additional refining requirements to meet transportation demand as follows (from major requirement to no requirement): (1) SRC II; (2) H-coal and EDS; (3) Fischer-Tropsch; and (4) Methanol and MMG.

## 3.0 WHAT ARE THE IMPORTANT LOCATIONAL FACTORS AFFECTING ENVIRONMENTAL IMPACTS?

The different regions of the country vary greatly in the type of coal resources and in the physiographic and social setting of these resources. These differences can affect both the type and size of commercial synfuels development and affect a range of air, water, land use, and ecological impacts. Within regions, small variations in location can influence both actual and perceived environmental impacts thus, local conditions are important to siting choices for individual plants. In addition, a range of institutional and economic factors affect siting choices and can result in site selections that conflict with environmental values. This section addresses three locational topics:

- Coal characteristics affecting regional location;
- Regional differences in environmental impacts; and
- Local differences in impacts within a region.

## 3.1 COAL CHARACTERISTICS

Several critical characteristics of coal affect where coal liquefaction plants may be deployed, including the size of coal deposits, the composition of coals, and the combustion characteristics. In addition, of course, a range of other environmental resources is required, including adequate land and water resources and a suitable workforce. Where coal liquefaction plants may be deployed and what coal resources may be developed are major concerns because they determine what regions and environments will be impacted by coal liquefaction. This section addresses how coal resources affect the choice and location of coal liquefaction technologies, while the following sections address environmental effects dependent on locational factors.

Liquefaction plants are most likely to be located in proximity to coal deposits (indicated in Figure 3-l). This is because transportation costs for shipping the coal would be substantially greater than the cost of transporting the volumes of liquid products that would be produced from that coal. However, shipping coal long distances (e.g., greater than 300 miles) is possible and would be dependent on the choice of transportation modes available and many siting factors. For example, construction costs for coal liquefaction plants in the Gulf Coast Province are substantially less than in the Northern Great Plains or Interior Provinces (Fluor 1979), reducing capital outlays in Gulf Coast locations. Because of the complexity of factors involved in siting facilities, it is not possible to determine the most favorable coal liquefaction facility location based on a single criterion, such as proximity to coal deposits.

Coal liquefaction processes vary in their suitability to certain coal types. Eastern and Interior bituminous coals are generally more suitable for direct liquefaction processes than western subbituminous coals and lignite. This difference in suitability is

