, large diameter borings, and plate load tests. The results of this program disclosed widely varying soil conditions with soil bearing capacities ranging from 1500 to 5500 pounds per square foot (psf). More than 50% of the site has a capacity of less than 3500 psf and consists of silts, silty sand, clay, and loose gravel. Minimum bearing capacities for the proposed plant require 4000 psf under the process units and 2500 psf under the ash and coal storage piles. In addition, the differential settlements which would occur under the storage areas could break the integrity of the liners incorporated into the design to collect any potential runoff and direct it for proper treatment. Because of the non-continuous pattern of dredge disposition and the non-homogeneous nature of the site, more than half of the total site area cannot be used for either process units or storage areas without removing the existing fill and replace it under carefully controlled compacting procedures. Furthermore, removal and recompaction of the existing material is not possible due to the variability in mixtures of the silts, clays, and sands. The use of piles does not represent a feasible solution, since the lateral piles, which would be required to protect the major structures of the plant from soil liquefaction, would be insufficient without better and more consistent soil conditions than currently exist.

In order to develop this site for the plant, it is estimated that approximately 3 million cubic yards of material, as a minimum, must be removed to produce acceptable load bearing conditions. This volume of material is based on replacing 50% of the fill placed above the original elevation on the 130 acre plant site. A much more extensive geotechnical and soil boring program would be required to define this volume more precisely, and it is possible that as much as 5-6 million cubic yards would have to be removed. The

cost for removal and transportation of the fill to a nearby site by truck is estimated to be about \$15-30 million, depending on the volume that must be moved. In addition, disposal of this material is difficult to accomplish without major environmental and schedule impacts, since the material cannot be returned to Lake McKellar and must be disposed of on land. The most likely nearby locations capable of receiving this quantity of material are the Allen Site and the Pidgeon Site. In each case, approval would have to be obtained from the owner of the site to accomplish the move, a process certain to be heavily scrutinized and reviewed for short and long term implications and, therefore, subject to delay and nonapproval.

Refilling the Rivergate Site with good quality hydraulic fill from Mississippi River sand bars requires the use of a hydraulic line more than 5 miles in length routed through or around Lake McKellar. This poses a technical problem, as well as added cost and schedule impacts to the process of site development. It is estimated that a cost of \$8-16 million would be needed for refilling the site, depending on the volume of material needed.

Site acquisition costs are expected to exceed \$5 million for the required area. Therefore, total acquisition and development costs for the site, excluding schedule considerations, will be in the range of \$28-51 million, which represents about 5-9% of the estimated total capital cost of the plant. An increased capital cost of this magnitude makes the financial structure of the plant uneconomical, since it places in jeopardy the ability to retire debt or repay the Government's share. Furthermore, the schedule penalty associated with the extensive site development activities described above will be approximately one year. Considering the overall cost of the plant and escalation, this would result in an additional increase of approximately \$70 million.

The plant area would use approximately 25 of the 60 proposed industrial plots in the Rivergate development. This will substantially alter the character of the development and negatively effect the desirability of the park to attract a variety of small sized industries. Under these conditions, negotiations for land acqui-



sition with the private owner will be a complicated and possibly lengthy process, thus adversely affecting schedule and leading to increases in costs.

The combination of technical, schedule, cost, and environmental criteria make the Rivergate site not practicable for the plant.

## 2. Non-Floodplain/Wetlands (NF/W)

### a. Mud Island Site

Use of this site is unacceptable because of a serious land-use conflict with the growing recreational and aesthetic value of the Mud Island area.

The site is within two miles of downtown Memphis and the multi-million dollar Volunteer Bicentennial Park, a recreational area under development on the southern end of Mud Island. In addition, the site is located adjacent to the primary automobile access road to the park and within the airport approach zone for the Downtown Airport. The construction of a heavy industrial plant on Mud Island contradicts the stated objective of local planning officials to maintain an attractive western approach to downtown Memphis. Most nearby commercial and industrial activities are light in nature, and the site is zoned for light industry (M-1). Rezoning the site for heavy industry (M-3) would be a major departure from present status. Significant public and local agency resistance to use of this site will occur. Opposition to the site has been expressed by the Memphis and Shelby County Planning Commission. This will lead to unpredictable schedule delays in receiving the necessary permits and approvals for the plant.

Therefore, on the basis of land use, zoning and public acceptance factors related to environmental and schedule criteria, this site is not practicable for the plant.

## 3. Floodplain/Wetlands (F/W)

All of the sites discussed in this section involve some construction in the 100-year floodplain for the plant or its auxiliary facilities, such as barge unloading and coal

conveyor systems. In addition, all of these sites have wetlands associated with them that will be impacted by site development.

a. North Site

Use of this site for the plant requires construction of coal handling systems in wetlands of high ecological value, re-zoning of agricultural land, and displacement of several residences. Each of these factors will result in long delays in receiving permits and project approvals from local agencies.

Construction of the coal barge handling and conveyor facilities for the site will affect high quality wetlands in the Mississippi River floodplain and be located near an existing diking system. Under these circumstances, receipt of necessary permit approvals from the Corps of Engineers for auxiliary construction near the site will be subject to controversy, delays, and nonapproval.

