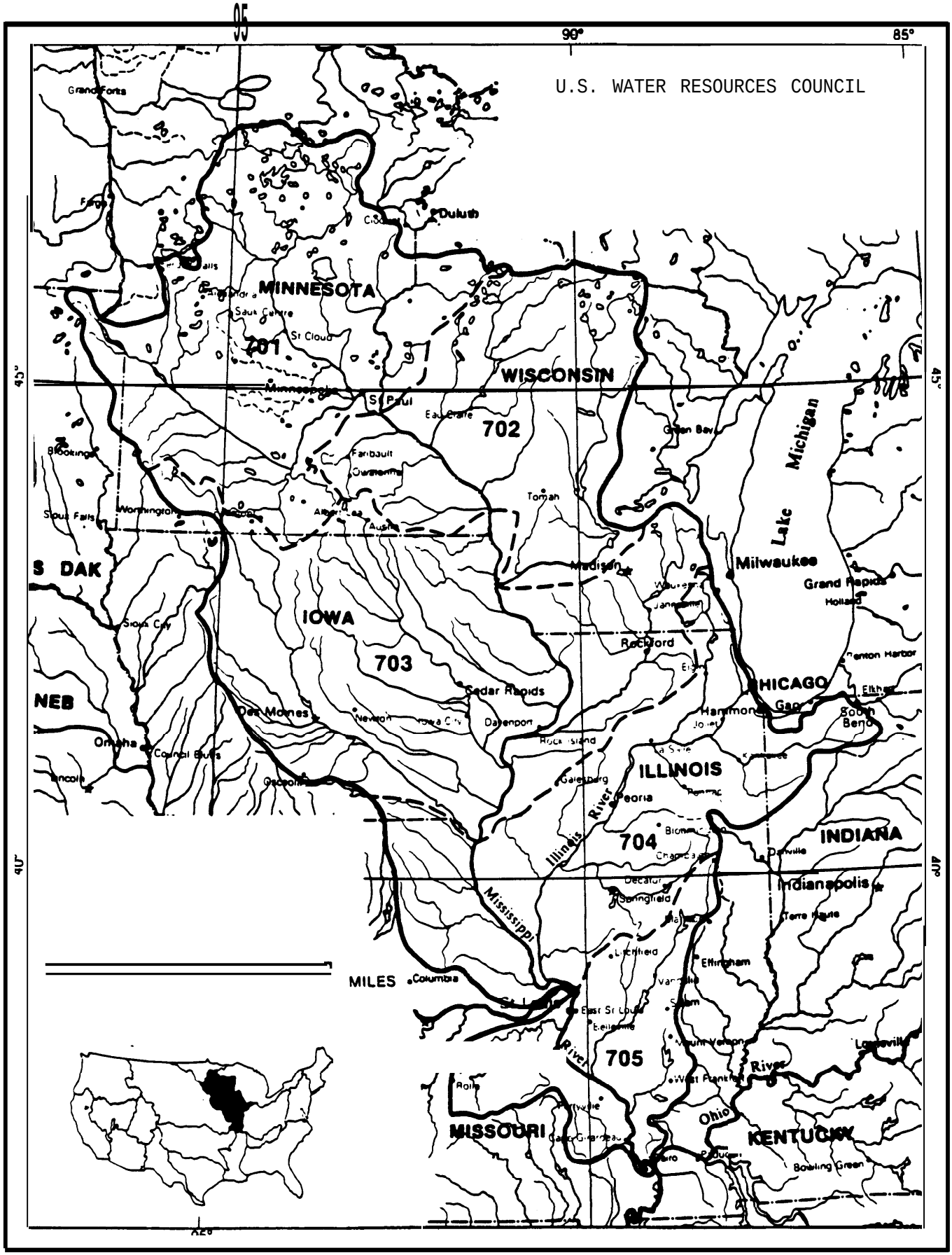
SECTION II
UPPER MISSISSIPPI RIVER BASIN