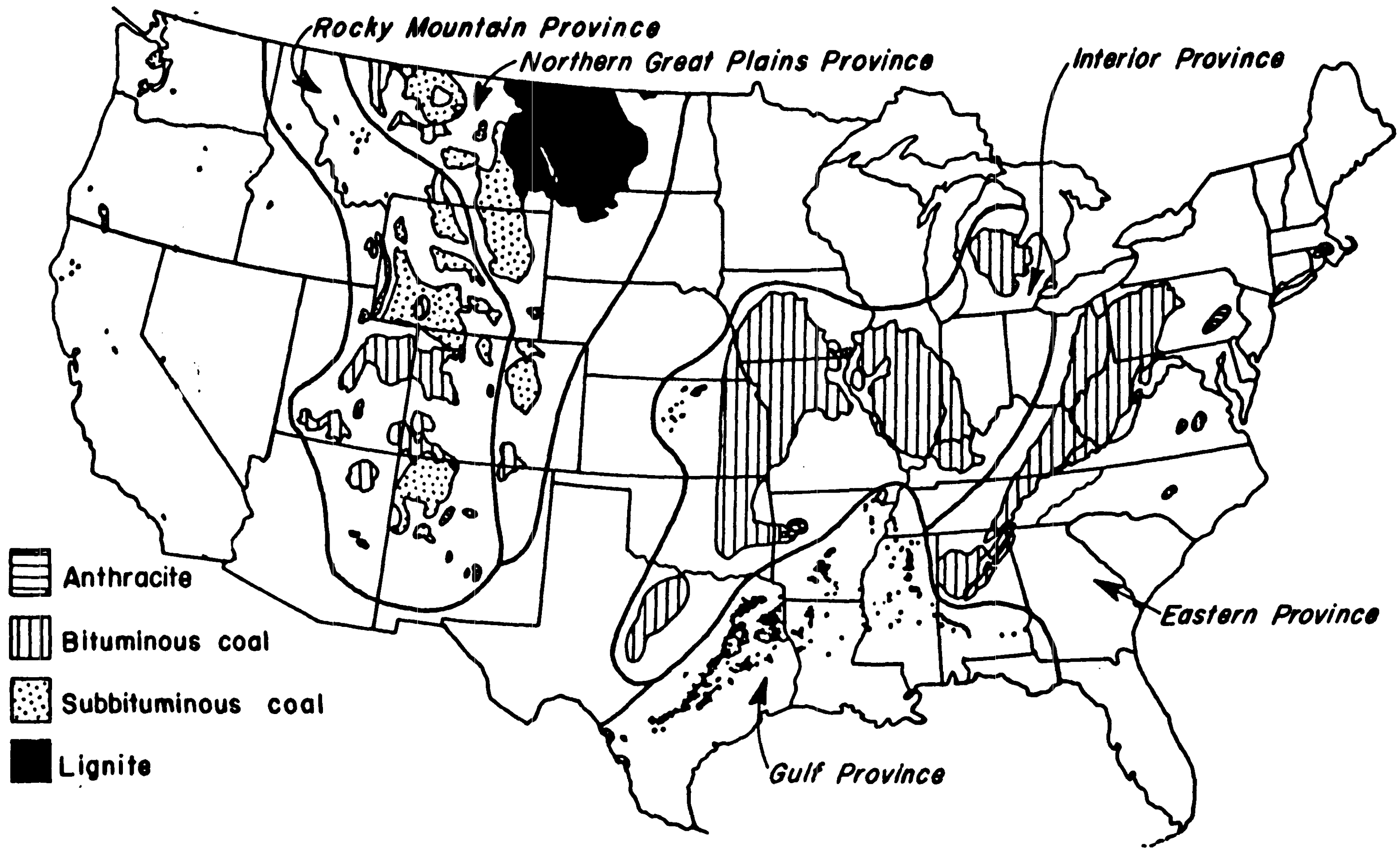


Figure 3-1: Distribution of coal resources in the coterminous -8 states.

Source: Univ. of Okla., S&PP 1975.

generally due to the higher liquids yield from bituminous coals (Epperly, Plumlee and Wade 1980; Fluor 1979). The yield differences for direct liquefaction processes are due to the additional hydrogenation requirements needed for coals with high oxygen content, characteristic of western coals and lignite (Simbeck, Dickenson and Moll 1980). This hydrogenation requirement is represented by the hydrogen distance in Figure 3-2. The higher capital and operational cost for hydrogenation generally offsets the lower cost advantage of lower rank western coals and lignites (Simbeck, Dickenson and Moll 1980; Fluor, 1979). The SRC II process is not suitable for western coals because of their low pyritic iron content. This iron acts as an essential catalyst for the liquefaction reactions in the SRC II process. Currently, direct process plants have been proposed only for eastern locations.

The indirect processes can utilize a wide range of coals. Although, like direct processes, they have higher yields per ton of coal for higher rank coals, they do not directly hydrogenate coal and, thus, do not operate at such an economic disadvantage as the lower cost subbituminous coals and lignites. For these reasons indirect process plants have been proposed for western as well as Interior and Eastern province locations. In addition, some studies indicate that indirect processes may be more favorable in western locations due to the lower coal costs (Simbeck, Dickenson and Moll 1980).

The caking or agglomerating properties of coal at high temperature restrict some gasifier and reactor applications. However,

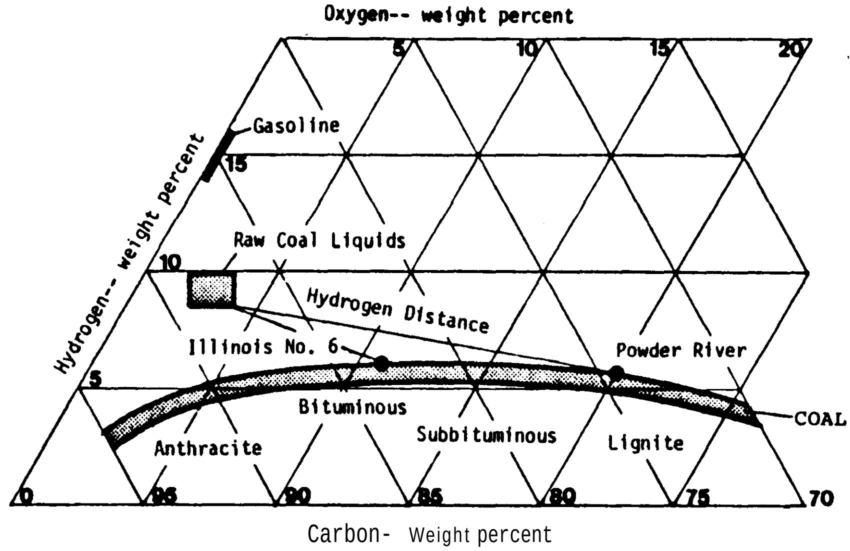


Figure 3-2: Direct coal liquefaction favors bituminous coals due to hydrogen requirements for oxygen.

Source: Adapted from Simbeck, Dickenson and Moll 1980.

recently even Lurgi gasifiers which were susceptible to clogging have been designed to accept caking coals.

In summary, direct processes are more likely to be deployed in Interior and Eastern coal regions than in Rocky Mountain, Northern Great Plains, or Gulf Coast coal provinces. Indirect processes have greater flexibility for utilizing different coals, potentially can be sited in a wide range of U.S. locations, and are perhaps favored in the West if coal costs remain lower there.