Land use policy in Shelby County opposes rezoning of agricultural areas (Ag) for heavy industry (M-3), particularly when there are adequate areas already available in the county with the M-3 designation. A rezoning of the type needed for this site is highly controversial and subject to close scrutiny because it conflicts with stated land use policy. Initial contacts with the Memphis and Shelby County Planning Commission indicated that there is opposition to the site being used for the plant.

Nearby land use is a mixture of woodlots, cropland, grazing, and residential areas. At a rural site like this, the plant would significantly alter the neighboring land-use pattern. Several residences, located on the proposed site, would have to be moved. Resistance to siting the plant here would come from nearby home and land owners who would be impacted by construction and operation, leading to delays in receiving project approval.

Therefore, on the basis of combined consideration of environmental, including impact on high quality wetlands; zoning; public acceptance; and schedule criteria, this site is not practicable for the plant.

b. Pidgeon Site

Use of this site for the plant presents difficult technical and environmental problems related to coal barging, impact on floodplains and wetlands, and protection from flooding.

Barge facilities would have to be built on either: (1) the Mississippi River floodplain or (2) the barge-turning basin in Lake McKellar. Facility construction in the floodplain would be located in or adjacent to high quality wetlands containing a mature bottomland forest and would result in high environmental impact to terrestrial and aquatic wildlife.

Also, since the river navigation channel is narrow in the region and close to the revetment where construction would take place, receiving approval from the Corps of Engineers to construct a barge unloading system there would be time consuming and controversial because of current river traffic. Any barge unloading channel cut into the bank to avoid interference with traffic would silt up at a rapid rate and require nearly continuous dredging maintenance. Use of the existing barge turning basin in Lake McKellar for coal delivery is not feasible since there is insufficient area available on the southern bank of the basin for the necessary barge handling equipment without conflicting with existing TVA facilities.

Development of land area for the plant within the levee would require raising over 100 acres to the project design elevation to avoid problems of water seepage beneath the levee from hydraulic pressure whenever the river level exceeds 210 to 215 feet msl. The alternative is to construct a secondary levee around the plant to protect it on all sides, since the plant would take up only a portion of the area currently protected by the existing levee. With a secondary levee, additional equipment and facilities would have to be provided to pump seeping water away safely. Therefore, use of a secondary levee is less acceptable than raising the site.

Based on a consideration of environmental, technical, and project acceptance criteria, this site is not practicable for the plant.

c. Allen Site

Locating the plant on the Allen Site requires elevation of the site from present levels of 205 to 210 feet (msl) to the project design flood level, 233 feet (msl), recommended by the Corps of Engineers at an estimated cost of \$9.0MM. The elevation can be accomplished in a proven and controllable manner so as to provide adequate bearing capacity for the plant facilities as well as flood protection. A hydraulic fill operation using sand taken from a Mississippi River sand bar, located approximately 2 miles from the site, will be used to raise the site level. A commercially proven process called "vibroflotation" will be employed to compact the fill and minimize the risk from soil liquefaction during a major seismic event. Borings already conducted on soil beneath the site indicate satisfactory conditions for the proposed development.

The elevated site is not located within the main flow channel of the Mississippi River under flood conditions. On the basis of tests conducted on the Mississippi Basin Model, the Corps of Engineers has determined that the elevated site will not significantly (i.e., by less than 0.7 foot) alter the flood depths of surrounding areas in Lake McKellar and downstream during a major flood. Therefore, use of the Allen Site poses no added flood threat.

Coal transportation and unloading can be accomplished by barges utilizing the existing barge turning basin in Lake McKellar without affecting TVA facilities since such facilities would be on the north bank of the barge turning basin.

Use of the site would bring into productive use unutilized industrial land currently zoned for heavy industry (M-3) without negatively affecting the future industrial or recreational potential of the Memphis area. No present or planned land use conflicts would occur.

Site development will result in the loss of approximately 70 acres of wetlands. As previously described in Section IV.A., the quality of these wetlands is of low-to-medium value. They contain no unique ecological

resources and provide only limited food supply and diversity of habitat. The ecological community is relatively young, since the site area was underwater in the main flow channel of the Mississippi River in the late 1800's and was subsequently built up by dredging activities. Loss of this area will not appreciably affect terrestrial and aquatic wildlife within a three-mile radius of the plant because of the presence of more than 1000 acres of high quality wetlands in this region that will not be affected by site development. As a result of site development, mobile wildlife will migrate to these areas.

Public and regulatory acceptance of the Allen Site is expected to be satisfactory based on public knowledge of the site location since 1977, compatibility with land-use plans, and the lack of adverse comment to date from public exposure. Development of the site can be accomplished within acceptable cost, schedule and environmental considerations. Therefore, the Allen Site is the only practicable site for the plant.

V. ALTERNATIVE ACTIONS

There are three alternative actions including the proposed action, namely: construct on the proposed site; resolicit a new Industrial Partner to construct outside Shelby County; or, no action. These actions are discussed below.

A. Construct on Proposed Site

The Allen Site can be suitably protected from flooding by raising it above the project design flood elevation for the area. Therefore, the plant can be constructed with negligible danger of flood damage to either the plant or the surrounding area. The loss of low to medium quality wetlands from the site is not currently considered ecologically significant because of the nearby existence of large areas of much higher quality wetlands. It should be noted that the final determination with respect to these wetlands is dependent upon completion of the Final Environmental Impact Statement. No other site currently exists within Shelby County which meets the previously described constraints imposed on the project.