BACKGROUND

The Upper Mississippi River Basin is that portion of the Mississippi River upstream from the confluence of the Ohio and Mississippi Rivers at Cairo, Illinois and encompasses more than 115 million acres. The Upper Mississippi River Basin includes portions of the states of Minnesota, Wisconsin, Iowa, Illinois and Missouri. (See Figure 1.) Many rivers flow through the region in a generally north-south direction, and the Mississippi River bisects the area. The Upper Mississippi is a key element in the nation's inland waterway system. Large amounts of groundwater are stored within much of the region and the regional gross water supply is excellent (U.S. Water Resources Council, "The Nation's Water Resources," Volume 2, p. V-43). For a summary of hydrology in the Upper Mississippi Basin, see: U.S. Water Resources Council, "The Nation's Water Resources," Volume 2, Part V and Vol. 3, Appendix II.

Illinois is the only state in the Upper Mississippi River Basin with significant coal reserves: Illinois has 15.1 percent by tonnage of total demonstrated coal reserves in the United States or 16.6 percent of demonstrated coal reserves in the United States on the basis of heat value. Montana is the only state exceeding the reserves in Illinois. In comparison, no other state in the Upper Mississippi River Basin has more than 1 to 2 percent of demonstrated coal reserves in the United States.

Because of the concentration of coal reserves in Illinois, competition for water for synfuel development is expected to be significantly greater in Illinois than in other areas of the Upper Mississippi River Basin. Consequently, the assessment herein concentrates on availability of water for synfuel development in Illinois. This assessment is structured around review and analysis of available reports and information on water availability in Illinois. The discussion and conclusions resulting from this review and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analysis, however, extend beyond the reports reviewed and are generally applicable to those areas in the entire basin where demand for synfuel water supply exists, or will exist. Conclusions concerning deficiencies in analysis and forecasting procedures, deficiencies in quality and quantity of data, obstacles resulting from riparian water law, lack of economic and cost data, and statistical bias in streamflow data can be extrapolated to other states and areas in the Upper Mississippi River Basin outside of Illinois.

Reports reviewed were:

1. Smith, William H., and John B. Stall, "Coal and Water Resources for Coal Conversion in Illinois," Cooperative Resources Report for Illinois State Water Survey and Illinois State Geological Survey, Urbana, Illinois 1975.

2. Brill, E. Downey Jr., Glen E. Stout, Robert W. Fuessle, Randolph M. Lyon, and Keith E. Wojnarowski, "Issues Related to Water Allocation in the Lower Ohio River Basin," Volume III-G, Special Study Report, Ohio River Basin Energy Study, Phase I, May 15, 1977, University of Illinois at Urbana-Chanpaign.

3. Brill, E. Downey Jr., Shou-Yuh, Chang, Robert W. Fuessle, Robert M. Lyon, "Potential Water Quantity and Water Quality Impacts of Power Plant Development Scenarios of Major Rivers in the Ohio Basin," Ohio River Basin Energy Study, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, November, 1980.

4. Illinois Bureau of the Office of Planning, "The Availability and Resource Cost of Water for Coal Conversion," Springfield, Illinois, May, 1979.

5. Relevant Sections of U.S. Water Resource Council% Second National Assessment of the Nation's Water Resources.

The two reports from the Ohio River Basin Energy Study are relevant to the Upper Mississippi Basin since these reports cover rivers throughout the entire state of Illinois and are not limited to just the Ohio River Basin portion of the state.

Institutions in Basin

Major institutions involved with the availability of water for synfuel development in Illinois are: (1) the U.S. Congress, (2) the U.S. Army Corps of Engineers, (3) the U.S. Geological Survey, (4) the Illinois State Legislature and the Governor of Illinois, (5) various state agencies including the Illinois E.P.A., Illinois Dept. of Conservation, Illinois Department of Transportation, Division of Water Resources, Illinois Water Survey, and (6) various local governments including county and city governments and local drainage and levee districts. Other states in the Upper Mississippi River Basin have a very similar group of institutions affecting water availability for synfuel development.

Organization of Section

The analysis of these reports is woven into the discussion in this chapter regarding physical availability of supplies and institutional, legal and economic constraints.

