C.11
Geomorphic Assessment

Arkansas River Preliminary Geomorphic Assessment
Draft Final Report

By

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1. Study Objective

The objective of this study was to conduct a preliminary geomorphic assessment for the Arkansas River Navigation Study proposed deepening of the navigation channel of the McClellan-Kerr Arkansas River Navigation System (MKARNS). As part of this study, geomorphic reaches were classified, gravel bar locations were identified and correlated with bed material data, and the impacts of the proposed project on channel stability were evaluated. A helicopter reconnaissance was made of the entire navigation channel, with a geo-referenced digital video prepared.

2. Geomorphic Classification of Reaches

River Channel Classification. River channel classification is a means of reducing a complex system into a series of more easily understandable units, which in turn facilitates further study and the organization of management options. In this study, one goal of channel classification is to provide information that can be related to fish sampling data and management options. With this in mind, the 445-mile length of navigation channel was divided into geomorphic reaches (two to five per pool) that were classified using a modification of the Brice classification system (Brice, 1975).

Division into Reaches. Identification of geomorphic reaches (GRs) involves breaking down each main reach into discrete sub-reaches based on similarities in form and process. The aerial photographs were evaluated to identify changes in channel morphology, such as sinuosity and presence of islands. Lawson Smith's report on the lower portion of the Arkansas River gave valuable information on changes in geology and geologic controls. Significant occurrences such as the inflow from a major tributary were also used to locate breakpoints between geomorphic reaches.

Brice Classification. The Brice Classification describes the morphology of rivers or sections of rivers additively in terms of their degree and character of sinuosity, braiding, and anabranching. Each of these three aspects of planform is assigned a number and letter code for the degree and character, respectively, such that each reach can be described by a six letter code. Figure 2-1 shows the details of the classification. For example, a river section assigned the code 1D 2B 3C would be described as: 1D = having a sinuosity between 1 and 1.05 and be single phase, wider at bends with chutes common; 2B = between 35% and 65% braided with mostly bars and islands; and 3C = have >65% anabranching with split channel, sub-parallel anabranches. A total of 3,120 river types can be identified in this way (Brice 1975).

The system was developed based on the morphological characteristics that were observed from aerial photographs of about 250 river reaches, mostly within the United States but from other parts of the world also, and occurring in climates ranging from arctic to equatorial. In addition to the photographs, large-scale topographic maps, and gauging station data for 200 reaches were used to develop the classification (Brice 1975).

Modified Brice Classification (for Arkansas River). The Arkansas River is highly controlled, since it is a series of navigation pools, with a planform that is fixed in place by training structures. These factors make the Brice categories of braiding and anabranching less useful here. The braiding category was retained, since there were a few reaches where braiding was noted. The anabranching category was dropped, and was replaced with two additional categories: bars and islands. The breakpoints for the "degree of sinuosity" category were also modified slightly. The "modified Brice" classification is described in Table 2-1. The limits and modified Brice classification for the geomorphic reaches for each pool are given in Tables 2-2 through 2-5.

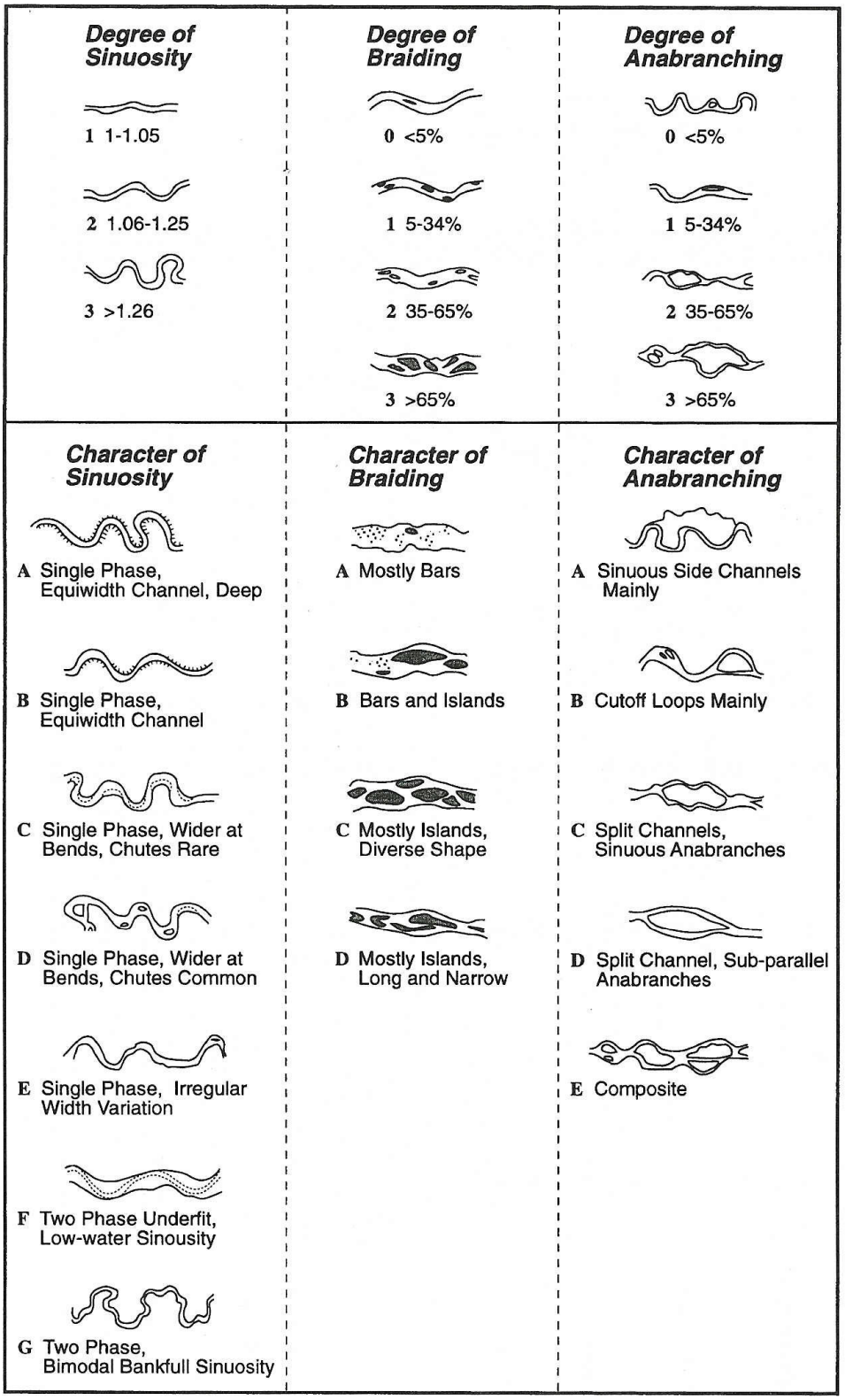

Figure 2-1. Brice Classification System (Brice, 1975)

Table 2-1. Modifications to Brice Classification for Arkansas River Project

Degree of Sinuosity – Brice classification modified as follows:

- (1) is a sinuosity of 1 – 1.10
- (2) is a sinuosity of 1.11 – 1.25
- (3) is a sinuosity of 1.26 and above

Character of sinuosity – Brice classification used

Degree of braiding – Brice classification used

Character of braiding – Brice classification used

Degree and character of anabranching – not used

Degree of bar formation – new category as follows:

- 0 is less than 5%
- 1 is 5 – 34%
- 2 is 35 – 65%
- 3 is over 65%

Character of bar formation – new category as follows:

- A is within main channel
- B is along side of channel
- C is in both main channel and along sides

Degree of islands – new category as follows:

- 0 is less than 5%
- 1 is 5 – 34%
- 2 is 35 – 65%
- 3 is over 65%

Character of islands – new category as follows:

- A is within main channel
- B is along side of channel
- C is in both main channel and along sides

Notes:

1. If the degree of a category was denoted as "zero," but still existed in a reach, its character was defined.
2. Braiding (degree and character) was only used in a few reaches. This category may not be applicable in a navigation channel.
3. The bars and islands categories are similar to the Brice categories, and seem to be more useful in the Arkansas River.

