Kansas River Dredging Operations

Baseline Study and Comparison of Alternatives

January 1986

Booker
Engineers Architects Planners

KANSAS RIVER DREDGING OPERATIONS

BASELINE STUDY

AND

COMPARISON OF ALTERNATIVES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

KANSAS RIVER DREDGING OPERATIONS

Baseline Study
and
Comparision of Alternatives

A. Introduction

Sand is essential to the manufacture of concrete, asphalt, fiberglass and other materials related primarily to the construction industry. In the Lawrence, Kansas and Kansas City Metropolitan area, industry demand for sand is satisfied by various firms engaged in commercial dredging operations in and along the Kansas and the Missouri Rivers.

Commercial dredging operations on each river, or in land based "pits" within the Kansas River flood plain, require different levels of investment to produce quantities and qualities of sand, and to a lesser extent, gravel that meet the needs of industry. The primary objectives of this report are to identify these investments and to estimate, for operations now on the Kansas River, the economic impacts which would result from a move to the Missouri River or a land based pit operation.

To accomplish these objectives, a three phased study process was utilized. Initially, a detailed baseline study was undertaken, focusing on dredging

operations on the Kansas River below Bowersock Dam. Site visits and interviews with dredging company representatives were conducted to identify operating procedures, equipment investment, employment levels and costs associated with sand and gravel production. In addition, data was collected to establish production levels (output) and prices for various types of sand and gravel. As a result of this process, estimates were formulated for the cost, per ton, of sand and gravel production accruing to a "typical" Kansas River dredging operation.

The next two study phases were designed to identify differences in operating procedures, investment and other production cost factors between Kansas River dredging operations, Missouri River dredging operations, and pit operations, respectively. Interviews and site visits were similarly conducted to gather data for these alternative operations. Using the production levels established for the typical Kansas River operation as a base, estimates were then formulated for the cost per ton of production on the Missouri River and for a pit operation.

The report which follows is presented in a format which corresponds to the study phases. In the first section, a brief overview of the regional sand and gravel industry is presented. Included in the overview are a description of the market area and estimates of the regional demand for sand and gravel. The remaining sections are devoted to a presentation of the baseline conditions for Kansas River dredging and the alternatives studied.

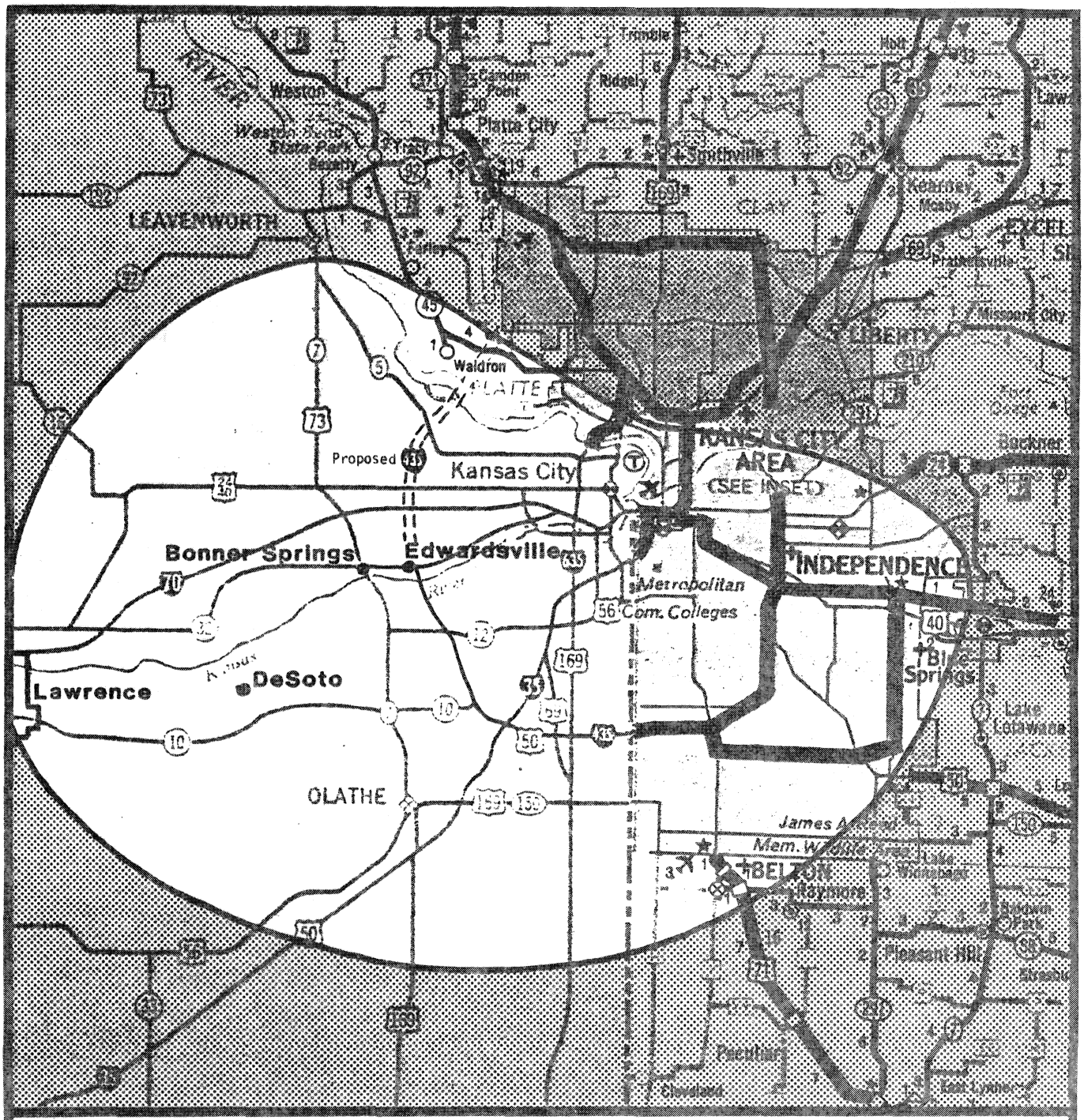
B. Regional Overview

Current estimates, based upon interviews with representatives of commercial dredging firms and their collective production figures, place the demand for sand and gravel in the Kansas City Metropolitan area at 3.5 to 4.5 million tons per year over the 1983 to 1985 time frame.

The building and road construction industries are the primary users of sand and gravel, accounting for approximately 90 percent of the total estimated regional demand. These industries utilize sand in the preparation of concrete, asphalt and mortar; all key components in the construction of roads, bridges, homes and commercial structures. This consumption is clearly illustrated in the construction of a typical home, although the construction of single family homes constitutes a minor part of the demand for sand and gravel.

An average size, one-story single family home affords an estimated 1600 feet of living space. In the construction of this home, with a full basement, Booker Associates estimates that 40 tons of sand would be utilized in the concrete walls, footings and basement floor. If brick veneer is considered, an additional 3 tons of sand would be used in the preparation of mortar.

Given that the building and road construction industries account for the majority of sand and gravel consumed, the primary market area for these materials is centered around Lawrence, Kansas and the Kansas City Metropolitan area where new construction is occurring. (See Plate B.1).



Primary Market Area
Plate B.1

Kansas River Dredging Operations

Both downtown Kansas City, Missouri and the suburbs to the south were identified as key segments within the broader market area.

In reviewing Plate B.1, it should be noted that the Missouri River is considered, by Kansas River dredgers, to be a north-northeastern boundary for their prime market area. This is due to a need for direct highway and bridge access to cross the Missouri River and thus service markets to the north and east of the river.

While the construction industry accounts for the majority of the regional demand for sand and gravel, there are other markets for these materials. Firms engaged in the manufacture of fiberglass, for example, account for an estimated 5 percent of the current demand for sand. These firms require sand, dried and of specified quality, to manufacture fiberglass. (See Section F for a detailed discussion of dry sand). Other uses for sand and gravel, which account for the remaining 5 percent of regional demand, include decorative rock and gravel (used in landscaping), sand for train engine traction and miscellaneous fill material.

As illustrated in Table B.1, the overall price of sand is relatively low in the Kansas City area when compared to other regions of the country.