PHYSICAL AVAILABILITY

Illinois receives more than 30-45 inches of precipitation in the average year and has relatively abundant water resources. Total runoff to streams in Illinois exclusive of the Mississippi River is approximately 26 million acre-feet per year and with the Mississippi about 59 million acre-feet per year (Smith and Stall, 1975). (In comparison, the Colorado River has a Mean annual "estimated flow of 13.8 - 15.0 million acre-feet per year.)

The three major reports reviewed for this study were the Smith and Stall analysis and the two studies by Brill, et al. Comparison of these three reports produces some interesting contrasts in study method. The Illinois Bureau of the Budget document is very general and wide-ranging. Despite its

title, it provides limited information on water availability in Illinois which is of practical use in assessing water availability. Consequently, a detailed review is not included herein.

Smith and Stall did not attempt to project future consumptive use by municipalities, industry, and agriculture, nor did they base their analysis on future scenarios of energy development. They basically took a "snapshot" picture of water availability at the present time for coal conversion in Illinois and looked at the potential for development of additional water resources using reservoir storage and groundwater. By not presenting estimates of future depletions due to municipal, industrial, agricultural and other demands, the Smith and Stall report avoids many uncertainties associated with making future demand projections for these sectors. This, however, leaves the report reader to his or her own devices for estimating future depletions. This method avoids the various problems inherent in predicting future consumptive use and assuming various scenarios for energy development. Smith and Stall analyzed low flow data for Illinois rivers based on the one day, 50-year low flow. The one day, 50-year low flow statistic is an estimate of an extremely infrequent event. The question of whether this is a "correct" or desirable statistic for decisioninaking purposes involving water supply is a complex question beyond the scope of this investigation. On the basis of these flow statistics, they demonstrate that a number of streams and rivers in the state have more than adequate flow at present, without additional storage, to support a synfuel or coal conversion industry.

For example, the Mississippi River on the western edge of Illinois was estimated to have a one-day, 50-year minimum low flow of 6,500 million gallons per day, an amount 100 to 1000 times greater than the consumptive use of a coal conversion plant. Along the southwestern part of Illinois, estimated one-day, 50-year minimum flows in the Mississippi River are between 20,000 and 23,000 mgd. Even on the smaller rivers in Illinois, the flow is adequate for a significant coal conversion industry. One-day, 50-year low flows for the Rock River in northern Illinois range from 60 mgd near the

Wisconsin state line to 500 mgd where the Rock River meets the Mississippi River. Even this relatively low flow of 60 mgd could easily supply several unit-sized synfuel plants (assuming 7500 acre-feet per year or about 6.7 mgd consumptive use for a unit-sized synfuel plant).

In addition, Smith and Stall present accurate and up-to-date information and data on groundwater which indicate that in 17 locations in Illinois a system of wells could be constructed to provide water supply of at least 14 million gallons per day. Detailed information on potential reservoir sites is referenced in the Smith and Stall report which indicates 228 potential reservoir sites with a yield of greater than 6 million gallons per day.

Water supply for synfuel development could be available from existing federal reservoirs (Shelbyville and Caryle Reservoirs in southern Illinois) for synfuel development. These reservoirs together could provide more than 40 million gallons per day for coal conversion.

Brill, et al. (1980), take a somewhat different-approach to forecasting water availability for synfuel development:

(1) Based on forecasts of consumptive use by municipalities and industry for the years 1975, 1985 and 2000, they estimate water availability from Illinois rivers for energy development. This approach does not require forecasting the number of synfuel plants for various river basins in Illinois.

(2) In addition, they employ several energy development scenarios to forecast future water availability for all uses in major Illinois river basins.

In preparing their estimates of future water use, Brill, et al, (1980) are quite candid concerning the problems inherent in their forecasts:

> 'Water use is difficult to measure and even more difficult to project since projections depend on population, income, relative prices, and technological developments. Thus the

> figures presented here should be interpreted cautiously and are more likely to represent orders of magnitude than specific values. This is especially true, of course, for the longer range projections." (P III-G-57).