Arkansas River (MKARNS)
Table 2-2. Results of Geomorphic Classification for Pools 2 through 6

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Char. of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 2										
2-1	19.0 – 22.7	1.09 (1)	A	0	0	0	B	1	B	1A00-0B1B
2-2	22.7 – 29.0	1.08 (1)	D	0	0	0	0	2	B	1D00-002B
2-3	29.0 – 47.0	1.35 (3)	A	0	0	0	A	1	B	3A00-0A1B
2-4	47.0 – 50.4	1.10 (1)	A	0	0	0	B	1	B	1A00-0B1B
Pool 3										
3-1	50.4 – 62.9	1.15 (2)	C	0	0	0	C	2	C	2C00-0C2C
3-2	62.9 – 65.9	1.09 (1)	A	0	0	0	0	0	0	1A00-0000
Pool 4										
4-1	65.9 – 76.0	1.40 (3)	C	0	0	0	0	1	C	3C00-001C
4-2	76.0 – 86.2	1.13 (2)	D	0	0	0	B	1	B	2D00-0B1B
Pool 5										
5-1	86.2 – 94.0	1.18 (2)	C	0	0	0	0	2	B	2C00-002B
5-2	94.0 –108.2	1.14 (2)	D	1	C	1	C	2	C	2D1C-1C2C
Pool 6										
6-1	108.2-114.0	1.16 (2)	D	0	C	0	0	3	C	2D0C-003C
6-2	114.0-125.6	1.08 (1)	C	0	0	0	0	0	B	1C00-000B

Arkansas River (MKARNS)
Table 2-3. Results of Geomorphic Classification for Pools 7 through 10

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Character Of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 7										
7-1	125.6-143.0	1.21 (2)	D	1	B	1	A	3	C	2D1B-1A3C
7-2	143.0-155.9	1.45 (3)	C	0	C	1	B	1	C	3C0C-1B1C
Pool 8										
8-1	155.9-162.5	1.78 (3)	D	0	0	0	A	1	A	3D00-0A1A
8-2	162.5-169.0	1.03 (1)	B	0	0	0	B	0	B	1B00-0B0B
8-3	169.0-176.8	1.42 (3)	C	0	0	1	B	1	B	3C00-1B1B
Pool 9										
9-1	176.8-186.0	1.24 (2)	C	0	0	0	0	0	B	2C00-000B
9-2	186.0-196.0	1.02 (1)	B	0	B	1	A	1	C	1B0B-1A1C
9-3	196.0-205.8	1.11 (2)	C	0	0	0	0	1	B	2C00-001B
Pool 10	Dardanelle									
10-1	205.8-224.0	1.12 (2)	A	0	0	0	0	0	A	2A00-000A
10-2	224.0-238.8	1.45 (3)	D	1	B	0	A	2	C	3D1B-0A2C
10-3	238.8-250.5	1.08 (1)	C	0	0	0	A	1	C	1C00-0A1C
10-4	250.5-256.8	1.03 (1)	B	0	0	0	0	0	0	1B00-0000

Arkansas River (MKARNS)
Table 2-4. Results of Geomorphic Classification for Pools 12 through 15

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Character Of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 12										
12-1	256.8-265.4	1.40 (3)	C	0	0	0	0	0	B	3C00-000B
12-2	265.4-276.2	1.03 (1)	B	0	0	0	A	1	C	1B00-0A1C
12-3	276.2-283.6	1.39 (3)	C	0	0	0	0	2	C	3C00-002C
12-4	283.6-292.6	1.06 (1)	C	0	0	0	0	1	C	1C00-001C
Pool 13										
13-1	292.6-308.0	1.84 (3)	D	0	0	0	0	2	C	3D00-002C
13-2	308.0-319.5	1.26 (3)	B	0	0	0	0	0	B	3B00-000B
Pool 14										
14-1	319.5-331.0	1.36 (3)	B	0	0	0	0	1	B	3B00-001B
14-2	331.0-336.4	1.09 (1)	B	0	0	0	0	0	B	1B00-000B
Pool 15										
15-1	336.4-350.8	1.08 (1)	A	0	0	0	0	0	A	1A00-000A
15-2	350.8-361.2	1.19 (2)	D	0	0	1	C	2	C	2D00-1C2C
15-3	361.2-366.6	1.01 (3)	B	0	0	0	B	0	B	3B00-0B0B

Arkansas River (MKARNS)
Table 2-5. Results of Geomorphic Classification for Pools 16 through 18

Reach	Navigation Mile	Degree of Sinuosity	Char. of Sinuosity	Degree of Braiding	Character Of Braiding	Degree Of Bars	Character Of Bars	Degree Of Islands	Character Of Islands	Channel Type
Pool 16										
16-1	366.6-378.0	1.30 (3)	A	0	0	0	A	0	A	3A00-0A0A
16-2	378.0-384.5	1.03 (1)	B	0	0	0	B	1	C	1B00-0B1C
16-3	384.5-395.2	1.41 (3)	C	0	0	0	0	0	B	3C00-000B
16-4	395.2-400.2	1.32 (3)	B	0	0	0	0	0	B	3B00-000B
16-5	400.2-401.3	1.00 (1)	A	0	0	0	0	0	0	1A00-0000
Pool 17										
17-1	401.3-403.0	canal	-	-	-	-	-	-	-	Not typed
17-2	403.0-409.0	1.02 (1)	B	0	0	0	0	0	0	1B00-0000
17-3	409.0-421.5	1.16 (2)	B	0	0	0	0	0	0	2B00-0000
Pool 18										
18-1	421.5-428.5	1.15 (2)	B	0	0	0	0	0	B	2B00-000B
18-2	428.5-437.6	1.37 (3)	B	0	0	0	B	0	B	3B00-0B0B
18-3	437.6-444.8	No maps	-	-	-	-	-	-	-	Not typed

3. Summary and Plots of Gravel Information

Plots of gravel data. The following plots combine information from several sources to assist in locating gravel bars. Information used is the following:

a. Bed material gradation data from USGS sampling
b. Gravel bars located during fish sampling by ERDC-EL
c. Gravel bars located during a helicopter reconnaissance by ERDC-CHL
d. Tributaries with a gravel load located during a helicopter reconnaissance by ERDC-CHL

Bed material samples collected by USGS. The percent gravel (sediment larger than 2 mm) was determined by subtracting the percent smaller than 2 mm in the gradation data. Zero values are plotted. The percent gravel was plotted against the river mileage. This data is extensive (although there are some gaps). The largest particle sizes were 16-32 mm (coarse gravel). The percentage of silt and clay in the bed samples was less than 10% in all but a handful of cases, with the exception of Pools 15 and 18.

Lock and dam locations. These were plotted to show the ends of the reaches, and assigned an arbitrary value of 50 percent.

Sources of gravel bar information. In order to see whether there was any correlation between the bed material samples and the presence of gravel bars, information on gravel bars from the field work was plotted. Sources of data are discussed in the following paragraphs.

Fish sampling. ERDC-EL conducted fish sampling during the summer of 2004, and could locate some gravel bars from the sound of the sampling equipment on the river bed. Fish sampling was only conducted in certain reaches.

Helicopter reconnaissance. ERDC-CHL conducted a helicopter reconnaissance in August 2004, during which exposed gravel bars (in both the Arkansas River and in tributaries) were noted. The entire navigation reach was flown, but many gravel bars may have been hidden by medium-high water levels. The gravel bar locations are from the field notes (rather than the digital movie record). Gravel bars were noted in some tributaries (and sand bars in others). The bed material in many tributaries was not visible because of the backwater from the navigation pools. These tributaries probably transport sediment (perhaps including gravel) into the river channel under high flow conditions.

Legend for bar locations. The gravel bar locations were plotted versus river mileage, and given arbitrary y-axis values (since no percentage is known).

e. G – FS. Gravel bar located during fish survey. (Arbitrary value of 50.)
f. G – H. Exposed gravel bar in Arkansas River noted during helicopter reconnaissance. (Arbitrary value of 50.)
g. G – trib. Gravel bar in tributary mouth noted during helicopter reconnaissance. (Arbitrary value of 55.)

Conclusions from plots. The comparison of gravel percentages in bed material with actual gravel bar locations produced some surprising results. One would expect to have gravel bars coincide with high gravel percentages (and many do), but there were some gravel bar locations with bed material gravel percentages as low as 2 and 5 percent. The table below includes a tabulation of the range of bed material gravel percentages in the reaches where there were gravel bars identified (within approximately one mile of the gravel bar location). If multiple bar locations were identified, the gravel percentages are listed separately for each.

Table 3-1. Gravel Percentages in Bed Samples in Areas near Field-Located Gravel Bars

Pool	Gravel bars located during field work	River Mile	Range of gravel percentages in bed material samples near the gravel bar
Pool 2	G – FS	44-45	0-1-5 %
Pool 3	none located	--	--
Pool 4	none located	--	--
Pool 5	G – FS	106-108	7-10-39%
Pool 6	G – FS	121-125	33% (one sample only)
Pool 7	G – FS G – H	146-150 154.5	0-2-4-9-20-27% 0-2-3-17%
Pool 8	G – trib	169	--
Pool 9	G – H G – FS	202 205.2	58-65-72% 38-54%
Pool 10 (Dardanelle)	G – FS G – trib G – FS	230 251 254-256	0-5% -- 26-31-49%
Pool 12 (Ozark)	G – trib G – FS and G - H	272 289-295	-- 0-2-8-17-34-35%
Pool 13	none located	--	--
Pool 14	none located	--	no samples
Pool 15	G – trib G – H	361 363.7	-- 0-2%
Pool 16	G – trib	394	--
Pool 17	G – FS G – FS	401.5-403 421.5	no samples
Pool 18	none located	--	--

Use of gravel percentages to locate additional gravel bars. It was hoped that the bed material sampling data could be used to refine the field search for additional gravel bars; that is, since the bed material data is fairly extensive, that search areas could be limited to (for instance) reaches where the gravel percent exceeded twenty percent. The table above

and the following plots indicate that gravel bars exist in some areas with low percentages of gravel in the bed material (as low as 2 to 5%). For instance, in Pool 2, gravel bars were noted although there is less than 10% gravel throughout the pool. In Pool 7, gravel bars were observed in a reach where there is less than 10% gravel in the bed material. This seems to indicate that the hydraulic sorting of the bed material is an important factor in forming gravel bars from bed material mixture that contains both sand and gravel.