TABLE B.1
SAND PRICES PER TON
FOR SELECTED CITIES

Baltimore	$6.20	Kansas City*	$ 2.95
Boston	7.50	Los Angeles	8.03
Chicago	4.75	Minneapolis	5.60
Cincinnati	3.93	Pittsburgh	11.15
Dallas	6.43	San Francisco	8.53
Detroit	2.85	Toronto	8.55

Source: Engineering News Record, October 10, 1985.

*Kansas River dredging company representatives indicated an average price of approximately $2.50 per ton. ENR reporting reflects prices for a broader area.

The low price of sand in the Kansas City area, relative to other cities, is probably a reflection of several interactive variables including:

- Regional Demand/Economic "Health" of Construction Industry
- Available Supply
- Ease of Extraction/Lower Production Costs
- Number of Producers/Increased Competition

In the sections which follow, data is presented with respect to production costs based on three alternative sources for sand and gravel. From these data, analyses are conducted to measure the impact of a switch by one segment of producers, those on the Kansas River, to alternative sand and gravel sources on the Missouri River and in pit operations within the Kansas River alluvium. The focus of the impact analysis is two-fold: First, to determine the economic impact of such potential moves on a "typical" dredging operation currently on the Kansas River, and second, to project the impacts on the sand and gravel industry in general including potential spin-off effects on the construction industry.

C. Kansas River Baseline

Data presented in this section are designed to establish baseline operation, investment and production information for dredging operations on

the Kansas River below Bowersock Dam (River mile 51.8 to 0). Based on information provided by the U.S. Army Corps of Engineers, Kansas City District, there are currently 11 permitted and 3 proposed dredge sites within this stretch of the Kansas River. Site visits and interviews were conducted with representatives of four firms, accounting for all of the 11 permitted dredge sites, with seven active dredges in this reach. (An eighth dredge was also active during the 1980-1984 time frame). Information gathered during the interviews, in conjunction with independent estimates prepared by Booker Associates, has been utilized to develop a profile for a "typical" dredging operation (i.e., one plant) on the Kansas River. Findings from this study are presented below.

1. Production

Production, in terms of annual tonnage sold, is highly variable among individual firms and active dredges*. These variations reflect not only the production capability of each dredging site but also the size of the firm; its business volume and/or market share. Annual production figures gathered during the interview process and presented below, reflect this variability.

*Note: Throughout this report, the terms "firm(s)" and "producer(s)" refer to dredging companies which may have one or more active dredges and processing plants. The term "typical dredging operation(s)" refers to one dredge and one plant.

TABLE C.1

KANSAS RIVER PRODUCTION
AVERAGE TONNAGE PER ACTIVE DREDGE
(BY SIZE OF FIRM)

	5 Yr. Avg.	1985
Small Firm	75,000	100,000
Mid-Size Firm	275,000	300,000
Large Firm	400,000	500,000

For all firms, small, mid-size or large, five year production averages per active dredge are lower than those estimated for 1985. This is most likely a reflection of the recession during this period, its impact on the construction industry and the accompanying decrease in demand for sand and gravel. Barring any similar economic downturn in the immediate future, production figures for 1985 are, for study purposes, assumed to be indicative of near term trends.

From the data presented in Table C.1, an estimate was derived by Booker Associates for the production level of a "typical" Kansas River dredging operation. Given the variations in the size of firms (business volume) and production from individual dredges, the "typical"

Kansas River dredging operation (i.e., one dredge and one plant) is estimated to produce 300,000 tons per year. The categorical uses for this output are discussed below.

Sand and gravel produced from the Kansas River has several categorical uses. Categorical uses, expressed as a percentage of total production, and prices at the plant have been estimated by Booker Associates and are displayed in Table C.2.

TABLE C.2

SAND AND GRAVEL

CATEGORICAL USES AND PRICES

	% Of Output		Price (@ Plant)	
	Range	Avg.	Range	Avg.
Ready-Mix Concrete Sand	40-70%	60%	$2.30- 2.60	$ 2.50
Asphalt Sand	10-30%	20%	2.10- 2.60	2.40
Masonry Sand (for mortar)	5-15%	10%	2.50- 2.75	2.65
Dry Sand	0-30%	5%	8.00-15.00	11.00
Fill Material & Misc.	1-10%	3%	1.00- 2.00	1.50
Rock & Gravel	1- 8%	2%	3.00-10.00 (+)	7.00

The averages (percent of output and prices) presented in Table C.2, with the exception of dry sand, are estimates for a "typical" Kansas River

dredging operation; an individual dredge and plant producing an average of 300,000 tons per year. It should be noted, however, that a given dredging operation may tend to specialize in certain products. For example, ready-mix concrete and asphalt sands may comprise 90 percent of the output for one operation and only 75 percent for another.

Dry sand, used in the manufacture of fiberglass, is not produced by all firms and is therefore not included in the analysis of a "typical" Kansas River dredging operation. This sand must meet certain standards of area manufacturers and requires additional processing, which includes drying the sand. The additional processing, and accompanying investment in equipment, is reflected in the higher sale price. A detailed analysis of the market and cost of production for dry sand is contained in Section F.

An analysis has been conducted by Booker Associates to estimate the average sale price for the total output, excluding dry sand, of a "typical" Kansas River dredging operation. In conducting this analysis, sale prices for individual products were weighted according to the percentage of total output they represent. (NOTE: the percentage of output allotted for dry sand (5%) was shifted to the concrete sand category. Concrete sand thus becomes 65% of total output for purposes of computing a weighted average sale price). Weighted sale prices were then summed, resulting in an estimated average sale price of $2.56 per ton of total output.

2. Transportation

Sand and gravel are transported from the plant by truck to consumers. The length of haul ranges from 1 to 150 miles. Some firms have serviced customers as far south as Springfield, Missouri. In other cases, the customer may be a ready-mix concrete manufacturer within a mile of the plant. The average length of haul, considering all trips and distance, is an estimated 20 miles for the typical operation.

The cost per ton/mile is the price charged by independent haulers and/or truck companies to deliver sand and/or gravel to the consumer. The cost per ton/mile ranges from $.08 to $0.20 with an average cost of $.12 per ton/mile.

In determining the cost per ton/mile, time of haul may be as important as length. A ten mile trip into downtown Kansas City may require more time, for example, than a twenty mile trip to an area located adjacent to Interstate Highway 435 due to the difference in traffic conditions. Deliveries to a downtown area may thus reduce the number of trips a truck can make, and in order to cover costs, the price per ton/mile may be higher.

Based on an average trip length of 20 miles at a cost of $.12 per ton/mile, the delivered price per ton of sand is an estimated $2.40 higher

than the price at the plant. For ready-mix concrete sand, the average delivered price per ton is thus estimated as $4.90 ($2.50 at the plant plus $2.40 in delivery costs). The total value of 40 tons of this sand, the amount used in constructing a typical home, would therefore equal $196.00 (40 tons x $4.90 per ton delivered). Given an estimated total construction cost of $64,000 ($40 per sq. ft. x 1600 sq. ft.) for this house, sand inputs represent .3 percent of total construction costs.

3. Equipment and Investment

Land, buildings and equipment are major components of dredging operations. Investment in these items, collectively referred to as the "plant", represents a significant portion of a given firms' cost of sand and gravel production.

Interviews and site visits were conducted to identify the types, and estimated value, of equipment utilized by firms dredging on the Kansas River. Since the age, and therefore book value, of equipment varies among individual firms, company representatives were asked to estimate the value of their equipment if purchased new. Follow-up questions were asked to determine the overall equipment replacement period (based on expected useful life) and salvage value upon disposal. All figures presented by company representatives were then checked for accuracy and reasonableness by Booker Associates and refined to reflect the equipment investment of a "typical" Kansas River dredging operation;

one plant producing an average of 300,000 tons per year. The findings of this study process are presented in Table C.3.

TABLE C.3

KANSAS RIVER BASELINE

EQUIPMENT INVESTMENT

	EST. VALUE (NEW)
Dredge, Pump and Pipeline	$500,000
Processing Plant (sizing tank, screens, etc.)	275,000
Conveyors	200,000
Loader (1)	150,000
Scale	30,000
Miscellaneous Equipment	100,000
TOTAL	$1,255,000

Source: Interviews with Kansas River dredgers and Booker Associates, Inc.