In implementing their first approach, Brill, et al (1980) estimate the number of power plants or coal conversion facilities which could be sited along the region's rivers without total municipal, industrial and power water consumption exceeding certain consumption limits (e.g. 5-10 percent of the 7-day, 10-year low flows.) This approach is somewhat similar to that used by Illinois Water Survey in that it does not require the assumption of specific scenarios concerning future energy development but differs in that forecasts of future consumptive use by municipalities and industry are required. This approach indicates the potential cumulative impact of potential synfuel development on specific river reaches, but it does not hypothesize various synfuel development scenarios In their second approach, Brill, et al. (1980) developed various scenarios for siting coal fired power plants (these could easily be coal conversion plants as well) throughout the State of Illinois. This method also permits forecasting cumulative impacts of energy development on the area's water resources but does have the disadvantage of overlaying the uncertainties of future energy development on the uncertainties of future municipal, industrial and agricultural consumptive use.

An interesting problem exists with the use of the 7-day, 10-year minimum low flows in that values for this statistical parameter are based on the historical record without attempting to correct for increased future depletions. If the 7-day, 10-year low flow of record occurred sometime in the distant past, the actual magnitude of a flow with this frequency will undoubtedly be less in the future because consumptive use will increase on most rivers and streams and will continue to increase in the future. This failure to correct the historical record for increased depletions in the recent past will bias frequency estimates of low- flows by underestimating the frequencies of low flow in the future. This failure to convert the historical record for increased depletions in the recent past will bias frequency

estimates of low flows by underestimating the frequencies of low flows in the future. This apparent use of the 7-day, 10-year minimum low flow based on historical data, without attempting to correct the historical record for increased future consumptive use, appears to be characteristic of not only the reports reviewed for the Upper Mississippi River Basin but also for the Ohio/Tennessee River Basins. This failure to correct the historical record for increased diversions and consumptive loss in recent years before estimating the 7-day, 10-year minimum stream flows is apparently characteristic of eastern basins. In the western states, complex and tedious calculations incorporating many assumptions are used to transform the historical record into an estimate of "virgin flows," i.e., the estimated flow without any pumpage or diversions.

The Brill, et al. reports clearly specify the difficulties in estimating future consumptive use and developing scenarios for energy development. For example, a major problem in forecasting future consumptive use is that multiple sources of potential water supply exist in Illinois (as they do in many other areas). Consequently, assumptions must be made concerning whether future consumptive use will result from groundwater, direct diversions of surface water, or storage. Brill, et al, assume that the ratio of surface water to groundwater use for each county would be continued in the future. This is an example of the type of operational assumptions that must be made in order to assess availability of water for synfuel development, the importance of which may be ignored or misunderstood by decision-makers. It is difficult to say whether this assumption is adequate or not for general application. In northeast Illinois, this ratio will not remain constant in the future because communities and industry are changing to surface water supplies from groundwater because of the declining water levels in deep aquifers. Brill, et al.further assumed that groundwater withdrawal would not affect low flows; while incorrect hydrologically, this operational assumption may be acceptable for assessing water availability depending on local conditions. For example, in the 1980 Brill report (p.6-9), the demands of the Clinton Nuclear Power Plant in the Sangamon River Basin in

central Illinois have not been included in overall consumptive use estimates for this basin since it is assumed that the plant will use stored water and would not affect minimum low flow on the Sangamon River, a major tributary of the Illinois River. In other words, a major power plant (approximately 600 megawatts) is assumed not to have any consumptive use depletions on the Sangamon River. The point of this example is not whether this assumption is correct or not, but rather to demonstrate that there are many options involved for determining future consumptive use demands on a river. Consequently, estimates of future water availability for power plant cooling or synfuel development could vary significantly depending on whether these plants are assumed to use surface water, stored water, or groundwater.

INSTITUTIONAL/LEGAL, ECONOMIC ASPECTS OF WATER AVAILABILITY

The institutional aspects of water availability for synfuel development in the Illinois portion of the Upper Mississippi River Basin are less complex than comparable institutional aspects in the western United States. This is also true for other states in the basin. For all practical purposes, there is no regulatory groundwater law in the State of Illinois. Surface water use and development is governed by riparian law, a less complex set of laws than exists in the western United States. There are no irrigation districts, water conservancy districts or similar entities in Illinois. There is only one state agency in Illinois charged with operational management and regulation of water quality. This is characteristic of other states in the basin. Fewer governmental entities are involved with water resources management, development and regulation than in the western United States. With the exception of a U.S. Supreme Court decree concerning diversion of Lake Michigan water, no interstate compacts exist in Illinois. There are no Federal or Indian reserved rights affecting water availability.