Formation of gravel bars. Gravel bars form where there is both a sufficient supply of gravel size material and the hydraulic (sediment transport) conditions necessary to ensure that the coarsest grain sizes (gravel) remain and the finer grain sizes (sand and silt) are transported downstream. It might be helpful to perform a sediment budget for gravel size classes only in order to evaluate the potential replenishment of gravel areas. It seems likely that each lock and dam acts as a barrier to gravel movement, so that each pool is self-contained. There is evidently gravel coming in from some of the tributary streams. There may be gravel contributed by eroding stream banks along the main stem: even if erosion occurs at a slow rate, the cumulative contribution of miles of eroding riverbank could be significant. From the data from Pool 2, it seems that a small percentage of gravel in the bed material can be concentrated to form gravel bars by the hydraulics and sediment transport. This indicates that gravel bars may be formed by hydraulic sorting of material, with the finer sediments winnowed away to leave a residue of coarser material. As long as there is some gravel fraction present, the hydraulic conditions may be the determining factor in gravel bar formation. This hypothesis, if correct, would improve our chances of being able to successfully preserve or create gravel bars, by using modeled (or measured) velocities and sediment transport rates to predict future conditions. The links between gravel supply, hydraulic properties, and sediment transport rates should be investigated to see if a better understanding of these processes can aid in predicting gravel bar locations and suitable gravel bar mitigation sites.