Although the Allen Site is zoned industrial, the land would probably not be used for any other industrial purpose in the

near future since it is owned by MLGW and TVA holds ash disposal easement rights. Constructing on the Allen Site would utilize vacant industrial land without impacting the future industrial, aesthetic, or recreational potential in the Memphis area.

Development of the Allen Site, for the plant, is practicable from the standpoint of environmental and socio-economic acceptability, project cost, and implementation time. Furthermore, use of the site would expedite the use of advanced technology in accord with the current energy plan. Use of the site would also provide community and national benefits that would not otherwise be realized.

B. Resolicit New Industrial Partner to Construct Outside Shelby County

As previously discussed, Shelby County alternatives to the Allen Site are not practicable.

Selection by DOE of a site outside Shelby County could not involve MLGW and would result in a time delay to the project of at least 18 months, including time to resolicit a new industrial partner, negotiate a suitable new contract, and to modify the existing design with respect to the new site. The added project cost under these circumstances would exceed \$90 million for the most economic alternative, and the cost differential could, in fact, be several times greater for some sites.

C. No Action

If no action is taken at the Allen Site, the Tennessee Valley Authority (TVA) plans to exercise ash disposal easement rights which it holds on the site, and the Corps of Engineers will continue using the site to accumulate dredge spoils. Ash disposal and dredge deposition will result in aquatic and terrestrial impacts and eventual loss of the floodplain/wetlands area on the Allen Site. Moreover, the economic benefits to the Memphis area associated with the plant, including construction and operating jobs, increased tax revenues, and availability of industrial fuel gas, would be lost with the use of the Allen Site for ash disposal and dredge deposition.

The proposed plant is an integral part of DOE's alternative fuel demonstration plant program, which has the objective of

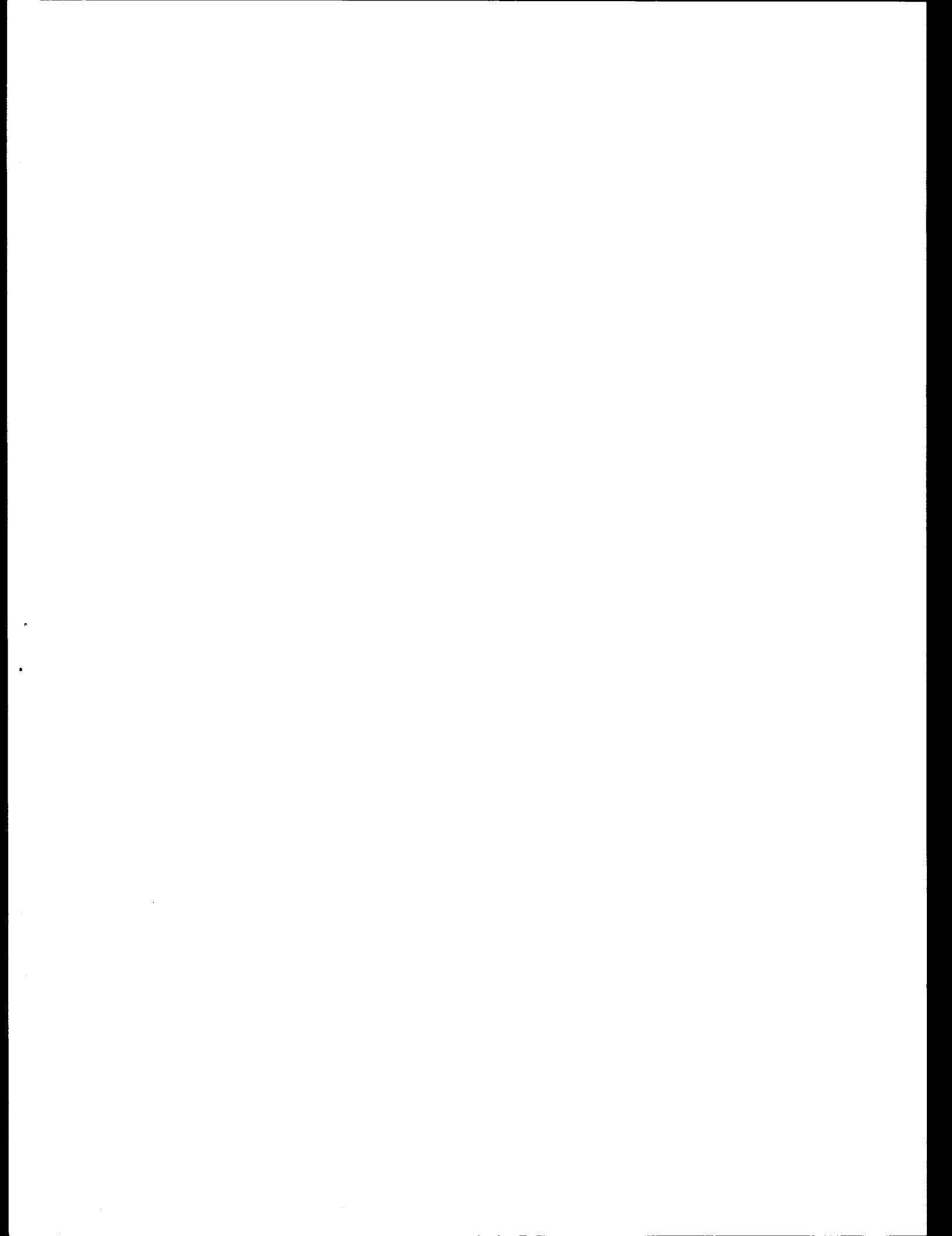
developing and demonstrating, in cooperation with industry, the technology for development of a commercial synthetic fuel industry. This program is part of an overall energy policy to achieve national energy independence. Moreover, the plant is an important element in MLCW's program to provide a reliable gaseous energy supply for industry in the Memphis area. Failure to implement the proposed project will not provide the intended information or advancement of technology nor assist in solving Memphis' long range energy needs. Although another project could be initiated to demonstrate this technology, significant delay in this portion of the national and local coal gasification demonstration program would result.