Equipment Replacement Period:

Range: 10-15 years

Average: 12 years

It should be noted that equipment life, and therefore the replacement period, will vary among individual equipment items and plants. The production volume handled and the degree of maintenance performed are two key variables which affect the length of useful equipment life. In addition, business profitability from year to year will affect the timing for purchases of replacement equipment.

Given these two data elements (equipment value new and replacement period), an estimate has been formulated for the average annual value of equipment investment using straight-line depreciation. The calculation procedure and findings are displayed in Table C.4

TABLE C.4

KANSAS RIVER BASELINE

AVERAGE ANNUAL EQUIPMENT INVESTMENT

Equipment Investment	$1,255,000
÷ Replacement Period	12 Years
= Average Annual Equipment Investment	$ 104,583

The estimated average annual equipment investment amount of $104,583 represents what an operation might typically set aside in a given year to replace equipment at the end of its useful life. Given this value and an average annual production figure of 300,000 tons, it is estimated that the equipment investment cost per ton of production for

a "typical" Kansas River dredging operation is $0.35 ($104,583 ÷ 300,000 = $.35).

The land, office buildings and utility hookups necessary for a dredging operation are treated separately from equipment which must be periodically replaced. Interviews with representatives of dredging firms were utilized to estimate land, office building and utility hookup requirements.

Land requirements vary according to production volumes. Smaller operations may require approximately seven acres to accommodate their operations while larger operations may require fifteen acres or more. Based on Booker Associates' review of dredgers operating along the Kansas River, the average acreage requirement for a "typical" operation was estimated as ten acres. Land values, and therefore acquisition costs, average $3,000 per acre. The investment in land for a "typical" operation would thus average $30,000 (10 acres @ $3,000 per acre).

An office building(s) and accompanying utility extensions/hookups are also included at each plant site. Office buildings generally include areas for clerical work, lunch/meeting room and maintenance equipment. Booker Associates estimates that the average square footage requirement for office space is 1400 square feet. Construction costs, including utility hookups are estimated at $35.00 per square foot yielding an investment of $49,000 (or $35.00 x 1400 = $49,000). By adding 15

percent of this figure for contingencies and miscellaneous site improvements, the total estimated investment would equal $56,350.

Various financing arrangements may be made for the purchase of land ($30,000) and office building construction ($56,350). Interviews with company representatives indicated that lenders would charge an estimated 1 to 2 percent above the prevailing prime rate (9.5%) on funds borrowed. For purposes of this analysis, it is assumed that firms would borrow $86,350 at 11 percent for twelve years, consistent with the estimated plant replacement period, to finance the purchase of land and an office building. The estimated annual cost associated with this purchase is thus $13,300. Land and office building costs are thus estimated as $0.04 per ton of production ($13,300 ÷ 300,000 = $0.04).

4. Repair and Maintenance

Equipment age, production volumes and river conditions (high flows, freezing, excessive debris, etc.) are key variables affecting repair and maintenance costs. For a "typical" dredging operation, producing 300,000 tons per year at a given Kansas River site, repair and maintenance costs generally range from $50,000 to $100,000 per year. Booker Associates has thus estimated, for study purposes, that repair and maintenance costs, including parts, contract labor and equipment, average $65,000 per year for a "typical" Kansas River operation at the mid-point of its estimated plant replacement period. The estimated cost per ton of production would thus equal $0.22 ($65,000 ÷ 300,000 = $.22).

5. Employment and Labor

Production volume is a major determinant of employment levels at given dredging operation sites. Interviews with representatives from various firms indicated that employment may average four persons for smaller operations and sixteen for larger operations. The average for a "typical" dredging operation was estimated by Booker Associates as twelve persons. These employees would include equipment operators and laborers, who are directly involved with production, as well as management, clerical workers and secretaries. Booker Associates estimates labor costs at $30,000 per annum per employee. Given an average employment level of twelve persons at $30,000 per year, total labor costs would be an estimated $360,000 per year for a typical operation. Given a 300,000 ton per year production level, labor costs are estimated at $1.20 per ton ($360,000 ÷ 300,000 = $1.20).

6. Miscellaneous Costs

Miscellaneous costs include such items as insurance, property taxes, utilities, fuel, supplies, and interest charges on equipment purchases. Based on interviews with company representatives, these costs may range from $110,000 to $150,000 per year for the "typical" operation depending on production volume, employment levels, and the value of land and equipment. Booker Associates, assuming a "high cost scenario", estimates that miscellaneous costs will average $150,000 per

year for a typical operation on the Kansas River. On a per ton basis, miscellaneous costs would equal an estimated $0.50 ($150,000 ÷ 300,000 = $0.50).

7. Summary - Kansas River Baseline

Total production costs per ton are displayed in Table C.5 for the "typical" Kansas River dredging operation. These costs are then compared to the average selling price, per ton, to estimate the gross profit margin of a typical Kansas River operation. (Note: Gross profit margin = profit ÷ selling price).

TABLE C.5

KANSAS RIVER BASELINE

PRODUCTION COST SUMMARY

ITEM	EST. COST PER TON
Equipment	$0.35
Office Building/Land	0.04
Repair and Maintenance	0.22
Labor	1.20
Miscellaneous	0.50
TOTAL	$2.31

Given an estimated average sale price of $2.56 per ton and production costs at $2.31 per ton, the gross profit margin is estimated as 9.8 percent for a "typical" Kansas River dredging operation; one producing 300,000 tons per year. Dredging company representatives indicated that profit margins may range from 5 to 15 percent depending upon production volumes and efficiencies.

For both smaller operations (in the range of 100,000 tons per year) and larger operations (500,000 tons per year) on the Kansas River, gross profit margins would likely remain within the 5 to 15 percent range. In order to compete and operate profitably, smaller firms may, for example, purchase used equipment to reduce start-up costs although the initial savings could be offset by higher maintenance and repair costs. These firms may carry fewer employees thus reducing labor costs. Land and office space requirements may also be scaled down for a smaller operation, resulting in a cost savings on these items. Lastly, small firms may focus only on markets and customers which are in closest proximity to their plant. Transportation costs would be lower, and thus, even if production costs and accompanying prices at the plant are higher than the "typical" operation, the delivered price would remain competitive.

Larger operations, producing 400,000 to 500,000 tons per site, require additional equipment investments, higher maintenance and repair budgets, and potentially more employees. These additional costs are,

however, spread out over a greater volume of production resulting in gross profit margins that would remain within the 5 to 15 percent range.

In closing this section, it is important to note that the figures presented are Booker Associates' estimates for production costs accruing to a "typical" Kansas River dredging operation. Estimated costs for individual categories (i.e., equipment, labor, etc.) will, of course, vary among firms and individual dredging operations. The key finding lies in the estimated total cost per ton of production ($2.31) and its comparison to production costs for alternative dredging operations on the Missouri River and in land based pits within the Kansas River alluvium. The sections which follow present an economic analysis of these two alternatives in comparison to Kansas River baseline data.

D. Missouri River Alternative

The purpose of this section is to identify investments and production costs associated with a Missouri River dredging operation and to gauge the economic impact of a switch to the Missouri River on dredgers currently utilizing the Kansas River. In performing this analysis, information developed in Section C for the "typical" Kansas River operation is used as a basis for comparison.

Dredging operations on the Missouri River differ from those conducted on the Kansas River. On the Kansas River, materials are dredged and pumped

via pipeline directly to the land based plant. On the Missouri River, a floating pipeline may be impractical to transport sand and gravel to the plant due to 1) the length of pipeline necessary to dredge a given reach, and, 2) the potential interruptions in pipeline operations prompted by barge and other traffic on the river. In lieu of a pipeline, dredgers use a tow boat and barge to transport sand and gravel from the dredge to the land based plant. The added investment which this represents, as well as the secondary treatment of sand to remove lignite, are the key differences between a Missouri River and Kansas River dredging operation. The sections which follow present an economic analysis of these differences and the effect on production costs for a "typical" dredging operation.

1. Production

For purposes of this analysis, a comparison of alternatives and their impact on a "typical" Kansas River operation, production levels are assumed to remain constant at 300,000 tons per year; consistent with the Kansas River baseline. This assumption is necessary so that the change in equipment investment and other operating costs associated with a Missouri River operation may be analyzed according to their impact on the cost per ton of production.

An analysis of production costs on the Missouri River will indicate the effect of this alternative on Missouri River sand and gravel prices.