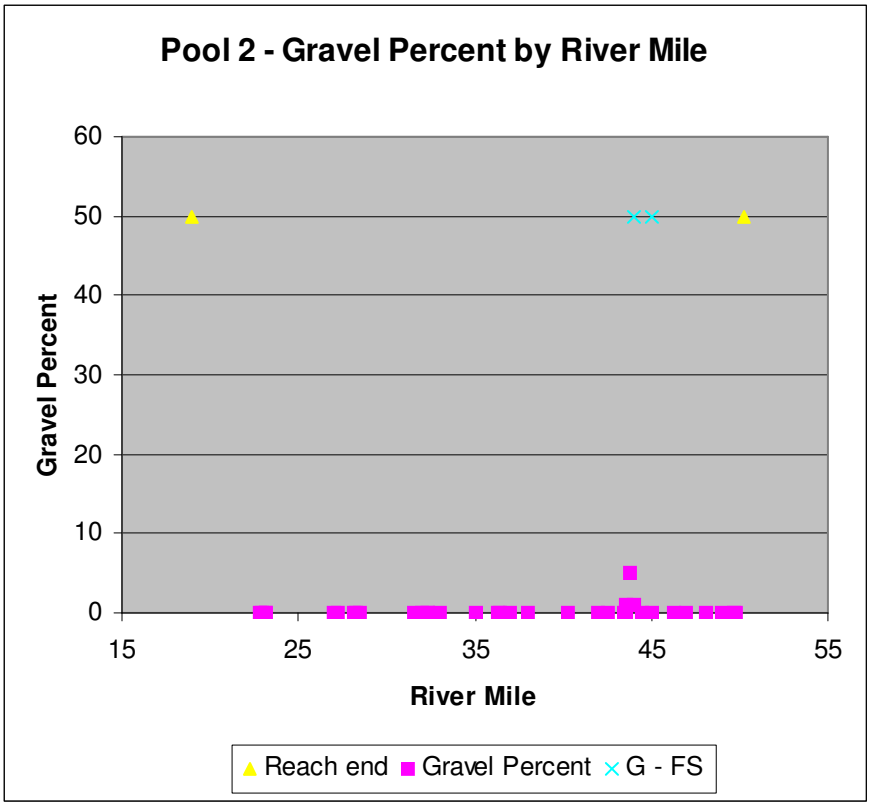

Figure 3-1. Pool 2 – Gravel Percent by River Mile

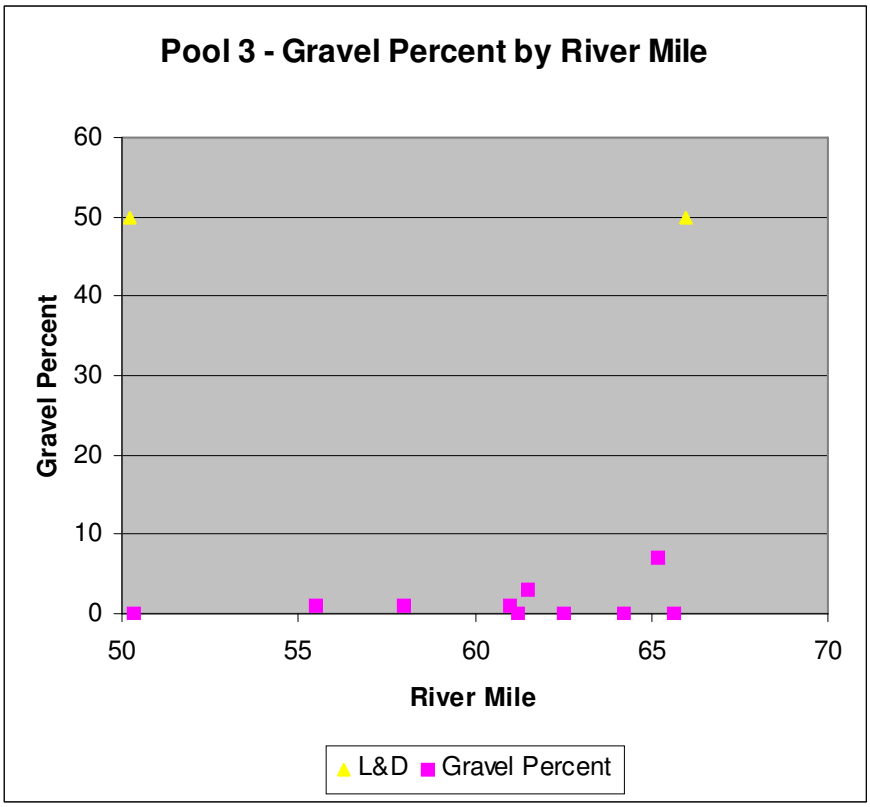

Figure 3-2. Pool 3 – Gravel Percent by River Mile

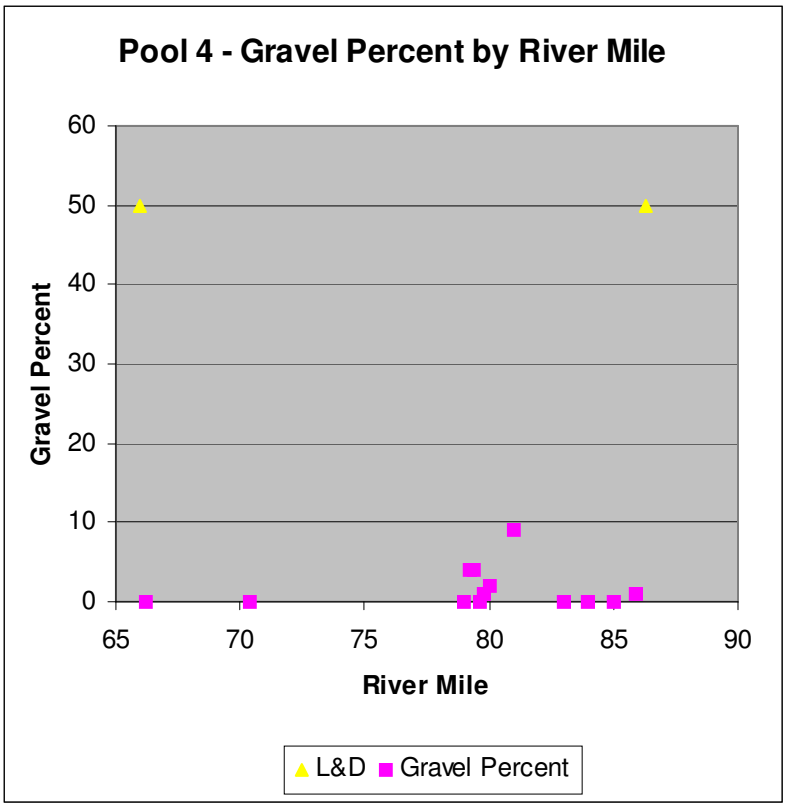

Figure 3-3. Pool 4 – Gravel Percent by River Mile

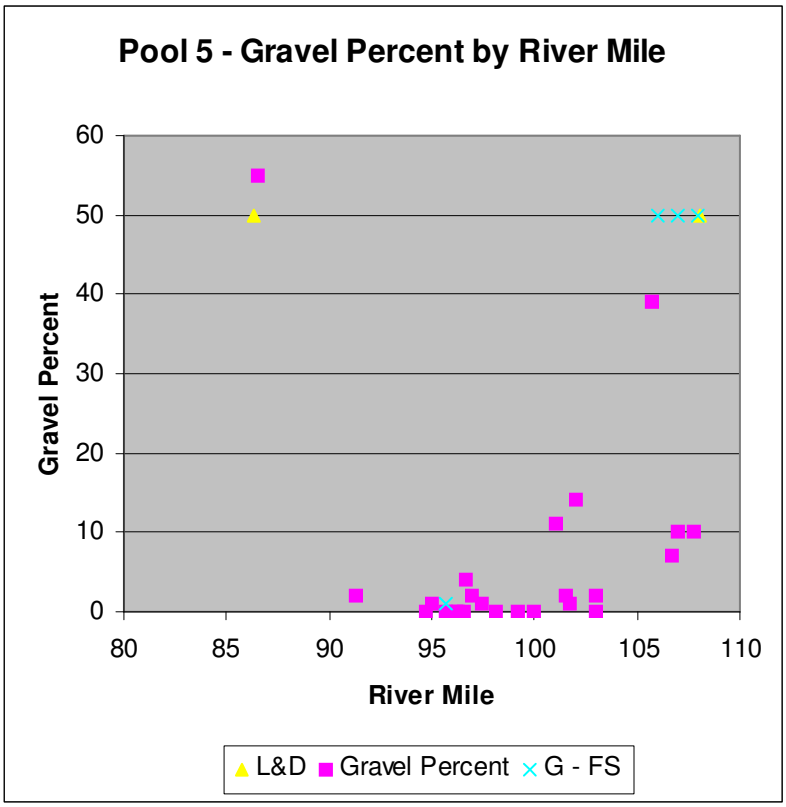

Figure 3-4. Pool 5 – Gravel Percent by River Mile

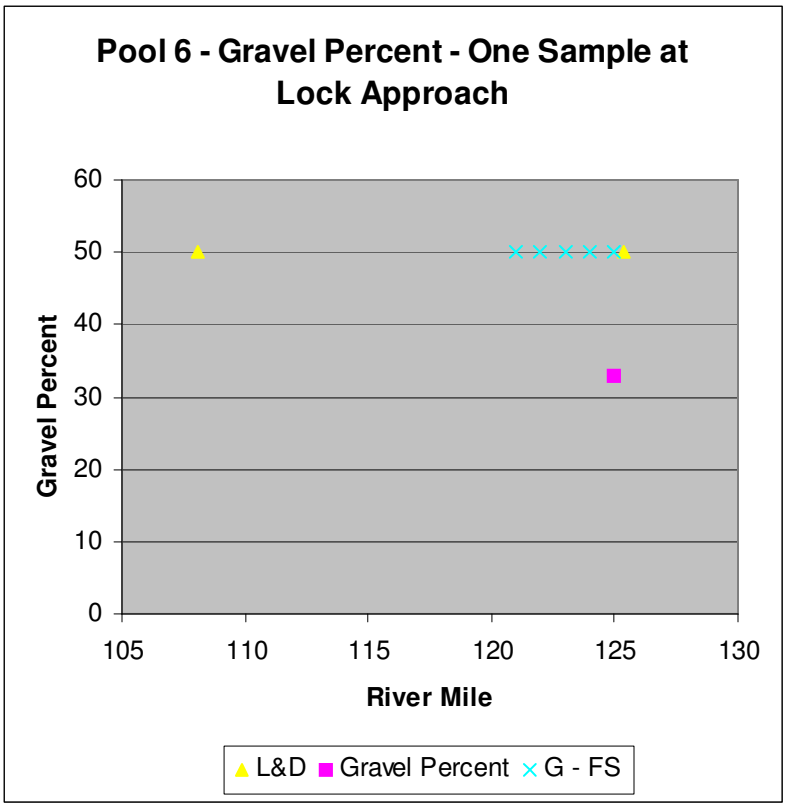

Figure 3-5. Pool 6 – Gravel Percent by River Mile

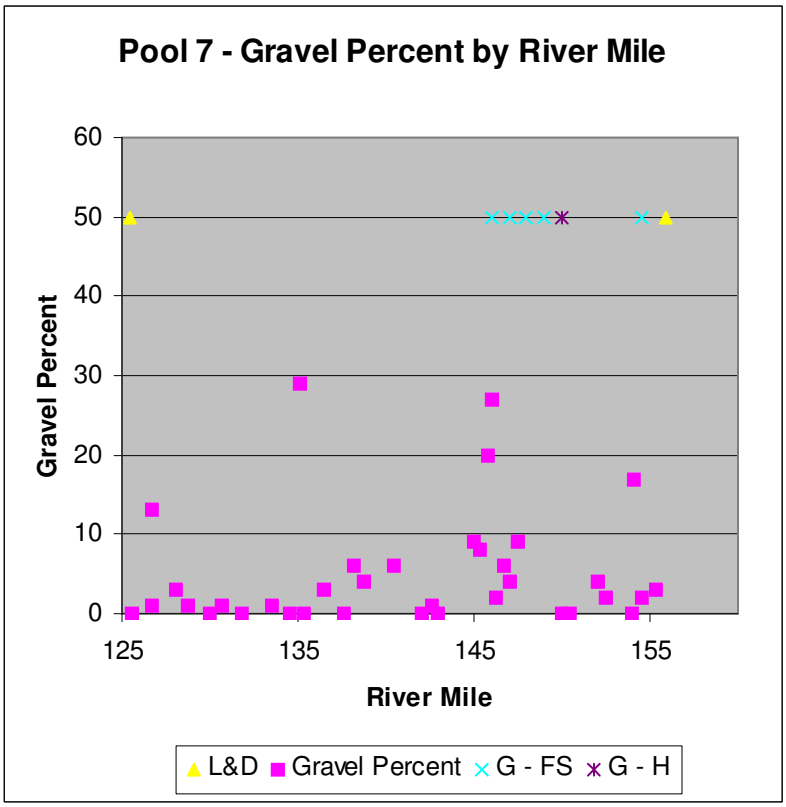

Figure 3-6. Pool 7 – Gravel Percent by River Mile

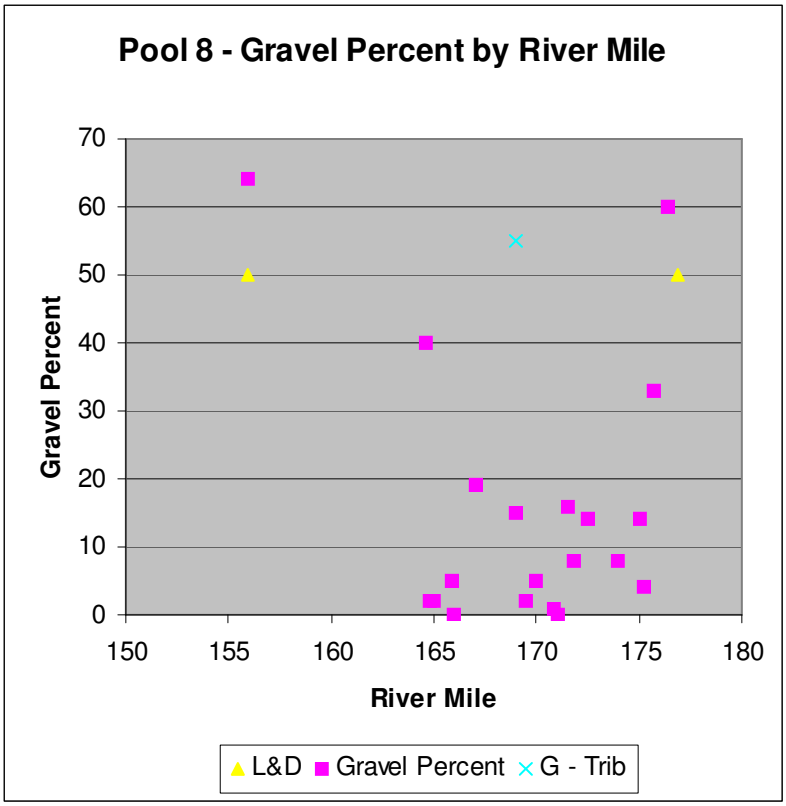

Figure 3-7. Pool 8 – Gravel Percent by River Mile

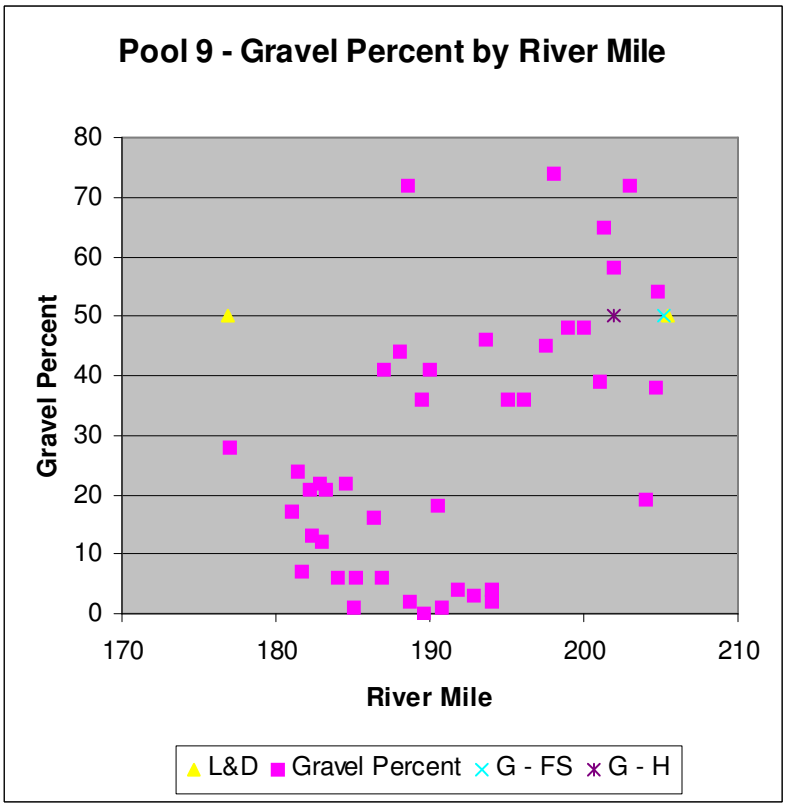

Figure 3-8. Pool 9 – Gravel Percent by River Mile

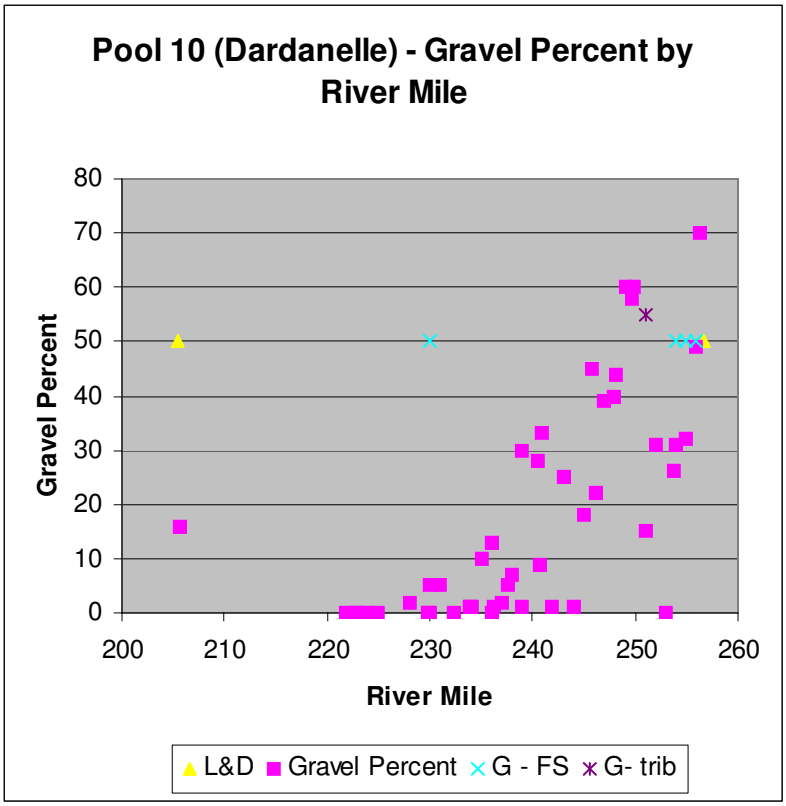

Figure 3-9. Pool 10 – Gravel Percent by River Mile

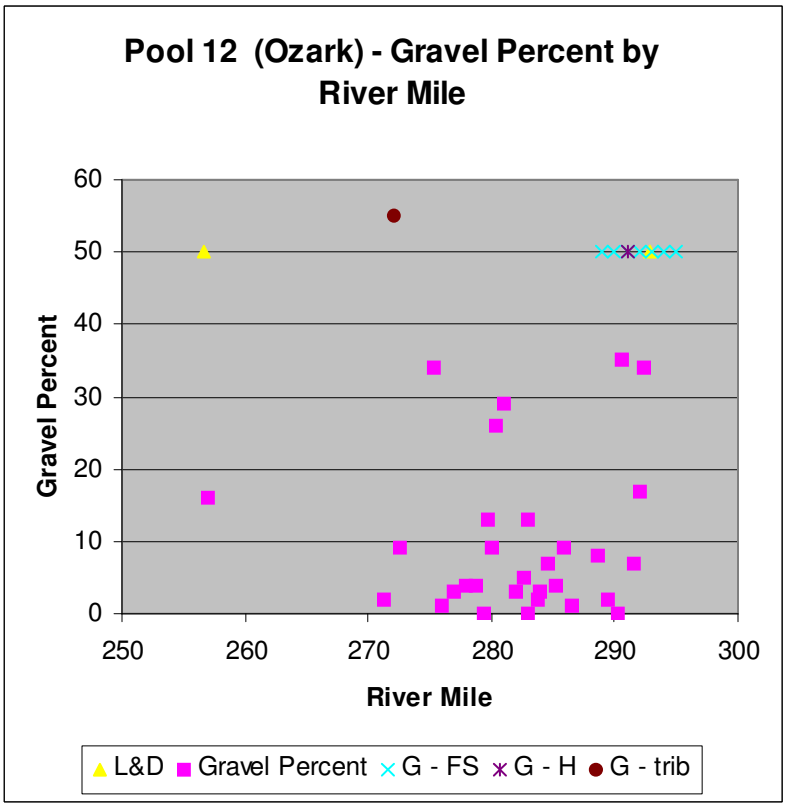

Figure 3-10. Pool 12 – Gravel Percent by River Mile

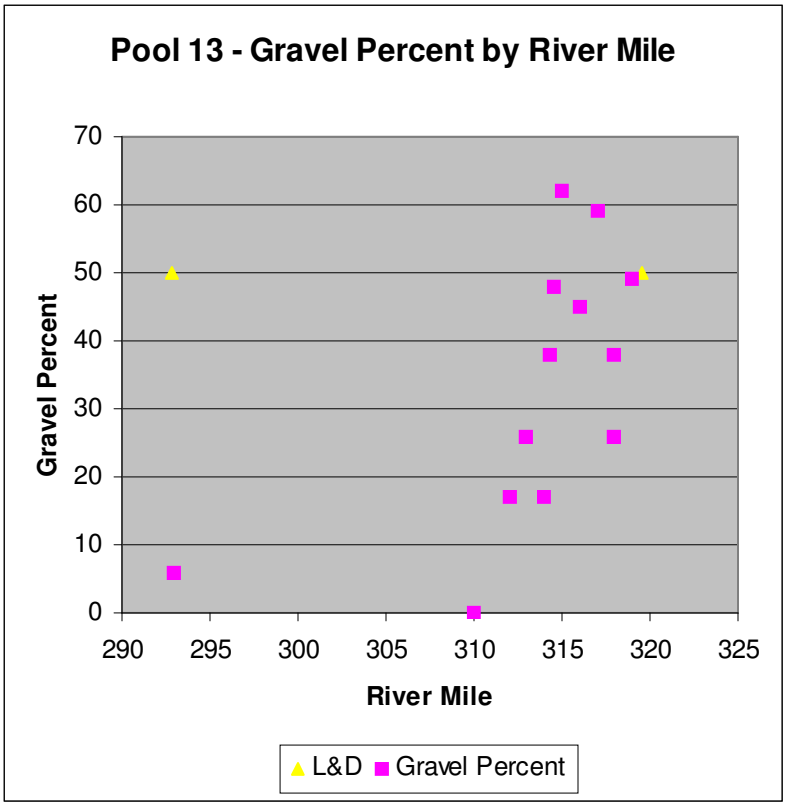

Figure 3-11. Pool 13 – Gravel Percent by River Mile

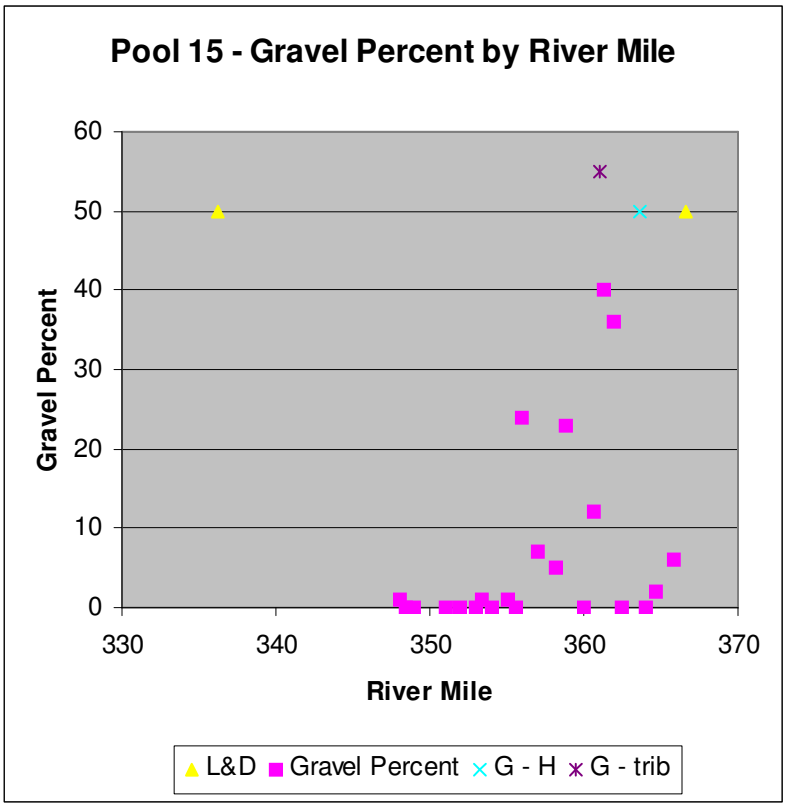

Figure 3-12. Pool 15 – Gravel Percent by River Mile

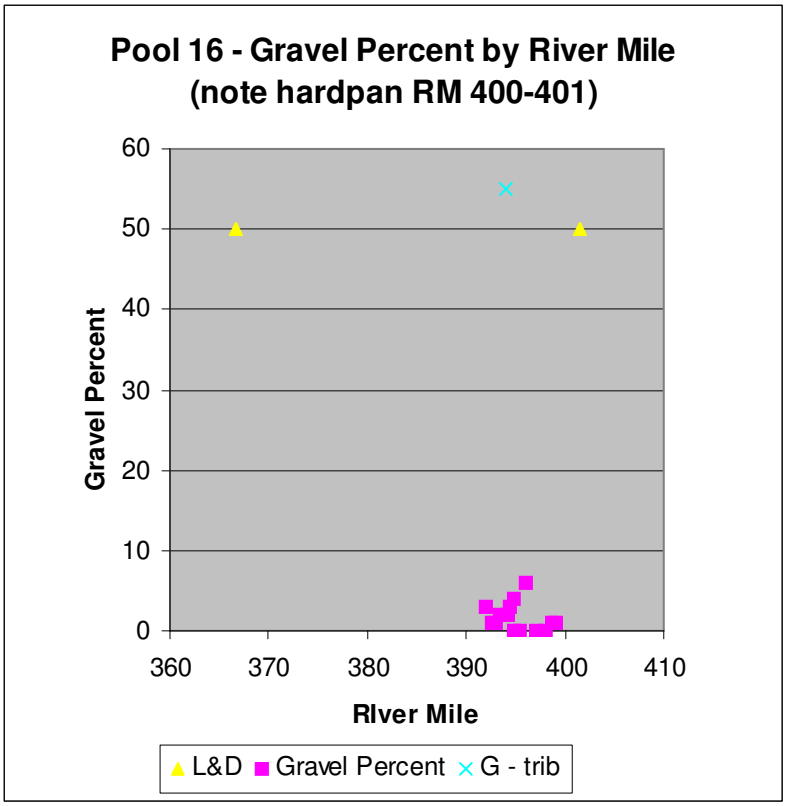

Figure 3-13. Pool 16 – Gravel Percent by River Mile

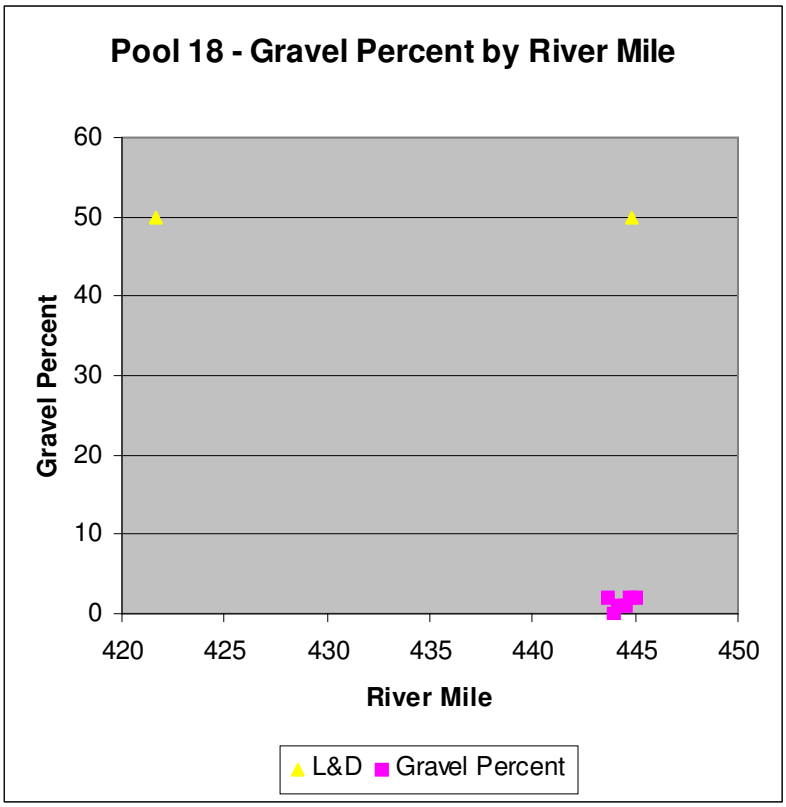

Figure 3-14. Pool 18 – Gravel Percent by River Mile

4. SIAM Modeling of Proposed Navigation Project, Pool 7, Arkansas River

Study Objective. The objective of this portion of the study was to evaluate potential impacts of the proposed navigation project on channel stability in the Arkansas River.

Study methodology. Project-related impacts on channel stability will occur through changes in sediment transport rates in affected river reaches. The magnitude and direction of these changes are driven by the hydraulic impacts of the project. If a project feature does not cause significant changes in hydraulic parameters, there should be no associated sediment (and channel stability) impacts. If a project modification does cause changes in channel shear stress, sediment transport computations are necessary to determine the magnitude of channel stability impacts. The incoming sediment load is compared to the sediment transport capacity to determine whether the channel bed will erode (if transport capacity exceeds sediment supply) or aggrade (if the inflowing sediment load exceeds the transport capacity). If sediment transport capacity is approximately equal to the inflowing sediment load, then the channel is stable (neither aggrading nor degrading) and is said to be in equilibrium. However, the determination of project impacts on channel stability derives directly from the hydraulic impacts shown by the HEC-RAS modeling.