VI. REFERENCE DOCUMENTS

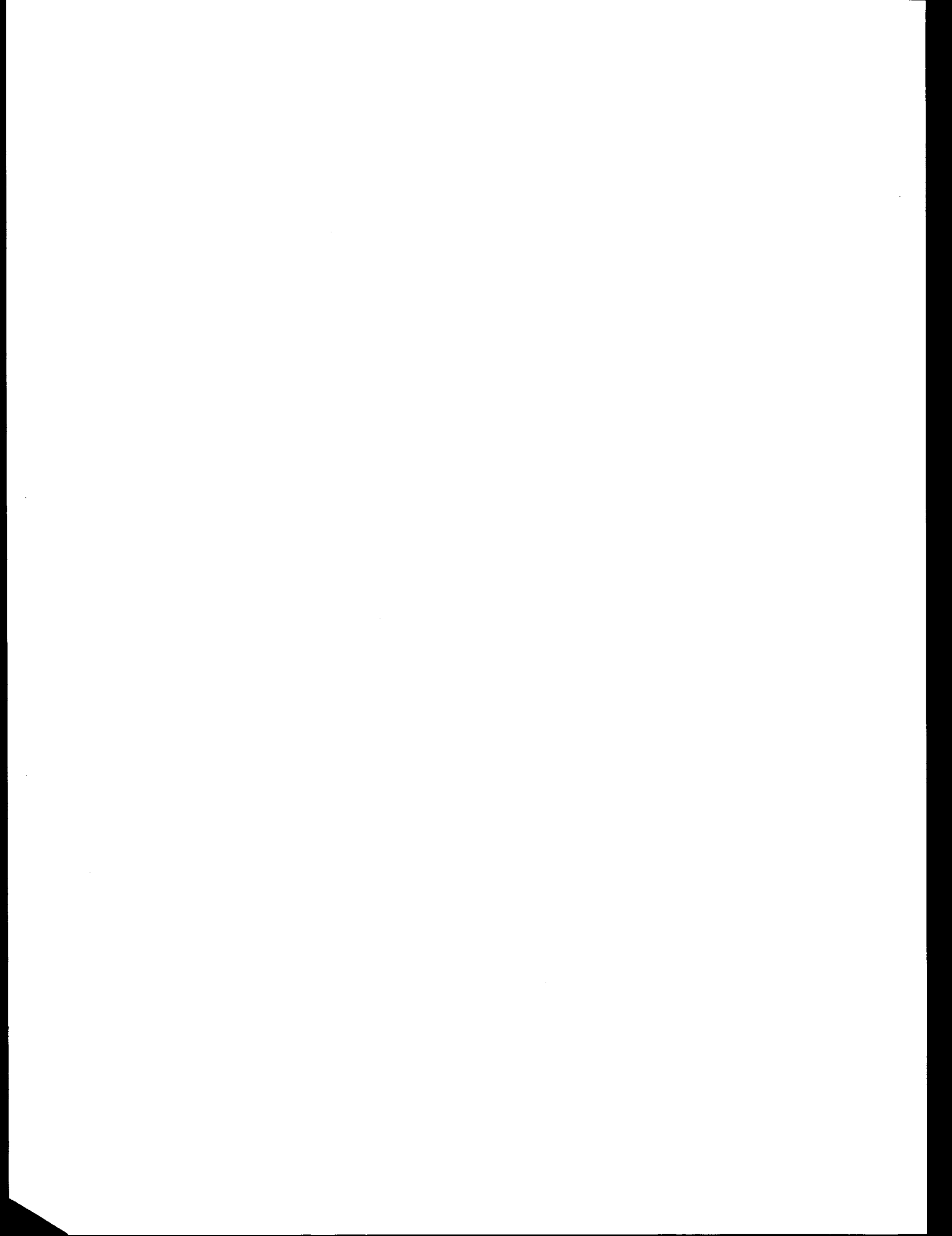
1. Memphis And Shelby County Zoning Regulations, Memphis and Shelby County Planning Commission, 1972
2. Fuel Gas Program RFP No. E(49-18)-2043, Energy Research And Development Administration, January 1976
3. Executive Order 11988, Floodplain Management, May 1977
4. Executive Order 11990, Protection Of Wetlands, May 1977
5. Map showing "Future Land Use Development Pattern For Shelby County", Memphis and Shelby County Office of Planning and Development, Bureau of Economic Development, 1977, Obtained 1980
6. Letter, "Results of Model Tests of Fill Along the Mississippi River at Mile 725.5", H.B. Simmons Engineer Chief, Hydraulics Laboratory, COE to District Engineer, U.S. Army Engineer District, Memphis Tennessee, November 1977
7. Floodplain Management Guidelines for Implementing E.O. 11988, U.S. Water Resource Council, 43 FR 6030, February 1978
8. Memphis And Shelby County Land Use Analysis, Memphis and Shelby County Office of Planning and Development, December 1978
9. Site Evaluation and Selection, Memphis Light, Gas and Water Division, February 1979 (Contract Deliverable No. 26)
10. Compliance with Floodplain/Wetlands Environmental Review Requirements, Department of Energy, 10 CFR 1022, March 1979
11. Letter, "Flood Levels At The Project Site", Noah Johnsen, COE to R.W. Gray, MLGW, June 1979
12. Letter, "Field Survey of Proposed Site of Memphis Coal Gasification Plant", P.C. Davis Chief, Operations Division, COE to R.W. Gray, MLGW, July 1979
13. Environmental Report, Memphis Light, Gas and Water Division, August 1979 (Contract Deliverable No. 27)
14. 1980 Memphis Comprehensive Economic Development Strategy, Memphis and Shelby County Office of Planning and Development, Bureau of Economic Development, November 1979