## 3.2 REGIONAL DIFFERENCES IN ENVIRONMENTAL IMPACTS

Table 3-1 presents key environmental factors affecting coal liquefaction impacts and describes how these impacts are affected by regional differences in these underlying factors. The thickness of coal seams, for example, results in more land disturbance in the

## TABLE 3-1: REGIONAL CONDITIONS AFFECTING ENVIRONMENTAL IMPACTS

| An EXISTING CONDITION | Determines an INTERMEDIATE EFFECT | Which partially determines an ENVIRONMENTAL IMPACT | REGIONAL IMPLICATIONS |
|---|---|---|---|
| Thickness of the coal seam | The amount of land disturbed | Ecological impacts | Minable coal seam thickness ranges from less than several feet in the Eastern Province to more than 50 feet in the Northern Great Plains. Ecological impacts that are caused by direct land disturbance due to surface mining include preemption of wildlife habitat, recreational areas, and agricultural lands. These will be more serious in the East than in the West. |
| Sulfur content of the coal | Sulfur emissions | Air quality and ecological impacts | Average sulfur content ranges from less than one percent in the Northern Great Plains and Rocky Mountain provinces to more than four percent in the Interior Province. However, the potential for increased SOx emissions in the East is partially offset by the ability to add emission controls to a synthetic fuel facility. Sulfur emissions affect ambient air concentrations of SOx and acid rain formation; acid rain, in turn, reduces species diversity and productivity in terrestrial and aquatic ecosystems. These problems are, therefore, potentially more serious in the East than in the West. |
| Ash content of the coal | Solid waste amounts | Ecological and water quality impacts | Ash content ranges from about seven percent in the Northern Great Plains Province to as much as fifteen percent in the Eastern Province. Thus, the amount of solid waste that requires disposal is greater in the Eastern Province than in the Northern Great Plains. The amount of land required for solid waste disposal increases with ash content as do the ecological impacts caused by that disturbance. To the extent that leaching from the solid waste disposal sites occurs, water quality is affected. |
| Rainfall | Reclamation potential, potential for flooding, potential for seepage. The need to discharge effluents | Ecological and water quality impacts | Rainfall ranges from over 50 inches per year in parts of the Eastern Province to less than seven inches per year in parts of the Rocky Mountain Province. High rainfall is beneficial in the sense that reclamation is made easier and soils are generally better. It can, however, also cause prob ems: floods increase the ike hood of a spi from a waste disposal site; seepage and leaching from waste disposal sites increase with precipitation; and evaporation rates are lower causing water effluents to accumulate if not discharged. Thus, the high rainfall in the East reduces land impacts but increases water quality impacts; the reverse is true in the West. |
| Wind and inversion frequency | Air dispersion potential | Air quality impacts | A combination of wind and temperature conditions generally determines the potential for dispersion of air pollutants. While it varies both seasonally and by location within a coal province, it is generally very good in the Northern Great Plains and Gulf Coast provinces; this ameliorates air quality problems there. |
| Terrain | The potential for plume impaction | Air quality impacts | Rough terrain occurs through the Eastern Province and in parts of the Rocky Mountain Province. Consequently, the probability of plume impaction from synfuel stacks on elevated terrain is greatly increased; such impaction greatly increases ground level concentrations of air pollutants. |

(continued)

TABLE 3-1: Continued

| An EXISTING CONDITION | Determines an INTERMEDIATE EFFECT | Which partially determines an ENVIRONMENTAL IMPACT | REGIONAL IMPLICATIONS |
|---|---|---|---|
| Popu ation dens ty | Wilderness character | Ecological and human health impacts | The low population density of the Great Plains and Rocky Mountain coal provinces affects the ecological sensitivity of the area. Synthetic fuel development will cause an increase in population density in the West. This increase will fragment eco-systems, fragment wildlife habitat, alter the natural appearance of the West's vistas, and in general, change its open-space character. On the other hand, with lower popu-lation density, there are fewer risks of adverse human health effects from coal lique-faction pollution. |
| Existing agricultural lands | Changed land use | Agricultural impacts | Agriculture is sometimes in competit on with energy development for land; the Interior Coal Province s characterized by pr me agricultura land--some of the best in the U.S. While land reclamation following mining in that province is possible, reclamation to existing high fertility levels is questionable. Preemption of agricultural lands by coal mining is also an issue in the Northern Great Plains--not because the land is so fertile but because reclamation is in doubt and agriculture is a way of life there. |
| Existing ecosystems | Reductions or modifications to land and plants | Ecological impacts | Values associated with terrestrial ecosystems include uniqueness, vastness, wildlife habitats (including endangered species habitats), recreation, and productivity. The ecosystems in the West are valued very highly for their wilderness character, vast-ness, and high quality wildlife habitat; in the East they are valued more for their productivity. |
| Existing air quality | | Air quality impacts | In general, air quality is worse in the Interior and Eastern provinces than in the Northern Great Plains or Rocky Mountain provinces; non-attainment with respect to one or more criteria pollutants is more of a problem in the East. The presence of poor a r quality and non-attainment will make synthetic fuel development difficult. In the Rocky Mountain Province, however, the presence of many Class I PSD areas will make synthetic fuel development difficult. |
| Existing water quality | | Water quality impacts | Streams in the Interior and Eastern provinces are, in general, more polluted with or-ganic and inorganic chemicals than those in the Northern Great Plains and Rocky Moun-tain provinces; this could make synthetic fuel develoment in the East more difficult in water quality limited streams, where additional discharges may be restricted. |

East than in the West. The sulfur and ash content of coal also affects the extent of air and solid waste impacts. Meteorological conditions can intensify some air impacts especially in the East where ventilation rates are low and the frequency of inversions is higher. Population density and the composition and character of existing ecosystems are also important. Table 3-2 summarizes how regional sensitivity to impacts from synfuels can vary.