Selection of Pool 7 for channel stability analyses. HEC-RAS models for existing and with-project conditions were obtained from Little Rock and Tulsa districts. Model results for existing ("base") and with-project ("modified") conditions were compared to locate reaches with the most sedimentation impacts. Changes in stage, channel velocity, and channel shear stress were tabulated for the entire project. Since changes in channel shear stress are the most direct indicator of changes in sediment transport rates, this was weighted most heavily in selecting reaches to model. Pool 7 has the largest change in shear stress, and also has known gravel locations that could be affected by the project.

Channel stability analyses. Long-term impacts on channel stability were evaluated using methods recommended in USACE EM 1110-2-1418, "Channel Stability Analyses for Flood Control Projects". An annual average sediment budget analysis was conducted. The sediment transport capacity as a function of discharge was integrated with an annual flow duration curve to obtain a value of annual average bed material sediment transport capacity for a given reach (values in tons per year). This value was compared with the annual average bed material inflow to the reach, in order to determine the long-term sediment balance. If the annual average sediment inflow exceeds the annual average sediment transport capacity, then bed deposition (aggradation) is indicated. If annual average sediment transport capacity exceeds the annual average sediment inflow, then bed erosion (degradation) is indicated. The differential quantity of sediment (in tons per year) can be converted to an average depth of erosion or deposition using the channel dimensions. The Sediment Impact Assessment Model (SIAM), which is described in more detail below, was used to perform sediment budget computations for this study.

Bed material load and wash load. The total sediment load can be divided into two portions: the bed material load and the wash load. The distinction is important because