15. Amendatory Agreement among City of Memphis And Memphis Light, Gas and Water Division and Tennessee Valley Authority, December 1979
16. Plan for Use and Disposition of Industrial Fuel Gas, Memphis Light, Gas and Water Division, December 1979 (Contract Deliverable No. 29)
17. Economic Reassessment Report, Memphis Light, Gas and Water Division, December 1979 (Contract Deliverable No. 39)
18. Letter, "Information on Endangered Species in the Project Area", Thomas S. Talley, Field Supervisor, U.S. Fish and Wildlife Service to R.W. Laza, DOE, December 1979
19. Map Showing "Test Boring Results for Rivergate Industrial Port", Obtained March 1980
20. Maps Showing "Wetlands Near the Candidate Sites", Memphis COE, Obtained March 1980



Appendix C.8.2  
PRELIMINARY STATEMENT OF FINDINGS



## C.8.2 PRELIMINARY STATEMENT OF FINDINGS

**Medium Btu Industrial Fuel Gasification Demonstration Plant, Memphis, Tenn.; Notice of Floodplain/Wetlands Preliminary Statement of Findings**

**AGENCY:** Department of Energy.

**ACTION:** Notice of Preliminary Statement of Findings for Locating a Medium-Btu Industrial Fuel Gasification Demonstration Plant within the Mississippi River Floodplain/Wetlands in Memphis, Tennessee.

**SUMMARY:** The Department of Energy (DOE) announces its Preliminary Statement of Findings for locating a medium-Btu industrial fuel gasification demonstration plant within a floodplain/wetlands area. The Preliminary Statement of Findings and supporting analysis conclude that there is no practicable alternative to locating a plant in the Mississippi River floodplain/wetlands. The proposed DOE action will cost-share the construction and operation of an industrial fuel gas demonstration plant. The plant is to be located in Shelby County, Tennessee (in the immediate vicinity and southwest of Memphis, Tennessee). The applicant, the Memphis Light, Gas and Water Division (MLGW) of the City of Memphis has proposed a facility which would convert 3155 tons per day of high sulfur coal into a fuel gas for pipeline distribution to selected customers in the Memphis area. This notice is being published to provide the public with an opportunity to participate early in the decision making process. Comments by: June 8, 1980.

Interested agencies, organizations, and the general public desiring to submit comments or suggestions for consideration with this Preliminary Statement of Findings are invited to do so. The comment period for this Preliminary Statement of Findings will close June 8, 1980.

**FOR FURTHER INFORMATION CONTACT:** Peter Lui at the address noted below.

All comments may be expressed in writing to: U.S. Department of Energy, Chicago Operations and Regional Office, Project Management Division, 9800 South Cass Avenue, Argonne, Illinois 60439. Attn: Peter Lui, Project Manager, telephone (312) 972-2274.

**SUPPLEMENTARY INFORMATION:** A medium-Btu industrial fuel gas demonstration plant is being proposed for construction and operation in Shelby County, Tennessee, by Memphis Light, Gas and Water Division (MLGW) on a cost-shared basis with the Department of Energy. The Demonstration Plant will convert high sulfur coal to medium Btu

gas for industrial applications. MLGW is a municipal chartered utility that distributes electricity, gas and water in Shelby County, Tennessee. The proposed 134-acre site for this plant, named the Allen Site, is located in a 100-year floodplain and contains land which has been designated as wetlands by the U.S. Corps of Engineers and U.S. Fish and Wildlife Service.