Five ecological issues associated with synthetic fuel development provide a broad framework for examining the regional variations in environmental impacts:

- Degradation of air quality;
- Degradation of water resources, including native stream and riparian ecosystems;
- Degradation of terrestrial ecosystems from mining;
- Degradation of terrestrial and aquatic ecosystems due to acid rain, especially in the East; and
- Degradation of the overall ecological character of some areas.

These problems are not unique to synthetic fuel development, but are generally associated with any intense industrial development. Ecological impacts such as reduction in wildlife populations and changes in plant communities result from the cumulative effects of many disturbances. Coal liquefaction is just one of many industrial and social developments that disturb ecosystems; and, together with increasing industrialization in resource rich areas of the nation, it will contribute to progressive changes in ecosystems.

TABLE 3-2: FACTORS CONTRIBUTING TO REGIONAL ENVIRONMENTAL SENSITIVITY TO SYNTHETIC FUEL DEVELOPMENT
(relativey sensitivity)

| Province | Air Quality | Water Quality | Water Availability | Ecological | Population Impacts |
|---|---|---|---|---|---|
| Eastern | Complex terrain and poor ambient air quality; scenic vistas (high) | Widespread existing pollution sources (high) | High rainfall and streamflow (low) | Valued forest lands (moderate | Varied population density (moderate) |
| Interior | Poor ambient air quality (moderate) | Widespread existing pollution sources (high) | High rainfall and streamflow (low) | Varied land use (low) | Varied population density (low) |
| Gulf Coast | Locally poor air quality in some areas contributes to sensitivity; good ventilation (moderate) | Local existing pollution sources (moderate) | High rainfall and streamflow (low) | Varied land use (low) | Varied population density (low) |
| Rocky Mountain | Complex terrain and several Class I PSD areas; scenic vistas (high) | Limited flow; variable quality (high) | Limited rainfall and stream flow (high) | Valued recreation land (high) | Low population density (high) |
| Northern Great Plains | Good ventilation, good existing quality (low) | Moderate flow, variable quality (low) | Limited rainfall (moderate | Agriculture cropland (moderate | Low population density (moderate) |

## Air Resources

From an air quality perspective, synthetic fuel development will have the greatest impact in the Eastern and Rocky Mountain Coal Provinces. Rugged terrain and existing air quality regulations may make it difficult to site in some air quality control regions in the Eastern Province (Table 3-3). For example, several of the major coal producing areas of Kentucky and Tennessee are currently classified as nonattainment areas. In the West, existing air quality is excellent in the Northern Great Plains and good in most of the Rocky Mountain Region. However, complex topography and the numerous Class I PSD areas could constrain some developments in the Rocky Mountain Province (Univ. of Okla., S&PP 1981).

## Water Resources and Aquatic Ecosystems

Synthetic fuel development will impact stream and riparian ecosystems in several ways:

- Consumption of between 3,500 to 5,900 AFY of water (for a 50,000 bbl/day plant), depending on the location and design;[1]

- Continuous and intermittent discharges of wastewater, which can degrade water quality and amplify stream flow variations;

- Water pollution from synfuel plants due to accidents and floods, and spills from product transport;

- Dissolved solids and sediment loading due to runoff from surface mines; and

- Acid mine drainage from surface and underground mines, especially in the East.

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[1]Although coal liquefaction facilities consume significant quantities of water, on a per-Btu basis they consume 3 to 4 times less water than power plants (see Ballard et al. 1980).

## TABLE 3-3: AIR QUALITY CHARACTERISTICS AND PROBLEMS

| Province | Existing Quality (No. of PSD Class I areas)[a] | Meteorological Pollution Potential (days)[b] | Terrain | Implications |
|---|---|---|---|---|
| Eastern | Numerous nonattainment areas; Some Class I PSD areas (7) | High 30-40 | Rugged (plume impaction | Sensitive to siting in industrial and rural areas |
| Interior | Numerous nonattainment areas; Some Class I PSD areas (5) | High 20-40 | Flat to rolling hills | Sensitive to siting in industrial areas |
| Rocky Mountain | Nonattainment areas in central cities; Numerous Class I PSD areas (46 | Moderate (0-20 potential pollution days) | Very rugged (plume impaction) potential stagnation | Very sensitive to siting; potential limitations to big levels of development |
| Northern Great Plains | Some attainment areas; Some Class I PSD areas (9 | Low (0- 0) | Flat | Fewer air quality limits to development |
| Gulf Coast | Nonattainment areas in central cities; Few Class I PSD areas (1) | Low (o- o | Flat | Limitations to development in some industrial areas |

[a]PSD Class I areas within 300 miles of coal deposits; compiled from Garvey et al. 1978.