the bed material load is hydraulically controlled, while the wash load is limited only by availability. The wash load is composed of grain sizes that are not found in the channel bed in significant amounts. For practical purposes, the stream can carry a quantity limited only by availability of material. The bed material load is composed of the grain sizes that make up the channel bed. The stream has a certain finite transport capacity for bed material, which is functionally related to hydraulic variables such as shear stress. The evaluation of channel stability focuses on the bed material load. The sediment sizes finer than the smallest 10 percent of the bed material are commonly designated as wash load. This usually includes silts and clays, and often includes different sand fractions. The dividing grain size between wash load and bed material load can (and often does) vary between river reaches.

SIAM model. Pool 7 was modeled with SIAM to assess impacts of project features. SIAM uses the hydraulic output from HEC-RAS to compute average hydraulic parameters for reaches selected by the user. The hydraulic data is used in conjunction with sediment and hydrology data input by the user to compute average annual sediment transport capacity and average annual erosion or deposition in tons per year, per reach, for existing and modified conditions. Since the model was not precisely calibrated, the absolute values of the average annual aggradation or degradation are not exact; rather, its proper utility in this type of situation is to compare relative changes between with and without project features. The model will give a reasonable representation of the trend and magnitude of the impacts of channel and flow alterations on channel stability, as well as a reasonable picture of the sensitivity of the impacts to changes in various parameters.

Sediment reaches. Pool 7 was broken up into five reaches:

Reach	**Navigation Mile**
Reach 1	148-155
Reach 2	141-147
Reach 3	135-141
Reach 4	128-135
Reach 5	125-127

The reach break points were based on several factors: project modifications (channel dredging and dikes); changes in channel cross-section or profile; and geomorphic reach boundaries.

Bed material. The USGS bed material sample data was averaged for each reach. The D_{10} of this average was used to select the size fraction of the wash load for each reach. In Reaches 1, 3, and 4, fine sand (and all smaller grain sizes) are wash load. The bed material in Reach 2 is slightly coarser; medium sand and all smaller grain sizes were designated as wash load. Reach 5, which is at the downstream end of the pool (just above the dam), has the finest bed material: very fine sand (and all smaller grain sizes) are wash load. This information is shown in Table 4-1 below.