In compliance with Executive Order 11988, "Floodplain Management," Executive Order 11990, "Protection of Wetlands," Water Resources Council "Floodplain Management Guidelines," 43 FR 6030, February 10, 1978, and DOE regulations "Compliance with Floodplain/Wetlands Environmental Review Requirements," 10 CFR 1022, various alternatives to this proposed action have been identified and evaluated. Accordingly, a tentative determination has been made by the Secretary, Department of Energy, that no practicable alternative exists to proceeding with the project for construction at the Allen Site.

**Identification and Evaluation of Alternatives**

In the preliminary identification of alternative sites, basic siting constraints have been identified which candidate sites must satisfy to qualify for consideration. The following is a list of these constraints:

1. **Statute Requirements**—Land outside of Shelby County, Tennessee is not available for siting the plant since, as a municipal chartered utility, MLGW is governed by Chapter 381 of the Private Act of 1939 which limits all MLGW construction to Shelby County.
  2. **Zoning, Land-Use**—Due to current land use policies, only those areas currently zoned for heavy industry or available for rezoning to heavy industry are available for siting the plant.
  3. **Barge vs. Rail Delivery of Coal**—Based on an economic evaluation of alternative transportation costs for coal, only those regions in the county accessible to barge transport are possible locations for the plant.
  4. **Proximity to Fuel Gas Users**—The capital costs of the fuel gas transmission and distribution system establish a constraint on the maximum distance which the plant can be located from potential fuel gas customers.
  5. **Minimum Site Area of 100 Acres**—The prospective plant site must be a contiguous area of at least 100 acres in size, presently unoccupied by existing facilities or structures and available for development by this project.
- Five alternative sites were identified which were not eliminated by these

constraints. The sites and a brief description of their location are as follows:

1. **Site A** is the Allen Site located near the confluence of the Mississippi River and Lake McKellar and across a barge turning basin from TVA's Allen Generating Plant. The site is located within the 100-year floodplain and would impact wetlands.

2. **Site B** is the Pidgeon Site located in the northwest section of the 4,000 acre Pidgeon Industrial Park. The site is located within the 100-year floodplain and would impact wetlands.

3. **Site C** is the Rivergate Site located on Lake McKellar adjacent to site is outside the 100-year floodplain but would impact wetlands.

4. **Site D** is the Mud Island Site located on the northern portion of the peninsula, Mud Island, adjacent to the Wolf River Lagoon. The site is outside the 100-year floodplain but would impact wetlands.

5. **Site E** is the North Site located on the bluffs above the Mississippi River as close as possible to the river. The site is located within the 100-year floodplain and would impact wetlands.

In accordance with the Water resources Council Guidelines, siting criteria were used to determine the practicability of each of the five alternative sites. The guidelines state that, at a minimum, site practicability shall be addressed in light of natural, social, economic, and legal considerations. In the context of this project, these considerations have been further analyzed with respect to the following criteria:

1. **Schedule**—The ability of each alternative site to meet program/project schedules for contractual obligations, permit applications, site preparation, foundation requirements, public acceptance, and long lead-time activities.
2. **Cost**—The ability of each alternative site to avoid incurring prohibitive costs as a result of special requirements, such as the construction of new railways, auxiliary facilities, extensive site development; or significant increases in operating costs caused by factors unique to that site.
3. **Environmental**—The ability of each alternative site to satisfy environmental regulations or avoid adverse environmental impacts which cannot be mitigated. These include considerations in the areas of water quality, aquatic ecology, air quality, terrestrial ecology, land use, socio-economics, and noise.
4. **Engineering/Technical**—The ability of each alternative site to avoid high technical risks and an inordinately large number of technical problems.

As a result of the preliminary alternative site evaluations, the Allen Site was found to be the only practicable site within Shelby County upon which to build the plant.

In conjunction with the alternative site determination, an alternative action evaluation was also conducted. The following alternative actions were considered:

1. *Resolicit New Industrial Partner to Construct Outside Shelby County*—Selection by DOE of a site outside Shelby could not involve MLCW and would result in a time delay to the project of at least 18 months, including time to resolicit a new industrial partner, negotiate a suitable new contract, and to modify the existing design with respect to the new site. The added project cost under these circumstances would exceed \$90 million for the most economic alternative, and the cost differential could, in fact, be several times greater for some sites.

2. *No Action*—If no action is taken, the demonstration of a viable energy alternative, medium Btu coal gasification for multiple industrial users, in the National Energy Program will be impacted and delayed for a minimum of 18 months. Furthermore, the Tennessee Valley Authority (TVA) plans to exercise ash disposal easement rights which it holds on the site and the Corps of Engineers will continue using the site to accumulate dredge spoils. Ash disposal and dredge deposition will result in aquatic and terrestrial impacts and eventual loss of the floodplain/wetlands area on the Allen Site. Moreover, the economic benefits to the Memphis area associated with the plant, including construction and operating jobs, increased tax revenues, and availability of industrial fuel gas, would be lost with the use of the Allen Site for ash disposal and dredge disposition.