[b]Total number of forecast days of high meteorological potential for air pollution (U.S., DOE 1979).

Degradation of floodplain productivity and wildlife habitat as well as aquatic habitat could accrue from these changes. The extent of that degradation, however, will be critically dependent on site-specific conditions. Also, these impacts and issues are highly uncertain and controversial because such changes are difficult to quantify and are usually the cumulative result of many human activities.

As indicated in Tables 3-2 and 3-4, from a water availability perspective, the Eastern Region is more suitable than other regions for synthetic fuel development. Water is more abundant there although conflicts over appropriate use are emerging (Ballard et al. 1980). In the West the lack of precipitation causes water availability problems--most severe in the Colorado River Basin and in parts of the Northern Great Plains Region. From a water quality perspective, however, eastern locations are already receiving a great range of industrial and municipal discharges. In these locations, water quality may be least suitable for receiving discharges from coal liquefaction plants.

## Terrestrial Ecosystems

The large coal requirements for a synfuels industry can lead to substantial land impacts, especially those associated with mining. A midrange estimate for the area of mined lands disturbed for coal liquefaction can be obtained by disaggregating coal supply to eight national coal supply regions and utilizing estimates of land area disturbed by surface mining based on average regional coal deposit characteristics (see Table 3-5). This results in a production

TABLE 3-4: WATER RESOURCES AND AQUATIC ECOSYSTEMS: CHARACTERISTICS AND PROBLEMS

| Province | Ecosystem Types | Existing Primary Stresses | Coal Liquefaction Effects | Implications (primary problems) |
|---|---|---|---|---|
| Eastern | Mid and low altitude lakes; primarily continuous flowing streams and rivers | Eutrophication; acidification; siltation; organic and inorganic pollution | Discharges to receiving stream; water consumption; potential groundwater pollution; spills | Sensitive to incremental organic and inorganic pollution; additional impoundments (water quality) |
| Interior | Low altitude lakes; primarily continuous flow streams | Eutrophication, acidification, siltation | Discharges to receiving streams; water consumption; potential groundwater pollution; spills | Sensit[illegible] to [illegible]l organic [illegible] inorganic [illegible]ution (water [illegible]lity) |
| Rocky Mountain | High altitude lakes; continuous and intermittent stream types | Siltation; some pollution; impoundments | Water consumption; potential ground water pollution; spills | Sensitive to stream flow reduction (water availability and habitat modification) |
| Northern Great Plains | Continuous and intermittent streams | Siltation; eutrophication | Water consumption; potential groundwater pollution; spills | Sensitive to additional biological oxygen demand; local stream flow reduction (water availability) |
| Gulf Coast | Coastal lagoons, marshes; estuaries; broad rivers and flood plains | Drainage; filling; eutrophication | Water consumption; potential groundwater pollution; spills | Sensitive to population growth and habitat modification; pollution (water quality habitat modification) |

TABLE 3-5: ANNUAL PATTERN OF LAND USE FOR COAL SURFACE MINING PROJECTED IN 1985

| Supply Region | Regional P report ion of Total U.S. Surface Mining Production[a] | Proportion of Coal Surface Mined Within Each Region (%) | Surface Area Disturbed (acres per million tons production) |
|---|---|---|---|
| Northern Appalachia | 12 | 47 | 127 |
| Central Appalachia | 13 | 31 | 214 |
| Southern Appalachia | 2 | 57 | 125 |
| Eastern Interior | 16 | 48 | 160 |
| Central and Gulf Coast | 9 | 98 | 107 |
| Northern Great Plains | 40 | 100 | 21 |
| Rocky Mountains | 1 | 38 | 102 |
| Southwest | 7 | 98 | 52 |
| | 100 | | |
| U.S. Average (production weighted ) | | 62 | 98 |

Source: Based on data in U.S., DOE 1979.

[a]Projected total U.S. coal production of 1,080 tpd by 1985; 671 tons are surface mined (U.S., DOE 1979).

weighted U.S. average of 98 acres disturbed per million tons of coal produced by surface mining. Thus, a two million bbl/day syn-fuel industry utilizing 300 million tons of coal a year (with 62 percent surface mined) would disturb about 850 square miles from surface mining over a 30 year period.[1] Note this figure does not

[1]The projected patterns are based On a major use for coal as an industrial and boiler fuel; thus, it may be biased against Interior and Appalachian coal, which is most suitable for direct processes ( see Section 3.1) . A shift to using greater proportions of Appala-chian and Interior coals would favor underground mining and might reduce the extent of surface disturbance. This reduction would be counterbalanced to some extent by larger areas disturbed per ton of coal supplied from surface mines in the Interior and Appalachian regions (Table 3-5).

include surface disturbances from underground mining, such as coal cleaning areas, storage or subsidence effects.