Sediment Size	Very Fine Sand (VFS)	Fine Sand (FS)	Medium Sand (MS)	Coarse Sand (CS)
Reach 1	**Wash load**	**Wash load**	**Bed material**	**Bed material**
Reach 2	**Wash load**	**Wash load**	**Wash load**	**Bed material**
Reach 3	**Wash load**	**Wash load**	**Bed material**	**Bed material**
Reach 4	**Wash load**	**Wash load**	**Bed material**	**Bed material**
Reach 5	**Wash load**	**Bed material**	**Bed material**	**Bed material**

Table 4-1. Bed Material Load and Wash Load for Reaches 1 – 5 in Pool 7

Inflowing sediment load. Since no inflowing sediment load data were available for Pool 7, an estimate had to be made based on the report, "Downward Trend in Mississippi River Suspended-Sediment Loads", (Dardeau and Causey, 1990). This report gives an average postconstruction figure of 11.4 million tons per year suspended sediment for the Arkansas River at Little Rock. (For comparison, the preconstruction sediment load averaged 63.6 million tons per year.) Unfortunately, no gradation values for these loads were reported. Therefore, the percentages for the different size classes of sediment were based on gradation data from long-term sampling data on the Mississippi River at various locations. The breakdown into size classes was estimated as follows: 70% silt and clay (8.0 million tons); 30% sand (3.4 million tons). Since silt and clay are transported as wash load through the entire reach (they are not found in the bed in significant amounts), this fraction of the inflowing load does not affect channel stability within the reach, and was not modeled. The sand fraction of the inflowing load was broken down into four size classes:

VFS (very fine sand) - 60% or 2.0 million tons per year
FS (fine sand) - 25% or 0.85 million tons per year
MS (medium sand) - 10% or 0.34 million tons per year
CS (coarse sand) - 5% or 0.17 million tons per year

It must be re-emphasized that these data are only estimates based on previously published reports from the Mississippi River, and therefore, may not reflect actual conditions at Pool 7. Due to the uncertainty in the sediment data, an analysis was performed to evaluate the sensitivity of the model to changes in the inflowing sediment load. Results of the sensitivity analysis are discussed below.

Sediment concentration. The inflowing sand load of 3.4 million tons per year is equivalent to 80 mg/l. The total inflowing load of 11.4 million tons per year is equivalent to 265 mg/l. These values were computed using a mean discharge of 43,390 cfs, and the equation

$$Q_{sed} = 0.0027 \times Q \times \text{concentration}$$

Where Q_{sed} is the sediment load in tons per day
Q is the mean discharge
Concentration is the sediment concentration in mg/l or ppm

Hydrology. A flow duration curve for the Arkansas River at Little Rock was obtained from Tulsa District, and was used for both existing and with-project conditions. Additional HEC-RAS runs were made (for both base and modified conditions) at lower discharges to better evaluate the sediment transport capacity of frequent events. The flow duration curve was input as days per year to determine annual average values of sediment load.

Sediment transport function. The Laursen (with Copeland modification) sediment transport function was used because of its ability to handle the sand and gravel sizes found in the bed material.

Conversion of model results to depth of deposition or degradation.. Model results were given in tons per year, and converted into feet of aggradation/degradation per year (using methods recommended in EM 1110-2-1418). The average bottom width for each reach was estimated from the cross sections. The reach length was taken from the navigation mileage. A unit weight of 90 pounds per cubic foot was used for sediment density. A depth of 0.15 foot of aggradation or degradation per year was taken as the threshold for equilibrium. It should be noted that since the model evaluates conditions on a reach-averaged basis, that sedimentation conditions at any one point in the reach can be expected to vary from the average.

Evaluation of model results for existing conditions. The model results for existing conditions were evaluated to see if they corresponded with the known prototype conditions. If model inputs are reasonable, then the results should not conflict with observed conditions and common sense. Model results for existing conditions are given in Table 4-2. Reaches 1 through 4 are in equilibrium (using 0.15 ft/year as a threshold). Reach 5 is aggrading, at an estimated rate of 0.64 feet/year. Since this is the reach immediately upstream of the lock and dam, deposition would be expected. (Further investigation would improve the precision of this number, but is outside the scope of this study.) Due to the lack of comparative survey or gage trend data in Pool 7, a precise calibration of SIAM is not possible, however, the computed trends do appear reasonable, and therefore, the model should be adequate to capture the significant changes between pre- and post-project conditions.

Evaluation of model results for project conditions. As stated above, the differences between alternatives are more precise than the predictions for the alternatives themselves. The results are listed in Table 4-2. The maximum difference between project conditions and existing conditions is 0.04 foot (one-half inch) per year of average bed change. These small changes are well within the uncertainty limits of the model, and suggest that there are no discernible impacts in Pool 7.

Sensitivity analyses. Sensitivity analyses were conducted to evaluate the model's response to reasonable changes in program inputs. The sensitivity of the model was evaluated for two parameters: 1) changes in the inflowing sediment load, and 2) modification of the wash load threshold in Reach 2 (from medium sand to fine sand). The results are listed in Tables 4-3, 4-4, and 4-5. SIAM was run with the inflowing

sediment load multiplied by 1.5 and 0.5 to test the sensitivity of the results. (This would correspond to a sand fraction of 15% to 45% of the total load.) When the inflowing sediment load is multiplied by 1.5 or 0.5, the net aggradation and degradation numbers change (for reaches 1 and 5 only), but there is no change in the difference between existing and modified conditions. When the wash load grain size is changed for Reach 2, then Reach 2 becomes slightly more degradational and Reach 3 becomes slightly more aggradational. However, both reaches remain within the equilibrium range. There are no changes at other reaches. The maximum difference between existing and modified conditions increases to 0.07 foot per year, or less than one inch. This is still low enough to be categorized as no discernible impact. The results of the sensitivity analysis indicate that the modeled results are relatively insensitive to reasonable changes in program inputs.

Conclusion. A sediment budget analysis was conducted to evaluate project impacts on long-term channel stability. Pool 7 was selected for analysis because of the impacts of the project on shear stress, and the presence of gravel bars (and potential project impacts). The HEC-RAS results (for existing and with-project conditions) were used along with the SIAM model to compare sediment transport capacity to sediment inflow for the bed material load for average reach conditions. The sediment budget analysis (conducted according to methods recommended in EM1110-2-1418) showed no significant project impacts. Sensitivity runs were performed and showed no significant increase in project impacts for reasonable modifications of data inputs. The study results suggest that the hydraulic impacts of the navigation project are unlikely to cause long-term channel stability impacts. These results should be considered preliminary due to the data limitations of the model and lack of prototype information. However, the results do indicate the utility of SIAM to evaluate impacts on the Arkansas River.

Table 4-2. SIAM Results for Existing and With-Project Conditions							
Pool 7	**Comparison of Existing and With-Project Conditions**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	3,360,000		3,360,000				
Reach 1 (NM 148-155)	**93,000**	**aggradation**	**109,000**	**aggradation**	**16,000**	**0.01**	**increased aggradation**
	3,267,000		3,251,000				
Reach 2 (NM 141-147)	**-139,000**	**degradation**	**-188,000**	**degradation**	**-49,000**	**-0.03**	**increased degradation**
	3,406,000		3,439,000				
Reach 3 (NM 135-141)	**188,000**	**aggradation**	**222,000**	**aggradation**	**34,000**	**0.02**	**increased aggradation**
	3,218,000		3,217,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	3,047,000		3,045,000				
Reach 5 (NM 125-127)	**665,000**	**aggradation**	**627,000**	**aggradation**	**-38,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	2,382,000		2,418,000				
total deposition	1,117,000		1,130,000				
total erosion	-139,000		-188,000				
Sed. Outflow / Inflow	0.71		0.72				
% passing Pool 7	71%		72%				

Table 4-2. SIAM Results for Existing and With-Project Conditions

Table 4-3							
Pool 7	**Sensitivity Analysis for Inflowing Sediment Load Increased by 50%**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	5,040,000		5,040,000				
Reach 1 (NM 148-155)	**348,000**	**aggradation**	**364,000**	**aggradation**	**16,000**	**0.01**	**increased aggradation**
	4,692,000		4,676,000				
Reach 2 (NM 141-147)	**-139,000**	**degradation**	**-188,000**	**degradation**	**-49,000**	**-0.03**	**increased degradation**
	4,831,000		4,864,000				
Reach 3 (NM 135-141)	**188,000**	**aggradation**	**222,000**	**aggradation**	**34,000**	**0.02**	**increased aggradation**
	4,643,000		4,642,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	4,472,000		4,470,000				
Reach 5 (NM 125-127)	**1,090,000**	**aggradation**	**1,053,000**	**aggradation**	**-37,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	3,382,000		3,417,000				
total deposition	1,797,000		1,811,000				
total erosion	-139,000		-188,000				
out/in	0.67		0.68				
% passing Pool 7	67%		68%				

Table 4-3. Sensitivity Analysis for Inflowing Sediment Load Increased by 50%

Table 4-4							
Pool 7	**Sensitivity Analysis for Inflowing Sediment Load Decreased by 50%**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	1,680,000		1,680,000				
Reach 1 (NM 148-155)	**-162,000**	**degradation**	**-146,000**	**degradation**	**16,000**	**0.01**	**decreased degradation**
	1,842,000		1,826,000				
Reach 2 (NM 141-147)	**-139,000**	**degradation**	**-188,000**	**degradation**	**-49,000**	**-0.03**	**increased degradation**
	1,981,000		2,014,000				
Reach 3 (NM 135-141)	**188,000**	**aggradation**	**222,000**	**aggradation**	**34,000**	**0.02**	**increased aggradation**
	1,793,000		1,792,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	1,622,000		1,620,000				
Reach 5 (NM 125-127)	**240,000**	**aggradation**	**203,000**	**aggradation**	**-37,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	1,382,000		1,417,000				
total deposition	599,000		597,000				
total erosion	-301,000		-334,000				
out/in	0.82		0.84				
% passing Pool 7	82%		84%				