2. Transportation

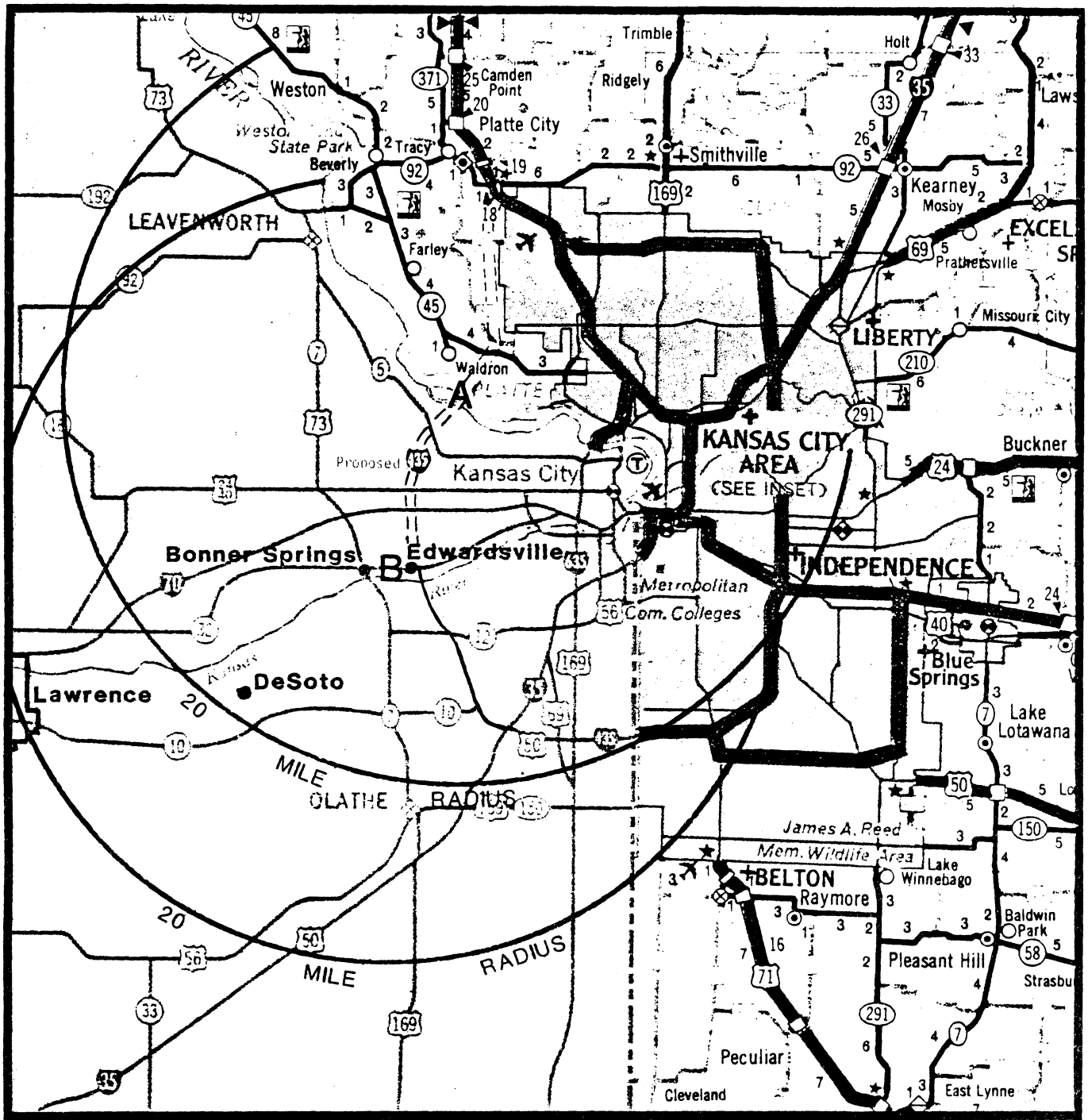
A review of Missouri River dredging operations indicated no change from Kansas River baseline data in terms of the method of haul or the ton/mile cost to deliver sand and gravel. Truck delivery at an average cost of $.12 per ton/mile is therefore assumed in the analysis of a Missouri River alternative. Depending upon the plant site selected, the average length of haul may, however, increase under this alternative.

Based on an examination of probable locations, the likely site for a Missouri River dredging operation would be northwest of Kansas City, Missouri. More specifically, given road and bridge access requirements and the market area served by dredging operations, it is assumed that the plant would be situated near the Interstate 435 bridge (under construction) crossing the Missouri River (see Plate D.1).

Given the assumed location for a Misouri River plant, it is estimated that the average trip length will increase 10 miles in order to continue service to existing markets. At $.12 per ton/mile, the additional trip length would increase delivery costs by an estimated $1.20 per ton; a 50 percent increase over the average transportation cost estimated for the Kansas River baseline.

3. Equipment and Investment

Although certain equipment utilized in a Kansas River operation may be employed at a Missouri River plant, other equipment must be added in



A = Proposed I-435 bridge and likely location of future dredge site.

B = Center of current dredging operations below Bonner Springs.

Missouri River Alternative Average Length of Haul Plate D.1

Kansas River Dredging Operations

order to dredge on the Missouri River. This additional equipment is required due to the operating procedures associated with Missouri River dredging. Differences in operating procedures and accompanying change in equipment are discussed below.

As was noted in the introduction to Section D, dredging operations on the Kansas River utilize a floating pipeline through which materials are pumped from the dredge to the land based processing plant. On the Missouri River, due to the length of the reach dredged, barge traffic, and other river traffic, a pipeline may be impractical. In lieu of the pipeline, materials are dredged, deposited on a barge and brought back to the plant via towboat. The barge, towboat and an unloading facility thus represent a substantial increase in equipment investment.

Other differences between a Kansas and Missouri River operation are in the size of the dredge and processing of materials. On the Missouri River, a larger dredge is utilized to excavate sand and gravel. At least one firm utilizes a floating processing plant whereby dredged materials are initially processed on the river at the dredge site. Once dredged materials reach the processing plant, a slurry treatment facility is utilized to remove lignite from Missouri River sand. The increased dredge size and slurry treatment facility represent further equipment investments for a Missouri River operation. The total estimated equipment investment associated with a Missouri River operation, both with and without a floating processing plant, are itemized in Tables D.1 and D.2.

TABLE D.1

MISSOURI RIVER

EQUIPMENT INVESTMENT

(WITHOUT FLOATING PROCESSING PLANT)

	Est. Value (New)
Conveyors	$ 200,000
Land Based Processing Plant	300,000
Scale	30,000
Loader (1)	150,000
Miscellaneous Equipment	100,000
Loader (2)	150,000
Dredge	1,000,000
Barge	250,000
Tow Boat	400,000
Conveying System	400,000
Slurry Treatment Facility	250,000
Unloading Facility	200,000
Gross Equipment Investment (Without Floating Processing Plant)	$3,430,000
-Resale value of equipment not adaptable to Missouri River*	250,000
Net Equipment Investment (without Floating Processing Plant)	$3,180,000

*Estimated at 50 percent of its value new and assumes:

1) Equipment would be at the mid-point of its useful life.
2) A market would exist for used Kansas River equipment.

TABLE D.2

MISSOURI RIVER

EQUIPMENT INVESTMENT

(WITH FLOATING PROCESSING PLANT)

	Est. value (new)
Conveyors	$ 200,000
Land Based Processing Plant	150,000
Scale	30,000
Loader (1)	150,000
Miscellaneous Equipment	100,000
Loader (2)	150,000
Dredge	1,000,000
Barge	500,000
Tow Boat	400,000
Conveying System	400,000
Slurry Treatment Facility	250,000
Unloading Facility	200,000
Gross Equipment Investment (With Floating Processing Plant)	$3,780,000
-Resale value of equipment not adaptable to Missouri River*	320,000
Net Equipment Investment (With Floating Processing Plant)	$3,460,000

*Estimated at 50 percent of its value new and assumes:

1) equipment would be at the mid-point of its useful life, and
2) a market would exist for used Kansas River equipment.

A floating processing plant allows for the initial processing of dredged materials on the river and may therefore reduce the size and estimated investment needed in a land based processing plant as displayed in Table D.2. In addition, the floating processing plant may increase operating efficiencies since unwanted materials may be discarded at the dredge site, reducing the number and cost of barge trips (from the dredge to the land based plant) needed to produce a given volume and quality of output. However, not all operations utilize a floating processing plant. To allow for this contingency, an estimated equipment investment for a Missouri River operation was developed without a floating processing plant. The larger size and estimated investment in a land based processing plant is displayed in Table D.1.