In addition to mining, terrestrial ecosystems are modified by transportation, processing facilities, solid waste disposal, and by urban growth associated with increased industrialization. Impacts from coal liquefaction activities are related to the degree that modifications to terrestrial environments can be assimilated or "absorbed" by the ecosystem. In areas with rich soils and moderate-to-high rainfall such as the Gulf Coast, Interior, and Eastern provinces, regrowth of vegetation occurs comparatively rapidly following a disturbance such as surface mining. However, some characteristics of the Eastern Province such as complex topography, make restoration of environmental features difficult and contribute to reclamation problems. Table 3-6 identifies some general characteristics of terrestrial ecosystems in the major coal producing regions where coal liquefaction may occur.

Based on the existing patterns of communities and stresses, the Gulf Coast terrestrial ecosystems appear able to absorb mining impacts substantially, and regrowth of dominant plant species is quite rapid. In the Eastern sections of the Gulf Coast Lignite Province, for example, forest areas act as an additional buffer, providing capacity for significant local and regional development.

In contrast, the arid and semiarid regions of the Rocky Mountains have a slower regrowth, and animal species are less buffered by dense forest stands in many areas. Thus, Rocky Mountain

TABLE 3-6: TERRESTRIAL ECOSYSTEMS: CHARACTERISTICS AND PROBLEMS

| Province | Ecosystem Types | Existing Primary Stresses | Coal Liquefaction Effects | Implications (problem importance) |
|---|---|---|---|---|
| Eastern | Pine forest; maple, oak, hickory forests; agricultural lands | Urban growth, mining | Increased mining; industrial growth; localized deforestation | Numerous stresses; ecosystems somewhat resilient (ecosystems can absorb some coal liquefaction development) |
| Interior | Oak-hickory forest; grasslands; agricultural lands; pine forests | Urban growth; mining; agriculture | Increased mining; industrial growth; localized grassland and crop removal | |
| Rocky Mountain | Subalpine forest; ponderosa pine forest; sagebrush grassland | Urban growth; mining; recreational activities; and local land conversion | Increased mining; industrial growth locally near required transportation corridors; local deforestation | Numerous stresses; some ecosystems relatively fragile (ecosystem can absorb relatively little development |
| Northern Great Plains | Grassland; cropland; riparian deciduous trees; pine forests | Agricultural development | Increased mining; industrial growth | Comparatively few stresses, ecosystems resilient (ecosystem can absorb substantial development) |
| Gulf Coast | Grassland; cropland; pine forests | Urban growth; agriculture; industrial development | Increased mining; industrial growth | Numerous stresses but ecosystems resilient (ecosystems can absorb substantial development) |

terrestrial ecosystems are more sensitive to direct disturbances than Gulf Coast or Eastern ecosystems.

Linkage Between Air, Water, and Land Resources: Acid Rain

Synthetic fuel facilities produce $NO_x$ and $SO_x$, and these pollutants in combination with moisture in the air form nitric acid and sulfuric acid--acid rain. Particles containing sulfate, nitrate, and chlorides can also settle from the air without atmospheric moisture. These particles can then acidify soils, streams, and lakes. Although acid rain has been a problem associated primarily with the Northeast, it is now spreading to the Southeast and perhaps even to the West. In all these regions, 10 to 50 percent of the acid deposition may be dry (Kerr 1981). The possible damage in reduced productivity and loss of species over the long term is highly uncertain with present knowledge, but may be very significant (U.S., EPA, ORD 1980). Multiple coal liquefaction plants could contribute to a significant proportion of the $NO_x$ and $SO_x$ emissions as measured against 1975 levels of emission (Table 3-7).

Even in regions where existing air pollution levels are low, such as the Rocky Mountains and Northern Great Plains, localized acidification has been measured. Although both the levels of development and potential impact in western regions are uncertain, possible elevated levels of sulfur and nitrogen oxides (as illustrated in Table 3-7) raise concerns in the Rocky Mountain and Northern Great Plains Region because of plant species known to be sensitive to acidification, including pines and wheat (U.S., EPA, ORD 1980; White *et al*. 1979). Thus, acid rain and dry deposition

TABLE 3-7: EXAMPLES OF POTENTIAL CONTRIBUTORS TO ACID RAIN (thousands of tpy)

| | A Local Case<br>260,000 bbl/day in Henderson Co. Kentucky[a] | | A Regional Case<br>One million bbl/day Liquefaction in Montana, North Dakota, and Wyoming | |
|---|---|---|---|---|
| Conditions | $SO_2$ | $NO_x$ | $SO_2$ | $NO_x$ |
| *1975-1976* Emission Level | 266 | 57 | 1,123 | 339 |
| Synfuel Plants[b] | 50 | 74 | 110 | 110 |
| Percent Increase | 23% | 130% | 10% | *32%* |

[a] See Enoch 1980.

[b] Note range of emissions among regions reflects different coal composition and technology combinations.

stemming, in part, from synthetic fuels development are likely to remain an ecological issue and to increase in importance as an agricultural issue.