3. *Construct on Proposed Site*—The Allen Site would be used since both the plant and/or surrounding area would encounter negligible danger from flood damage. Existing wetlands are not considered ecologically significant and no other site currently exists within Shelby County which meets the previously described constraints imposed on the project. Locating the plant on the Allen Site requires elevation of the site from present levels of 205 to 210 feet (msl) to the project design flood level, 233 feet (msl), recommended by the Corps of Engineers. The elevation can be accomplished in a proven and controllable manner so as to provide adequate bearing capacity for the plant facilities as well as flood protection. A

hydraulic fill operation using sand taken from a Mississippi River sand bar, located approximately 2 miles from the site, will be used to raise the site level. A commercially proven process called "vibroflotation" will be employed to compact the fill and minimize the risk from soil liquefaction during a major seismic event. Borings already conducted on soil beneath the site indicate satisfactory conditions for the proposed development. Of the three action alternatives, a preliminary determination has been made that this alternative is the only practicable choice.

The proposed plant could be built such that it will conform with all applicable State and local floodplain protection standards as well as appropriate building codes, zoning codes, and Federal and State Environmental Regulations and Permits.

The elevated site is not located within the main flow channel of the Mississippi River under flood conditions. On the basis of tests conducted on the Mississippi Basin Model, the Corps of Engineers has determined that the elevated site will not significantly (i.e., by less than 0.7 foot) alter the flood depths of surrounding areas in Lake McKellar and downstream during a major flood. Therefore, use of the Allen Site poses no added flood threat.

Coal transportation and unloading can be accomplished by barges utilizing the existing barge turning basin in Lake McKellar without affecting TVA facilities since such facilities would be on the north bank of the barge turning basin.

Site development will result in the loss of approximately 70 acres of wetlands considered to be of low to medium ecological value by the Corps of Engineers and U.S. Fish and Wildlife Service. They contain no unique ecological resources and provide only limited food supply and diversity of habitat. The ecological community is relatively young, since the site area was underwater in the main flow channel of the Mississippi River in the late 1800's and was subsequently built up by dredging activities. Loss of this area will not appreciably affect terrestrial and aquatic wildlife, due to the fact that within a three-mile radius of the plant, there are more than 1,000 acres of high quality wetlands that will not be affected by site development. As a result of site development, mobile wildlife will migrate to these areas.

Based on an evaluation of available data, development of the Allen Site for the plant is considered practicable from the standpoint of environmental and

socio-economic acceptability, project cost, and implementation time. Although the Allen Site is zoned industrial, the land would probably not be used for any other industrial purpose in the near future since it is owned by MLCW and the TVA holds ash disposal easement rights. Constructing on the Allen Site would utilize vacant industrial land without impacting future industrial, aesthetic, or recreational potential in the Memphis area. Furthermore, use of the site would expedite the use of advanced technology in accord with the current energy plan. Use of the site would also provide community and national benefits that would not otherwise be realized. No other site currently exists within Shelby County which meets the siting constraints imposed on the project. After considering alternatives, DOE has made a preliminary determination that no practicable alternatives to locating at the Allen Site in the floodplain/wetlands is available. The site alternatives, as well as the action alternatives, will be re-examined in detail following completion of the floodplain/wetlands assessment.

The identification and evaluation of alternatives to locating in the floodplain/wetlands discussed above is supported by a document entitled, "Identification and Evaluation of Alternatives to the Location of a Proposed Federal Action in the Floodplain." Copies of this document, which was used in the preparation of the Preliminary Statement of Findings, are available for public inspection at the following locations:

U.S. Department of Energy, Chicago Operations and Regional Office, Project Management Division, 9800 South Cass Avenue, Argonne, Illinois 60439.

Government Document Room, Memphis-Shelby County Public Library, and Information Center, 1850 Peabody Avenue, Memphis, Tennessee 38101. Public Reading Room, FOI, Room GA-152, 1000 Independence Avenue SW., Washington, DC 20585.

#### COMMENTS

All interested parties are invited to submit comments or suggestions in connection with the Preliminary Statement of Findings. Those desiring to submit comments or suggestions should send them to the individual previously listed in this statement.

In conjunction with the development of the Environmental Impact Statement (EIS) for this proposed project, a floodplain/wetlands assessment will be completed which will identify the impacts of locating the project in the

floodplain/wetlands. This assessment will be included in the EIS and will also address measures available to mitigate any adverse effects on the floodplain/wetlands.

In addition to this opportunity to comment on the Preliminary Statement of Findings, interested persons will have an opportunity to comment on the floodplain/wetlands assessment when the draft EIS is published for comment.

Following publication of the floodplain/wetlands assessment and the draft EIS, DOE will consider all comments received on both the Preliminary Statement of Findings and floodplain/wetlands assessment. A Statement of Findings which will be incorporated into the Record of Decision will be published subsequent to the final EIS.

All suggestions, comments, and questions submitted to DOE, with respect to the Preliminary Statement of Findings, will be carefully considered in preparing the EIS.

Dated at Washington, D.C. this 18th day of May, 1980.

For the United States Department of Energy.

John C. Sawhill,  
*Deputy Secretary.*

[EIS Doc. No. 15023 Filed 5-21-80; 8:42am]

BILLING CODE 6480-01-M

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1. The first part of the document is a letter from the President of the United States to the Congress, dated January 1, 1861. It is a very important document, as it sets out the President's views on the state of the Union and the course of action he proposes to take.