As a result, the reports reviewed for the Upper Mississippi River Basin are only minimally concerned with legal or institutional constraints to water availability for coal conversion or synfuel development.

The “laissez-faire” aspects of riparian based water law, however, do present constraints to water availability for synfuel development. For example, the State of Illinois owns a portion of the water supply storage in Shelbyville and Carlyle Reservoirs in southern Illinois. Both of these reservoirs are Corps of Engineers’ projects. The State of Illinois has sought to sell this water for several years, thereby reducing its repayment responsibility to the Federal government. Energy companies have approached the State, but sales have not been made because of uncertainties with regard to delivery of the water. The most efficient scheme would be simply to release water from Carlyle and Shelbyville reservoirs and allow this water to flow down the Kaskaskia River to a convenient point for diversion to a synfuel or coal conversion plant. However, under existing Illinois riparian law, this water could be pumped from the river by any riparian land owner downstream from the reservoirs. Consequently, in order to insure delivery of this water, the energy companies would be faced with building an expensive pipeline for conveyance of the water directly from the reservoirs to the plant site. This conveyance problem, while having a direct engineering solution, poses an economic and legal obstacle to use of water stored in the Federal reservoirs for coal conversion purposes.

The lack of existing groundwater law also provides a constraint to water availability since development of a groundwater supply has very limited protection against over-pumping by adjacent wells under existing Illinois law.

The Smith and Stall report has especially good economic data on the costs of reservoir and groundwater development. This information and data is presented as a series of cost functions for development of various sources of water supply. While they must be used with caution, these cost functions should be very useful for programmatic analysis as well as initial screening of specific sites. In general, however, economic data on the cost of water for synfuel development, or any other use, is not available, except for site specific conditions or individual projects. There are no water rights to purchase so the cost of water is totally dependent on the cost of the

riparian land and the costs of water control and conveyance facilities--all of which are site specific.

CONCLUSIONS

From a regional perspective water supplies for synfuel development in the Upper Mississippi River Basin are adequate. Localized problems, however, may result depending on the specific site for a synfuel plant. Water supply shortages and negative impacts on water resources are most likely to occur for synfuel sites on tributaries. These shortages and negative impacts can be eliminated or reduced by construction of reservoir storage on tributaries, conductive use of ground and surface water or other measures to reduce diversions from unregulated streams during low flow periods.

In general, there is relatively little available information and few reports on water availability for synfuel development in the Upper Mississippi Basin in comparison to that available for western basins where significantly more competition exists for water. The reports and information analyzed herein focus on Illinois since this is the area in the Upper Mississippi River Basin where synfuel development will most likely occur, and consequently the greatest demand for water for synfuel development. The results of the analysis are, however, generally applicable to other areas of the Upper Mississippi River Basin where synfuel development might occur because of the similarity in hydrology, water law and institutions, for all states in the basin.

The Smith and Stall report does a good job of presenting estimates of current water availability for coal conversion “or synfuel activities in Illinois. Since it does not forecast future consumptive use, it is of limited use for predicting future water availability. However, by limiting itself to present availability, it also avoids all of the significant uncertainties present in forecasting future consumptive use by the municipal, agricultural, and industrial sectors. In general, the Smith and Stall report should be of use to a number of decisionmakers and in a number of

decisionmaking situations. It bridges the gap between the site specific and programmatic decision.

In comparison, the Brill, et al.reports present forecasts of water availability until the year 2000 and candidly indicate the difficulties and uncertainties in providing these forecasts. The portion of the Brill, et al. reports that do not depend on future energy development scenarios are probably more useful for site specific and programmatic decision-making than when the additional uncertainty of an energy development scenario is overlaid on the water availability estimates.