Overall Ecological Characteristics

Finally, there are unique and special values associated with the wilderness character of some areas--particularly the Rocky Mountain region--which could be changed by large scale synfuels development. A desire to preserve the "Big Sky Country" and the "wide open spaces" is expressed by citizens across the U.S. Coal mines, liquefaction plants, and other energy facilities, along with the added population increases would:

- Change local land use patterns;
- Degrade air quality, including visibility;

- Increase water consumption;
- Lower water quality; and
- Increase pressures for recreational space (White et al. 1979).

In combination, these modifications would alter the unique and special features of some western locations.

Incrementally, changes brought about by development are small; for example, the amount of land used by direct development of mines and liquefaction facilities would in most cases be between 0.05 and 1.0 percent of the land area of any one county with coal resources under projected ranges of potential development (White et al. 1979). Thus, in many cases, changes are more likely to be perceived impacts than measured ones. Exceptions to this may occur where facilities would be concentrated around the major coal development communities such as Gillette, Wyoming, and Farmington, New Mexico.

The broader ecological issue is not that ambient air concentrations will exceed standards, that water will become polluted, or that coal mines will preempt ranchland; rather, the issue is multifaceted and based on values and perceptions stemming from the combination of changes brought about by industrial and urban development in any area.

Many western areas are viewed as the only pristine areas left, and coal development will locally change that. The potential for that change in social and ecological character is a major source of conflict.

## 3.3 LOCAL FACTORS AFFECTING ENVIRONMENTAL IMPACTS

Within regions, several site-specific factors can influence the kind and extent of environmental impacts. Table 3-8 identifies several factors affecting air, water, solid waste, ecological, and public perception impacts. For example, locating a plant in an elevated area can reduce local air quality problems because the pollutants will be dispersed over a wider area and diminish plume impaction on terrain. Avoiding areas of critical habitat and flood plains can help to reduce ecological problems and the chances for water pollution. Thus, locational differences of just a few miles may be very important in preserving environmental values.

TABLE 3-8: LOCAL FACTORS AFFECTING ENVIRONMENTAL IMPACTS

| Environmental Impact Category | Locational Factors |
|---|---|
| Air Quality | Dispersion potential<br>Proximity to nonattainment area<br>Proximity to PSD Class I area<br>Elevated terrain |
| Water Quality | Proximity to flood plain<br>Proximity to water-quality limited streams<br>Aquifer characteristics |
| Solid Waste | Proximity to flood plain<br>Presence of porous soils (sand, sandstone, loam) |
| Ecology | Presence of critical habitat for endangered species<br>Presence of wildlife refuges<br>Presence of breeding habitat<br>Wetlands and riparian habitat |
| Perception | Proximity to towns and cities<br>Proximity to archaeological sites<br>Public perceptions of development |

An increasingly important factor in industrial development is public reaction to a facility. For example, the visibility of a facility and the plume from its stacks are often regarded as negative aesthetic and environmental impacts. This apparently is the case for the Morgantown SRC-II demonstration plant, which would be easily seen from the University of West Virginia campus. Many residents of Morgantown consider the high visibility of the plant and fear of adverse impacts as changing the character of the area from a small university town to an industrial city (see also Section 4.3). An alternative location just a few miles away could have avoided this problem.

Table 3-9 indicates the proximity to population centers of five coal liquefaction demonstration or commercial facilities at an advanced planning stage. Three of the facilities are within 4 miles of towns with populations of 20,000 or more. The other two facilities, although located near small towns, are 10 to 25 miles from larger population centers.

Although these local factors can be very important to the environment, they are usually less important to developers than economic factors. Table 3-10 identifies the initial criteria used by developers to select sites for two demonstration plants. As indicated, important economic factors affecting plant location are:

- Proximity to the coal resource;
- Proximity to transportation systems (for example, navigable rivers);
- Availability of water supply and receiving water for discharges; and

## TABLE 3-9: SURVEY OF SITES SELECTED FOR COAL LIQUEFACTION PROJECTS AT ADVANCED STAGE[a]

| Plant Description | Status | Location | Distance to Nearest City of 20,000 or more (miles) | Families Displaced at Site | Distance to Nearest Town (population size) |
|---|---|---|---|---|---|
| SRC-I Demonstration 6000 tpd | Draft EIS filed | Newman, Davies Co., Kentucky | Owensboro (10) | 24 | 0.0 to 0.6 miles to Newman (400)[b] |
| SRC-II Demonstration | Final EIS filed | Ft. Martin, West Virginia | Morgantown (4) | 10[c] | 4 miles to Morgantown (71,000) |
| W.R. Grace Mobil Methanol-to-Gasoline 28,900 | Preliminary design | Baskett, Kentucky | Henderson (3) | NA | 1 mile to Baskett (25O)* |
| Tri-State Synthetic Fuels Project 30,668 tpd Lurgi-Fischer-Tropsch | Preliminary design | Henderson, Henderson Co., Kentucky | Henderson (3) | NA | 3 miles to Henderson (23,000) |
| H-coal 23,000 tpd | Preliminary design | Breckinridge Co., Kentucky | Owensboro (25) | NA | 6 miles to Cloverport (1,208) |

NA = not available

*Kentucky Dept. of Commerce.