2. The second part of the document is a report from the Secretary of the Treasury, dated January 1, 1861. It contains a detailed account of the financial state of the country, and the measures proposed to meet the country's needs.

3. The third part of the document is a report from the Secretary of the Interior, dated January 1, 1861. It contains a detailed account of the state of the public lands, and the measures proposed to manage them.

4. The fourth part of the document is a report from the Secretary of the Navy, dated January 1, 1861. It contains a detailed account of the state of the Navy, and the measures proposed to improve it.

5. The fifth part of the document is a report from the Secretary of the War, dated January 1, 1861. It contains a detailed account of the state of the Army, and the measures proposed to improve it.

6. The sixth part of the document is a report from the Secretary of the State, dated January 1, 1861. It contains a detailed account of the state of the foreign relations of the country, and the measures proposed to improve them.

7. The seventh part of the document is a report from the Secretary of the Education, dated January 1, 1861. It contains a detailed account of the state of the public schools, and the measures proposed to improve them.

8. The eighth part of the document is a report from the Secretary of the Agriculture, dated January 1, 1861. It contains a detailed account of the state of the agriculture of the country, and the measures proposed to improve it.

9. The ninth part of the document is a report from the Secretary of the Commerce, dated January 1, 1861. It contains a detailed account of the state of the commerce of the country, and the measures proposed to improve it.

10. The tenth part of the document is a report from the Secretary of the Coinage, dated January 1, 1861. It contains a detailed account of the state of the coinage of the country, and the measures proposed to improve it.

11. The eleventh part of the document is a report from the Secretary of the Post Office, dated January 1, 1861. It contains a detailed account of the state of the post office of the country, and the measures proposed to improve it.

12. The twelfth part of the document is a report from the Secretary of the Land Office, dated January 1, 1861. It contains a detailed account of the state of the public lands, and the measures proposed to manage them.

13. The thirteenth part of the document is a report from the Secretary of the Indian Affairs, dated January 1, 1861. It contains a detailed account of the state of the Indian population, and the measures proposed to improve their condition.

14. The fourteenth part of the document is a report from the Secretary of the Marine Affairs, dated January 1, 1861. It contains a detailed account of the state of the marine population, and the measures proposed to improve their condition.

15. The fifteenth part of the document is a report from the Secretary of the Fisheries, dated January 1, 1861. It contains a detailed account of the state of the fisheries of the country, and the measures proposed to improve them.

16. The sixteenth part of the document is a report from the Secretary of the Forestry, dated January 1, 1861. It contains a detailed account of the state of the forests of the country, and the measures proposed to improve them.

17. The seventeenth part of the document is a report from the Secretary of the Mining, dated January 1, 1861. It contains a detailed account of the state of the mining industry of the country, and the measures proposed to improve it.

18. The eighteenth part of the document is a report from the Secretary of the Manufactures, dated January 1, 1861. It contains a detailed account of the state of the manufacturing industry of the country, and the measures proposed to improve it.

19. The nineteenth part of the document is a report from the Secretary of the Railroads, dated January 1, 1861. It contains a detailed account of the state of the railroad industry of the country, and the measures proposed to improve it.

20. The twentieth part of the document is a report from the Secretary of the Navigation, dated January 1, 1861. It contains a detailed account of the state of the navigation industry of the country, and the measures proposed to improve it.

21. The twenty-first part of the document is a report from the Secretary of the Steam Navigation, dated January 1, 1861. It contains a detailed account of the state of the steam navigation industry of the country, and the measures proposed to improve it.

22. The twenty-second part of the document is a report from the Secretary of the Marine Engineering, dated January 1, 1861. It contains a detailed account of the state of the marine engineering industry of the country, and the measures proposed to improve it.

23. The twenty-third part of the document is a report from the Secretary of the Marine Machinery, dated January 1, 1861. It contains a detailed account of the state of the marine machinery industry of the country, and the measures proposed to improve it.

24. The twenty-fourth part of the document is a report from the Secretary of the Marine Stores, dated January 1, 1861. It contains a detailed account of the state of the marine stores industry of the country, and the measures proposed to improve it.

25. The twenty-fifth part of the document is a report from the Secretary of the Marine Supplies, dated January 1, 1861. It contains a detailed account of the state of the marine supplies industry of the country, and the measures proposed to improve it.

26. The twenty-sixth part of the document is a report from the Secretary of the Marine Services, dated January 1, 1861. It contains a detailed account of the state of the marine services industry of the country, and the measures proposed to improve it.

27. The twenty-seventh part of the document is a report from the Secretary of the Marine Transport, dated January 1, 1861. It contains a detailed account of the state of the marine transport industry of the country, and the measures proposed to improve it.

28. The twenty-eighth part of the document is a report from the Secretary of the Marine Commerce, dated January 1, 1861. It contains a detailed account of the state of the marine commerce industry of the country, and the measures proposed to improve it.

29. The twenty-ninth part of the document is a report from the Secretary of the Marine Industry, dated January 1, 1861. It contains a detailed account of the state of the marine industry of the country, and the measures proposed to improve it.

30. The thirtieth part of the document is a report from the Secretary of the Marine Affairs, dated January 1, 1861. It contains a detailed account of the state of the marine affairs of the country, and the measures proposed to improve them.



Appendix C.9  
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