As indicated in Table D.1, a net equipment investment (without a floating processing plant) of $3.18 million has been estimated for the Missouri River alternative. With a floating processing plant, the net equipment investment is estimated in Table D.2, as $3.46 million. Net equipment investment, for study purposes, is thus estimated as $3.32 million for the Missouri River alternative, based on the average of these two figures.

Under the Kansas River baseline, a plant replacement period of 12 years was estimated. Booker Associates, based on a review of Missouri River operations, estimates no change in the plant replacement period for this alternative. Given a 12 year plant replacement period, and

utilizing straight-line depreciation, Booker Associates has estimated the average annual equipment investment represented in a Missouri River operation. This figure is then divided by average annual tonnage to estimate equipment investment costs per ton of production. The calculation procedures and findings are displayed as follows:

Net Equip. Investment	÷	Plant Replac. Period	=	Average Annual Equipment Investment
$3.32 Million	÷	12 Years	=	$276,670

Average Annual Equip. Investment	÷	Average Annual Tonnage	=	Average Equip. Investment Cost Per Ton
$276,670	÷	300,000	=	$.92

Land, office building(s) and utility hookups would also be necessary investments for a Missouri River operation. Land values, and therefore acquisition costs, are estimated to remain at $3,000 per acre for the Missouri River alternative. Total land area requirements are estimated, however, to increase for the Missouri River given the need for an unloading site and slurry treatment facility. Booker Associates has therefore estimated that 15 acres would be required to accommodate a plant producing 300,000 tons per year on the Missouri River. This represents an increase of 5 acres over the land area requirement

estimated for the Kansas River baseline. Land acquisition costs would thus total $45,000 (15 acres @ $3,000 per acre) for the Missouri River alternative.

Office building and utility hookup costs are estimated to remain the same under the Missouri River alternative. These costs, based on a 1,400 square foot office building, total $56,350 ($49,000 in construction costs plus 15 percent for site improvements and contingencies).

The annual cost of land and buildings is calculated based on the total cost ($101,350) amortized over 12 years at 11 percent interest, consistent with the Kansas River baseline. The resulting figure is then divided by average annual tonnage (300,000) to compute land and building costs per ton. The calculation procedure and findings are as follows:

$101,350 @ 11% over 12 years = $15,611 per year

$ 15,611 ÷ 300,000 tons = $.05 per ton

4. Repair and Maintenance

Repair and maintenance costs are a function of the type of equipment, its age, production volumes handled and river conditions (high flows, excessive debris, etc). Given production volumes of 300,000 tons per year and the increase in equipment investment associated with the Missouri River alternative (2.6 times greater than that estimated for

the Kansas River baseline), Booker Associates estimates average annual repair and maintenance costs of $130,000 for the Missouri River alternative. Given average annual production of 300,000 tons, repair and maintenance costs would be an estimated $.43 per ton for a Missouri River operation.

5. Employment and Labor

Employment and accompanying labor costs are estimated to increase under the Missouri River alternative. Dredging operations on the Missouri River would require additional equipment operating engineers for the towboat and a second loader. Two to three additional laborers are also estimated for the Missouri River alternative. Total employment is thus estimated as sixteen employees (twelve from the Kansas River operation plus four additional employees necessary for the Missouri River).

Labor costs are estimated to average $30,000 per employee, consistent with the Kansas River baseline. Total estimated labor costs for the Missouri River alternative would thus equal $480,000 per annum. Given average annual production of 300,000 tons, labor costs would be an estimated $1.60 per ton for a Missouri River operation.

6. Miscellaneous Costs

Miscellaneous costs include property taxes, insurance, supplies, utilities, fuel and interest charges on equipment purchases. These costs are projected to increase for the Missouri River alternative due

to added marine insurance, property taxes, fuel consumption and equipment purchases. Based on a review of area tax rates (averaging $4 per $100 assessed value), diesel fuel costs (averaging $1 per gallon), increasing liability insurance costs, and interest on equipment purchases, Booker Associates estimates an increase of 65 percent in miscellaneous costs for a Missouri River operation. Utilizing the $150,000 in miscellaneous costs estimated for the Kansas River as a base, the Missouri River operation would thus average $247,500 per year in miscellaneous costs. For a plant producing 300,000 tons per year, miscellaneous costs would be an estimated $.82 per ton.

7. Moving Costs

The physical movement of a given dredge operation from the Kansas to Missouri River involves plant disassembly, shipping and reassembly, as well as the installation of new equipment necessary for a Missouri River plant. The time, as well as labor and trucking costs, involved in moving are the topic of this section.

Interviews with dredging company representatives indicated that a move to the Missouri River would require, on average, three months to accomplish once site improvements are complete. The first phase of the moving process involves the disassembly of the existing plant. Booker Associates estimates a two to three week period for complete disassembly of the plant. A total of six persons, including equipment operating engineers and laborers, at an average hourly rate of $16.00,

are estimated for this project. Assuming 100 hours per person, the first phase of the move would cost an estimated $9,600.00.

The shipment of plant and office equipment would be accomplished by truck. Booker Associates has reviewed trucking costs and estimates an average hourly rate of $35.00 for one truck and driver. In addition, four laborers would be required to load and unload the truck. An average hourly rate of $15.00 has been estimated for these persons. Booker Associates estimates that complete shipment would require one week to accomplish. The total estimated cost of shipping would thus equal $3,800.00.

The reassembly of plant components shipped to the new site would require the time and labor equivalent to disassembly. A two to three week time period would be needed at an estimated cost of $9,600.00.

In addition to the reassembly of existing plant components, time and labor is allotted for the installation of new equipment. Booker Associates estimates that the installation of new equipment would require an additional two to three week period. Assuming six persons would be required for this time period, at an average hourly rate of $16.00, the moving costs associated with new equipment installation would be an additional $9,600.00.

The total cost to physically move operations from the Kansas to Missouri River is estimated at $32,600.00. A complete estimate of

moving costs should include, however, site selection and planning costs.

Booker Associates has conducted numerous site selection studies for industrial operations. In addition to the site selection study itself, Booker Associates has also prepared site plans which include the proposed layout of a new facility, roadway and utility extensions and legal descriptions of the site. The site plan elements are necessary to satisfy planning and zoning regulations in most regions. Based on Booker Associates' experience, site selection and planning would cost an estimated $20,000 to $25,000.

The total cost of a move to a Missouri River operation is thus estimated as $57,600:$32,600 in physical plant movement and $25,000 in site selection and planning. Although this cost is essentially borne "upfront", it is assumed for study purposes that a given firm would borrow funds and recover moving costs over a 12 year period; equivalent to the estimated plant replacement period. Moving costs have therefore been amortized over 12 years at 11 percent interest to derive the annualized cost of a move to the Missouri River. This figure is then divided by average annual production (300,000 tons) to estimate moving costs per ton of production. The calculation procedure and findings are displayed as follows:

$57,600 @ 11% for 12 years = $8,872

$8,872 ÷ 300,000 tons = $0.03 per ton

Although the time required to physically move an operation from the Kansas to Missouri River is estimated as three months, it may require a total of 18 months or more to select a site, secure its purchase, gain zoning and permit approvals, and make site improvements (including office building construction) needed to begin moving.

8. Summary - Missouri River Alternative

Total estimated production costs per ton are displayed in Table D.3 for the Missouri River alternative.

TABLE D.3

MISSOURI RIVER ALTERNATIVE

PRODUCTION COST SUMMARY

Item	Est. Cost Per Ton
Equipment	$ .92
Office Building/Land	.05
Repair and Maintenance	.43
Labor	1.60
Miscellaneous	.82
Moving	.03
TOTAL	$3.85

As the figures in this section indicate, an increase in equipment investment, as well as land, labor and miscellaneous costs are estimated for the Missouri River alternative. Given a dredge and plant producing 300,000 tons a year, production costs on a per ton basis would increase an estimated 67 percent. In order to retain a 9.8 percent gross profit margin (typical for Kansas River producers), the average sale price would rise to an estimted $4.27 per ton of output; an increase of 67 percent over the average sale price for Kansas River output. This sale price (at the plant) in combination with increased transportation costs would result in an estimated delivered price of $7.87 per ton; a 60 percent increase over the delivered price estimated for the Kansas River baseline.