[a]Advanced stage indicates that permitting, or environmental impact statement process, or site acquisition has been initiated.

[b]When expanded t. commercial size, plant border would be across the railroad tracks from downtown Newman.

[c]Estimated from number of residences within site boundaries.

TABLE 3-10: INITIAL SITE REQUIREMENTS SPECIFIED FOR COAL LIQUEFACTION DEMONSTRATION PLANTS

| Requirement | SRC I Demonstration Plant | SRC II Demonstration Plant |
|---|---|---|
| Coal Supply | Not specified | "Large reserves close" |
| Transportation | Navigable river; rail contiguous or nearby | Rail, highway, and barge access |
| Land (acres) | 800 to 1,000 "suitable shape" and topography | 1,300 |
| Water (gallons per minute) | 16,000 | 15,000 to 80,000[a] |
| Services | Not specified | Labor market adequate |
| Other | Ash disposal site (at least half of the site above 100 yr. flood elevation) | 40 megawatts electricity supply |

Source: Compiled from U.S., DOE 1981a, 1981b.

[a]Range reflects choices of consumptive use for closed cooling ( 15, 000) or once-through cooling (80, 000) .

. Proximity to adequate housing and public services for workforces and their families.

The importance of water and access to transportation corridors is indicated by the fact that all five proposed demonstration and commercial scale liquefaction plants (i.e., the five identified in Table 3-9) have been sited adjacent to navigable rivers. However, this also means that most coal liquefaction plants are sited partially or entirely on wetlands and floodplains. This can result in damage to wetlands habitat, water pollution from flooding, and failure to consider elevated terrain locations.

In an attempt to determine the most important considerations for siting a facility to convert coal to synthetic fuel, the Oak Ridge National Laboratory (Berry et al. 1978) used a panel of experts to generate a set of siting criteria (Table 3-11). The proximity of required raw resources (high-sulfur coal and water) and air quality were considered most important. The priority concern for air quality was to site conversion plants in areas not designated by the EPA as Air Quality Maintenance Areas--regions in which future air-quality degradation will be carefully monitored by regulatory agencies.

A number of siting analyses have been conducted which, together, have taken into consideration a wide variety of factors--resource availability, environmental impacts, production capabilities, availability of transportation, institutional and legal barriers, and prior commitment of the resources. Three studies (by the U.S. Geological Survey, the Bureau of Mines, and SRI International) used somewhat different criteria but identified 120 counties in common as potentially suitable for siting coal gasification and indirect liquefaction facilities (Hagler, Bailly 1980). In the Southern U.S., for example, eight Kentucky counties (Henderson, Hopkins, McLean, Muhlenberg, Ohio, Pike, Union, and Webster) and two New Mexico counties (McKinley and San Juan) were included. In addition, an ORNL analysis of the southeastern region of the U.S.

TABLE 3-11: SITING CRITERIA FOR A COAL CONVERSION FACILITY

| Variable (order of relative Importance) | Category or Value | Compatability[a] Index |
|---|---|---|
| Water availability | Adjacent to stream with 7-day/10-year low flow >194 Mgd | 10 |
| | Adjacent to stream which could have 7-day/10-year low flow >194 Mgd if additional regulation were imposed | 4 |
| | Adjacent to Great Lakes | 8 |
| | Adjacent to Atlantic Ocean or Gulf of Mexico | |
| AQMA | Not an AQMA | 10 |
| | Partially an AQMA | 5 |
| | Entirely an AQMA | |
| Accessibility of high-sulfur coal (>1.9% S) | Values represent calculations from gravity model using tonnage of high-sulfur coal | |
| | Highest value | 10 |
| | Lowest value | 1 |
| | >100 miles from high-sulfur coal reserve | |
| Barge accessibility | Adjacent to channel of >9 ft. depth | b |
| Seismic activity | Activity level I (lowest risk) | 10 |
| | Activity level II | 5 |
| | Activity level III (highest risk) | 0 |
| Rail accessibility | Adjacent to medium- or heavy-duty railroad | 10 |
| | Not adjacent to medium- or heavy-duty railroad | 0 |
| Accessibility of low-sulfur coal (<1.9% S) | Values represent calculations from gravity model using tonnage of low-sulfur coal | |
| | Highest value | 10 |
| | Lowest value | 1 |
| | >100 miles from low-sulfur coal reserve | 6 |
| Population density | 90-100% of county has >500 inhabitants per square mile | 0 |
| | 80-90% | 2 |
| | 70-80% | 3 |
| | 60-70% | 4 |
| | 50-60% | 5 |
| | 40-50% | 6 |
| | 30-40% | 7 |
| | 20-30% | 8 |
| | 10-20% | 9 |
| | 0-10% | 10-9 |

Mgd = thousand gallons per day AQMA = Air Quality Maintenance Area

= excluded from consideration as potential candidate counties

Source: Berry et al. 1978, p. B-23.

[a]10 = compatible; O = least compatible;

[b]Score equals number of miles of channel (maximum is 94.6)