Given the existence of nigher volume producers on the Missouri River, who are able to sell their products at competitive prices ($2.80 to $2.90 per ton), a producer of 300,000 tons per year would not opt for a Missouri River operation. Booker Associates estimates that production volumes of 500,000 tons per year would be the necessary minimum for a Missouri River plant to remain competitive within the Kansas City market given the estimated level of investment required. This tonnage estimate is based on the amount of production necessary to bring the cost per ton down to $2.31 as estimated for the Kansas River baseline.

E. Pit Mining Alternative

An alternative to Kansas and Missouri River dredging is pit mining; the extracting of sand and gravel from land based pits within the Kansas River alluvium. The focus of this section is on equipment investment and operating costs associated with pit operations. Costs for pit operations are then compared to the costs of river dredging as estimated for the Kansas River baseline.

1. Production

Production levels are held constant at 300,000 tons per year as estimated for the "typical" Kansas River dredging operation. In this manner, changes in equipment investment and operating costs may be gauged according to their economic impact on production costs, per ton, for a "typical" dredging operation (one dredge and one plant) currently utilizing the Kansas River.

Through a review of equipment investment and operating costs, the impact of the pit mining alternative on prices per ton will be estimated.

2. Transportation

The method of haul, average trip length and cost per ton/mile will affect the delivered price of sand and gravel for the pit mining alternative, Booker Associates found no differences between the pit mining alternative and Kansas River baseline in terms of method of haul or average cost per ton/mile. For purposes of analyzing the pit mining alternative, the average cost per ton/mile remains $0.12 with trucking as the method of haul. The probable locations for pit mining operations and their distance relative to existing Kansas River operations may, however, affect the average trip length and thereby the delivered price of sand and gravel.

Booker Associates conducted an analysis to determine probable locations for the pit mining alternative. In the first phase of this analysis, dredging company representatives were interviewed to determine the minimum depth of sand deposits necessary for economical operation. Based on this analysis, a minimum sand deposit depth of 25 feet was estimated for the pit mining alternative.

In the second phase of this analysis, Booker Associates examined data with respect to the depths of sand deposits at various locations within the Kansas River flood plain.

Given a required minimum deposit thickness depth of 25 feet and that most locations below Lawrence have suitable deposits, the probable locations for pit mining operations are between Edwardsville and Bonner Springs, Kansas. The probable locations for pit mining operations closely correspond with the location of existing Kansas River dredging operations. Based on this analysis, Booker Associates estimates no change in the average length of haul between the Kansas River baseline and the pit mining alternative. An average trip length of 20 miles is therefore estimated for the pit mining alternative. Transportation costs would thus add an average of $2.40 per ton (20 miles at $0.12 per ton/mile) to the delivered price of sand and gravel for the pit mining alternative; the same average cost estimated for the Kansas River baseline.

3. Equipment and Investment

Interviews with dredging company representatives were conducted to identify changes in equipment investment between a Kansas River operation and a pit mining facility. In conducting these interviews, both Kansas River dredgers and firms currently engaged in pit mining operations were contacted. Through this study process, Booker Associates determined that equipment now utilized for Kansas River dredging would be adaptable to a pit mining operation. Equipment investment would, therefore, remain the same for the pit mining alternative as estimated for the Kansas River baseline. Total equipment investment is estimated at $1,225,000 for the pit mining

alternative. Given a 12 year average plant replacement period, average annual equipment investment would be an estimated $104,583. For a 300,000 ton per year plant, equipment investment would be an estimated $0.35 per ton of production.

Land, office building(s) and utility hookups represent a separate investment category. For the pit mining alternative, office building and utility hookup costs are estimated to remain the same as those found in the Kansas River baseline study. The total cost for an office building, utility hookups, site improvements and contingencies is therefore estimated as $56,350 for the pit mining alternative.

Land requirements would increase for the pit mining alternative. Land requirements are estimated based on average annual production (tonnage) and the depth of sand deposits. The calculation procedure used to derive estimated land requirements is displayed as follows:

Estimated Average Depth of Deposit = 32 ft. (Edwardsville and Bonner Springs Area).

Square Feet per Acre: 43,560 sq. ft.
32 ft. x 43,560 s.f. = 1,393,920 cubic feet of deposit per acre
Average Weight of Sand per Cubic Foot: 109 lbs.
109 lbs. x 1,393,920 s.f. = 151,937,280 lbs. of sand per acre
Pounds per Ton: 2,000 lbs.
151,937,280 lbs. per acre ÷ 2,000 lbs. = 75,969 (say 76,000) tons of sand per acre

A dredging operation producing 300,000 tons per year would require 3.95 acres of land per year for the pit mining alternative (300,000 ÷ 76,000 = 3.95). Assuming that a firm would stay at a given pit mining location for a time equal, at minimum, to the average plant replacement period (12 years), the land needed for mining would equal 47.4 acres (12 years x 3.95 acres per year).

In addition to the acreage necessary for pit mining, an operation would require land to accommodate the office building, processing plant and on-site storage areas. Booker Associates estimates that the land required for these facilities would be 10 acres; the same as found during the Kansas River baseline study. Total land requirements for the plant and mining activities are thus estimated as 57.4 acres.

Depending upon the location selected, it may be necessary for a firm engaged in pit mining operations to acquire additional land to serve as a buffer between the mine and surrounding land uses and to provide security for the site. Booker Associates estimates that the buffer zone would be 25 feet in width extending around the perimeter of the site. For a 57.4 acre facility, a buffer zone of this width would require the acquisition of an additional 3.5 acres. Total land requirements for the plant, mining operations and buffer zone are thus estimated as 60.9 (say 61) acres.

The value, and therefore acquisition cost, of the land is estimated by Booker Associates as $3,000 per acre. For a 61 acre site, land acquisition costs would be an estimated $183,000. Combined land acquisition and office building costs would equal $239,350. This total cost is then amortized at 11 percent over 12 years, the expected "life" of the site, to derive average annual land and office building investment costs. Average annual costs are then divided by average annual production (tonnage) to derive an estimated land and office building cost per ton of production. The calculation procedure is displayed as follows:

$239,350 @ 11% for 12 years = $36,866 per year

$36,866 ÷ 300,000 tons = $0.12 per ton

As the figures presented in this section illustrate, an increase in land costs is expected for the pit mining alternative. For the Kansas River baseline, land and office building costs were estimated at $0.05 per ton while a pit mining operation could increase this cost to $0.12 per ton.

4. Removal of Overburden

Sand deposits are located at varying depths beneath the soil surface. In order to extract these deposits, the surface, or "overburden", must be removed. The cost of overburden removal is estimated based on the depth of overburden and the number of acres removed.

The average depth of overburden is 12 feet. Booker Associates estimates that the removal cost per acre for this depth of overburden would be $12,000, including machine hire, labor and fuel. Given the average acres mined (3.95) in a given year to produce 300,000 tons, average annual overburden removal costs would thus equal $47,400 (3.95 acres x $12,000 per = $47,400). Average annual overburden removal costs ($47,400) are then divided by average annual tonnage (300,000) resulting in an estimated overburden removal cost per ton of $0.16.

It should be noted that overburden removal costs may be offset by the sale of the material as fill. The market for fill is, however, highly variable and localized and the sale of this material is therefore not assumed for purposes of this study. The cost of overburden removal is thus an expense associated with the pit mining alternative that is not borne by Kansas River dredging operations.

5. Repair and Maintenance

Repair and maintenance costs are estimated to decrease slightly for the pit mining alternative. Adverse river conditions, such as high flows and excessive debris, which may damage equipment on the Kansas River, would not be encountered by a pit mining operation. The precise amount of damage, and therefore repair and maintenance costs, attributable to river conditions is, however, unavailable. In lieu of such cost figures, Booker Associates has conservatively estimated a 10 percent

reduction in repair and maintenance costs for a pit mining operation in comparison to the Kansas River baseline. Average annual repair and maintenance costs for the pit mining alternative are thus estimated as $58,500 ($65,000 - $6,500 = $58,500). For a plant producing 300,000 tons per year, repair and maintenance costs are thus estimated as $0.20 per ton of production ($58,500 ÷ 300,000 = $0.20).

6. Employment and Labor

Based on the interviews conducted by Booker Associates, no change in employment levels would result from the pit mining alternative. For a 300,000 ton per year operation, employment is estimated at 12 persons, the same as the Kansas River baseline. Labor costs are also expected to remain at an average of $30,000 per person per year for tne pit mining alternative. Given 12 employees at $30,000 per year, labor costs are estimated as $360,000 per year. For a 300,000 ton per year operation, labor costs are estimated at $1.20 per ton.

7. Miscellaneous Costs

Miscellaneous costs include insurance, property taxes, utilities, fuel, supplies, and interest charges on equipment purchases. In terms of a comparison between the Kansas River baseline and pit mining alternative, the greatest difference in tnis cost category relates to property taxes.

A survey of area property tax rates, conducted by Booker Associates, indicated an average rate of $175 per $1,000 assessed value with

property assessed at 30 percent of market value. The pit mining alternative is estimated to require 61 acres valued at $183,000 and an office building and other site improvements valued at $56,350. The total value of real property would thus equal $239,350. Given the average area tax rate, the average property tax liability for the pit mining alternative would be an estimated $12,566 per year. By comparison, a Kansas River operation with 10 acres and an office building valued at $86,350 would realize a property tax liability of $4,533 per year if the same tax rate is applied.

If all other miscellaneous cost categories are held constant (i.e., consistent with Kansas River baseline data), property taxes would add an estimated $8,000 per year to the cost of production for the pit mining alternative. Miscellaneous costs would thus total an estimated $158,000 per year ($150,000 from the Kansas River baseline plus $8,000 in added property taxes). Miscellaneous costs, given a 300,000 ton per year operation, would be an estimated $0.53 per ton for the pit mining alternative.

8. Moving Costs

The physical movement of a given dredging operation involves plant disassembly, shipping and reassembly at a new site. The time, as well as labor and trucking costs involved in moving are the topic of this section.

Interviews with dredging company representatives indicated that a move from the Kansas River to a pit mining operation would require, on average, two months once site improvements are completed. The first phase of the moving process, complete plant disassembly, is estimated by Booker Associates to require a two to three week period and the labor of approximately six persons, including laborers and equipment operating engineers. Given an estimated six persons, an average hourly rate of $16.00 and 100 hours per person, the first phase of the move would cost an estimated $9,600.

The shipment of plant and office equipment would be accomplished by truck. Booker Associates estimates, based on a review of trucking rates, that the average hourly rate for one truck and driver is $35.00. A minimum of four laborers would also be required to assist in loading/unloading at an estimated rate of $15.00 per hour. Booker Associates estimates that complete shipment would require one week. The total estimated shipment cost would thus equal $3,800.

Plant reassembly is estimated to require an additional two to three weeks. The number of persons required and the average hourly rate are expected to remain the same as estimated for plant disassembly. The estimated cost of reassembly is thus $9,600.

Given the calculations presented above, the total cost to physically move a plant from the Kansas River to a pit operation is an estimated

$23,000. A complete estimate for moving costs should, however, include site selection and planning costs.

In terms of site selection, a given firm would be seeking a site for pit mining that offered a minimum sand deposit deptn of 25 feet. The firm would likely contract for engineering services to provide test borings (holes) at alternative sites. Booker Associates estimates a cost of $5,000 for this service.

The preparation of a site plan would also be necessary in the process of satisfying planning and zoning requirements for the site selected. Site plans normally display the proposed location of major facilities, roadway and utility requirements, and a reutilization plan for the site after mining operations cease. Based on Booker Associates' experience in the preparation of such plans, an estimated cost of $15,000 would be reasonable for a site plan.

The total cost involved in a move from the Kansas River to a pit operation is estimated at $43,000:$23,000 in the physical movement of the operation and $20,000 in site selection and plan preparation. While these are essentially "up front" costs, it is assumed for study purposes that the firm would borrow funds and recover these costs over the expected "mining life" of the site; 12 years. Therefore, the $43,000 cost has been amortized over 12 years at 11 percent interest to derive the annualized cost of moving the Kansas River to a pit mining operation. The resulting figure is then divided by average annual

tonnage (300,000 tons) to estimate moving costs per ton. The calculation procedure and findings are displayed as follows:

$43,000 @ 11% for 12 years = $6,623

$6,623 ÷ 300,000 tons = $0.02 per ton

In closing this section, it should be noted that while the time to physically move a plant is in the range of two months, it may take 18 months or more to select and secure a site, gain zoning and permit approvals, and make site improvements (including office building construction) in order to begin making the move.

9. Summary

The costs per ton of production, given a 300,000 ton per year operation, are summarized in Table E.2 for the pit mining alternative.

TABLE E.1

PIT MINING ALTERNATIVE

PRODUCTION COST SUMMARY

	Estimated Cost Per Ton
Equipment	$0.35
Office Building/Land	0.12
Overburden Removal	0.16
Repair and Maintenance	0.20
Labor	1.20
Miscellaneous	0.53
Moving	0.02
TOTAL	$2.58

For a "typical" Kansas River dredging operation, the cost of production associated with the pit mining alternative is estimated as $2.58 per ton; a 12 percent increase in production costs estimated for the Kansas River baseline. In order to retain a 9.8 percent gross profit margin, the average sale price would be an estimated $2.86 per ton of sand and gravel output; also a 12 percent increase from the Kansas River baseline.

Additional transportation costs are not projected for the pit mining alternative. The average delivered price for sand and gravel output is thus estimated at $5.26 per ton ($2.86 at the plant plus $2.40 in average transportation costs). The estimated average delivered price ($5.26) represents a 6 percent increase over the average delivered price ($4.96) estimated for the Kansas River baseline.

A 6 percent increase in the delivered price of sand and gravel is not projected to significantly impact the construction industry; the primary market for sand and gravel. The delivered price for concrete sand, as an example, would be an estimated $5.19 per ton. Given 40 tons, the amount of sand used in constructing a typical home, at $5.19 per ton, the total value of sand inputs for constructing this house would be an estimated $208 for the pit mining alternative as opposed to $196 estimated for the Kansas River baseline. Further, given an overall construction cost estimated at $64,000 for this house, the cost of sand would represent .3 percent of total construction cost; the same percentage as was estimated for the Kansas River baseline.

F. Dry Sand

The term "dry sand" refers to a particular category of sand that, once dried and processed, is utilized primarily in fiberglass manufacturing. During the study process, Booker Associates found that two plants on the Kansas River are producing dry sand. The purpose of this section is to review production levels and prices as well as to estimate production costs associated with dry sand.

1. Production

The production of dry sand averages 150,000 to 200,000 tons per year from Kansas River producers. Booker Associates, after a review of Missouri River and pit mining operations in the Kansas City area, was unable to identify other producers of dry sand within the region aside from those found on the Kansas River. Kansas River sand reportedly offers a higher silica content (estimated at 87 percent) than that available from the Missouri River. Although further analysis would be required, a pit mining operation within the Kansas River alluvium should yield a quality of sand similar to that found within the Kansas River and which would meet industry specifications.

Prices for dry sand were found to range from $8.00 to $15.00 per ton with an average price of $11.00 per ton estimated by Booker Associates. The broad price range may reflect several factors including the degree of processing prior to sale and market conditions.

2. Transportation

Based on a review of fiberglass plant locations and the location of area dry sand plants, Booker Associates estimates an average length of haul of 15 miles for dry sand. Although dry sand is hauled by truck, the type of truck may vary from the type used to haul wet sand. For example, if the sand must be "blown" into containing bins, the truck utilized for this haul would be equipped with a compressor. Depending on the type of truck utilized, the delivery cost per ton/mile could be higher than the $0.12 average ton/mile cost estimated for wet sand delivery under the Kansas River baseline.

3. Production Costs

The production of dry sand requires additional equipment investment as well as increased labor and miscellaneous cost. The purpose of this section is to identify and estimate major investments and cost components associated with dry sand production.

- Equipment and Investment

The production of dry sand requires the same equipment needed for dredging as well as additional facilities for drying, screening, deironizing and storage. The drying facility, including the dryer, screens, magnetic separators and storage bins, has an estimated

value (new) of $2.5 million. If the equipment necessary for dredging and wet sand production is included, valued at $1.255 million, the total equipment investment for this plant would be an estimated $3.755 million (new).

In order to accommodate the drying facility, an estimated three additional acres would be required. Given an estimated value of $3,000 per acre, the additional land investment would equal $9,000.

Although no additional office building requirements are estimated for dry sand production, utility extensions and miscellaneous site improvements would be needed for the dry sand facility. Booker Associates estimates a cost of $5,000 to $10,000 for these improvements.

- Repair and Maintenance

In the Kansas River baseline study, average annual repair and maintenance costs for the dredge and plant were estimated at $65,000. Booker Associates estimates that the dry sand facility, depending upon age and production volumes handled, would add $25,000 in average annual repair and maintenance costs.

- Employment and Labor

The dry sand facility is estimated to require an additional two to four employees. Given an estimated labor cost of $30,000 per person, an additional two to four employees would represent a cost of $60,000 to $120,000 for dry sand production.

- Miscellaneous costs

Real and personal property taxes would increase in proportion to the increased value of equipment and land necessary for dry sand production. Depending upon the age, and therefore depreciated value of equipment, property taxes could average $50,000 per year for the dry sand facility.

Fuel is a major cost factor in the production of dry sand. Depending upon the fuel type (liquid propane or natural gas) and efficiency of the drying facility, expenditures for drying 100,000 tons of sand could range between $150,000 and $200,000.

4. Summary - Dry Sand

The average dry sand facility produces an estimated 100,000 tons per year. Since certain dredging and wet sand equipment and operating costs are necessary for the eventual production of dry sand, the cost per ton of dry sand production may vary according to the percentage

of total output which dry sand represents for a given operation. This concept is discussed below using the investment in a dredge as an example.

For a dredging operation producing 300,000 tons per year, of which 33 percent (or 100,000) tons is processed as dry sand, 33 percent of the $500,000 investment (or $165,000) in the dredge may be allocated to the cost of dry sand production. If a twelve year replacement period is assumed, the average annual investment in the dredge which is allocated to dry sand production would equal $13,750 (or $165,000 ÷ 12 years). Assuming the production of 100,000 tons, the cost of the dredge per ton of dry sand production would be an estimated $0.14.

In contrast to the above, for an operation producing 500,000 tons per year, of which 20 percent (or 100,000 tons) is processed as dry sand, only 20 percent of the $500,000 investment (or $100,000) in the dredge may be allocated to the cost of dry sand production. Assuming a twelve year replacement period, the average annual investment in the dredge which is allocated to dry sand production would equal $8,333 (or $100,000 ÷ 12 years). Assuming the production of 100,000 tons, the cost of the dredge per ton for dry sand production for this operation would be $0.08; 25 percent less than the cost assumed by a smaller operation.

As these examples illustrate, equipment investment costs per ton of dry sand production may vary according to the percentage of total output that dry sand represents for a given operation. The same principle would similarly apply to the other production cost variables (i.e., land, labor, repairs, etc.). Given the need for a reasonable profit margin, these production cost differences may impact the desired sale price among competing dry sand producers.

Moving costs were not calculated for the dry sand facility for several reasons. First, the Missouri River is not considered to be a viable alternative for dry sand given the quality of this sand. A move to a Missouri River location is, therefore, unlikely for a firm currently producing dry sand from a Kansas River location. Secondly, if a pit mining operation within the Kansas River alluvium is considered, it is likely that existing dry sand facilities would remain in place and that sand would be hauled from the pit operation to the facility for processing. Depending upon the distance from the pit operation to the drying facility, certain transportation cost would be added to the total cost of producing dry sand under this scenario.

G. Summary and Conclusion

In reviewing the data and cost estimates presented in this report, it is apparent that Kansas River dredging is, within the Kansas City area, the most cost effective method of sand and gravel production among the three

alternatives analyzed. The economic impacts which might result from a switch to the Missouri River or pit operations from the Kansas River are discussed below.

Regional economic impacts resulting from the Missouri River or pit mining alternative are measured in terms of employment, income and prices. The pit mining alternative would result in an estimated 6 percent increase in the average delivered price of sand and gravel. No measureable impacts on employment and income within the sand and gravel or related construction industries would be anticipated. Using the construction of a typical home as an example, sand inputs would continue to represent .3 percent of total construction costs. The pit mining alternative may, however, result in regional economic impacts outside of the sand and gravel and construction industries.

If all current dredging operations on the Kansas River below Bowersock Dam were to switch to land based pit operations, Booker Associates estimates that 500 acres of land would be converted to pit mining uses in order to accommodate existing production levels (2.5 million tons per year), for a 12 year period. Over a 50 year period, an estimated total of 2,000 acres would be converted to pit mining use if current production levels are sustained solely through pit mining operations. The regional economic impact resulting from the conversion of lands for pit mining use is contingent upon existing and potential future competing land uses and the availability of alternative sites for competing activities. If the conversion of 2,000 acres of land for pit mining uses precludes a more

intensive use of this land (i.e., more employees per acre and/or accompanying income generation), certain adverse regional economic impacts would result. These adverse economic impacts would then be weighed against potential positive impacts (reduced degradation and erosion of the Kansas River, for example) to arrive at conclusions regarding the benefit/cost ratio of the pit mining alternative and a quantification of net economic development benefits or disbenefits associated with this alternative.

The economic impact of the pit mining alternative on individual dredging firms is contingent upon several factors including price elasticity of demand for sand and gravel and the ability to acquire land at a suitable location and price. At an estimated average price of $2.86 per ton, sand and gravel produced from pit operations within the Kansas River alluvium (in the Bonner Springs and Edwardsville vicinity) would continue to be among the lowest priced in the market area served. In the absence of lesser cost substitutes, the market segment currently served by Kansas River producers is projected to remain the same under the pit mining alternative. The market share of an individual firm could, however, be impacted if the location of the pit operation is further from consumers than the existing Kansas River plant. The added distance would increase tranportation costs and therefore the delivered price of sand and gravel. Firms which are able to locate a pit operation closer to consumers could gain a competitive edge through reduced transporation costs.

The price paid for land may also impact the profitability of a given firm under the pit mining alternative. Given an estimated requirement of 61 acres for a typical 300,000 ton per year operation, an increase of $500 per acre, over the estimated average price of $3,000 per acre, would increase production costs by $.02 per ton. Holding other production costs and prices at the plant constant, firms paying more for land may realize a reduced profit margin. The increased cost of land must be offset by other locational advantages, such as proximity to consumers, which would enable the firm to charge more per ton at the plant and compete on the basis of the delivered price for their products. The future locations of pit operations and land values are thus critical variables to be addressed in order to minimize the economic impact of this alternative on individual firms.

The Missouri River alternative is, within the Kansas City market, the most costly means of sand and gravel production among the three alternatives analyzed. Equipment investment and operation/production costs associated with this alternative are substantially higher than the Kansas River baseline. The cost of production, given a typical 300,000 ton per year operation, is estimated at $3.85 per ton for the Missouri River. The economic impacts of this alternative are discussed below.

For firms competing in the Kansas City market, the Missouri River alternative is only economically viable for those firms with production in excess of 500,000 tons per year. It is conceivable, therefore, that a given firm with two or more Kansas River dredging operations, and/or with total production in excess of 500,000 tons per year, could consolidate

their Kansas River operations into one Missouri River operation. Since, however, these firms have already invested in Kansas River equipment, it is more likely that they would opt for the pit mining alternative where this equipment would be readily adapted.

Firms doing a substantial business volume in dry sand would not opt for a Missouri River opertaion due to the lower silica content of this sand. A pit mining opertion within the Kansas River alluvium would be the only real alternative for such a firm.

Smaller volume operations, with production levels closer to 300,000 tons per year, would be unable to compete on the Missouri River within the Kansas City market. As the analysis of a "typical" dredging operation illustrates, production costs for such an operation would exceed current prices for Missouri River sand (averaging $2.85 per ton within the Kansas City market).

In closing this section, based on an analysis of a "typical" dredging operation, a Kansas River firm with total production less than 500,000 tons per year would probably opt for the pit mining alternative should dredging operations cease on the Kansas River below Bowersock Dam. Even for those Kansas River firms producing in excess of 500,000 tons (either from one or more dredging operations), the pit mining alternative may be the likely option since Kansas River equipment is adaptable for use in a pit mining operation.