Table 4-4. Sensitivity Analysis for Inflowing Sediment Load Decreased by 50%

Table 4-5							
Pool 7	**Sensitivity Analysis for Modified Wash Load Threshold in Reach 2**						
Sand load only	Tons per average year						
	agg (+) and deg (-)						
Reach	**Existing conditions**		**With-Project conditions**		**Project impact**		**Direction of impact**
	(tons)		(tons)		(tons)	(feet)	
Inflowing sand load	3,360,000		3,360,000				
Reach 1 (NM 148-155)	**93,000**	**aggradation**	**109,000**	**aggradation**	**16,000**	**0.01**	**increased aggradation**
	3,267,000		3,251,000				
Reach 2 (NM 141-147)	**-193,000**	**degradation**	**-305,000**	**degradation**	**-112,000**	**-0.07**	**increased degradation**
	3,460,000		3,556,000				
Reach 3 (NM 135-141)	**242,000**	**aggradation**	**339,000**	**aggradation**	**97,000**	**0.06**	**increased aggradation**
	3,218,000		3,217,000				
Reach 4 (NM 128-135)	**171,000**	**aggradation**	**172,000**	**aggradation**	**1,000**	**0.00**	**no change**
	3,047,000		3,045,000				
Reach 5 (NM 125-127)	**665,000**	**aggradation**	**627,000**	**aggradation**	**-38,000**	**-0.04**	**decreased aggradation**
Outflowing sand load	2,382,000		2,418,000				
total deposition	1,171,000		1,247,000				
total erosion	-193,000		-305,000				
out/in	0.71		0.72				
% passing Pool 7	71%		72%				

Table 4-5. Sensitivity Analysis for Modified Wash Load Threshold in Reach 2

5. References

Brice, J. C. (1975). Airphoto Interpretation of the Form and Behavior of Alluvial Rivers. Final Report to the U.S. Army Research Office – Durham, Box CM, Duke Station, Durham, NC 27706, prepared under contract number DA-ARD-D-31-124-70-G89, Washington University, St. Louis, pp. 1-10.

Dardeau, E. A., Jr. and Causey, E. M. (1990). "Downward Trend in Mississippi River Suspended-Sediment Loads," Potomology Program (P-1), Report 5, Environmental Laboratory, US Army Engineer Waterways Experiment Station, Vicksburg, MS. Prepared for US Army Engineer District, New Orleans.

Smith, L. M., and Breland, P. L. (authors); edited by J. Dunbar and S. Jackson (2004). "Geomorphological Reconnaissance of the McClellan-Kerr Arkansas River Navigation System Dardanelle Lock and Dam to the Mississippi River," Geotechnical and Structures Laboratory, US Army Research and Development Center, Vicksburg, MS, prepared for the US Army Engineer District, Little Rock.

U.S. Army Corps of Engineers, Headquarters (1994). "Channel Stability Assessment for Flood Control Projects," Engineering Manual 1110-2-1418, Washington, DC.

C.12

Prime Farmland Coordination

C.12: Prime Farmland Coordination

C.12.1 Introduction

Federal agencies involved in proposed projects that may convert farmland, as defined in the Farmland Protection Policy Act, to nonagricultural uses, are required to coordinate a review to determine the quality of the farmland that may be impacted by the proposed project. The United States Department of Agriculture, Natural Resources Conservation Service (NRCS) is tasked with rating the relative value of the farmland to be converted on a scale of 0 to 100.

The Arkansas River Navigation Study has identified several agricultural land parcels that could be converted to nonagricultural uses if the study becomes a project and is implemented. These parcels are associated with creating new dredge material disposal sites necessary for the potential deepening of the navigation channel and ongoing navigation channel maintenance. These agricultural parcels were selected in lieu of high quality wildlife habitat to minimize the impacts to biological resources associated with project implementation.

The farmland parcels potentially influenced by project implementation include the following:

- 81 acres in LeFlore County, Oklahoma
- 159 acres in Muskogee County, Oklahoma
- 68 acres in Wagoner County, Oklahoma
- 308 acres in Arkansas County, Arkansas

C.12.2 Coordination & Form AD-1006

Copies of correspondence documenting the process associated with the review of potential farmland conversion impacts are included in the following pages:

Item	Date	Page
Letter to Poteau Field Service Center (LeFlore County) requesting coordination	May 24, 2005	C-914
Letter to Muskogee Field Service Center requesting coordination	May 24, 2005	C-915
Letter to Wagoner Field Service Center requesting coordination	May 24, 2005	C-916
Letter to Dewitt Field Service Center (Arkansas County) requesting coordination	May 24, 2005	C-917
Poteau Field Service Center response form AD-1006	June 14, 2005	C-918
Wagoner Field Service Center response letter and maps	June 27, 2005	C-919
Muskogee Field Service Center response form AD-1006	June 28, 2005	C-920
Dewitt Field Service Center response form AD-1006	June 28, 2005	C-921

C.12.3 Form AD-1006 Summary

A summary of the results of the Farmland Protection Policy Act AD-1006 determinations is present below.

Table C.12.1 Summary of Farmland Protection Policy Act AD-1006 determinations for Arkansas River Navigation Study EIS.

	Part III A & B	Part III C	Part IV A	Part IV B	Part IV C	Part IV D	Part V	Part VI
County	Acres to be Converted	Total Acres in Site	Total Acres of Prime and Unique Farmland	Total Acres Statewide and Local Important Farmland	% of Farmland in County to be Converted	% of Farmland in county with Same or Higher Relative Value	Relative Value of Farmland to be converted	Total Site Assessment Points
LeFlore	81	81	45	0	0.004	1.3	100	159
Muskogee	159	159	145	0	0.043	45	84	140
Wagoner**	-	-	-	-	-	-	-	-
Arkansas	308	308	308	176,628	0.074	0.074	84	128

Forms AD-1006 have not been completed NRCS for Wagoner county.
Source: NRCS 2005

**This information was not provided for Wagoner County in the response letter.

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May 24, 2005

USDA – Natural Resources Conservation Service
Poteau Field Service Center
P.O. Box 547
Poteau, OK 74953

ATTN: Kenneth Risenhoover, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Risenhoover:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the LeFlore County disposal area.

The LeFlore County portion of the Arkansas Navigation Study comprises approximately 26,612 acres. The LeFlore County disposal area comprises approximately 81 acres and is depicted in the attached figure. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

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May 24, 2005

USDA – Natural Resources Conservation Service
Muskogee Field Service Center
3001 Azalea Park Drive, Suite 1
Muskogee, OK 74401

ATTN: Steven Clark, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Clark:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the Muskogee County disposal area.

The Muskogee County portion of the Arkansas Navigation Study comprises approximately 46,709 acres. The Muskogee County disposal area comprises approximately 159 acres and is depicted in the attached figure. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

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Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

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May 24, 2005

USDA – Natural Resources Conservation Service
Wagoner Field Service Center
1312 S.W. 3rd
Wagoner, OK 74467-5518

ATTN: Brent Pannell, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Pannell:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the Wagoner County disposal area.

The Wagoner County portion of the Arkansas Navigation Study comprises approximately 40,182 acres. The Wagoner County disposal area comprises approximately 68 acres and is depicted in the attached figures. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

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May 24, 2005

USDA – Natural Resources Conservation Service
1015 West 2nd Street
DeWitt, AR 72042

ATTN: Marshall Handcock, District Conservationist

Re: Environmental Impact Statement, Arkansas River Navigation Study

Dear Mr. Handcock:

We are providing services to the U.S. Army Corps of Engineers (USACE) in preparation of the Environmental Impact Statement for the Arkansas River Navigation Study.

Attached please find the following:

1) Farmland Conservation Impact Rating Form with Parts 1 and 3 completed.
2) A figure indicating the Arkansas County disposal area.

The Arkansas County portion of the Arkansas Navigation Study comprises approximately 23,446 acres. The Arkansas County disposal area comprises approximately 308 acres and is depicted in the attached figure. The USACE intends to dispose of dredge material on these parcels and reuse of these parcels will be under the guidance of the USACE. Reuse plans developed to date do not include agricultural reuses, consequently the USACE assumes, for analysis purposes, that any prime farmland within the disposal area will be converted to non agricultural uses.

We would greatly appreciate if you could complete the enclosed Farmland Conservation Impact Rating Form and return it to our office. We would also like assistance in determining the answers to part VI, number 5 if possible. Thank you for your assistance in this matter, if you have any questions or require additional information please do not hesitate to call Ginny Flynn or me at (314) 576-7330.

Sincerely,

PARSONS

Richard E. Hall
Arkansas River Navigation Study, EIS Project Manager

Farmland Conversion Impact Rating Form AD-1006 from Poteau Field Service Center.

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*

1. Name of Project: Arkansas River Navigation Study EIS
2. Type of Project: Navigation
3. Date of Land Evaluation Request: 5/24/05
4. Sheet 1 of _____
5. Federal Agency Involved: U.S. Army Corps of Engineers - Little Rock and Tulsa Dist.
6. County and State: Le Flore, Oklahoma

PART II *(To be completed by NRCS)*

1. Date Request Received by NRCS: 6/13/05
2. Person Completing Form: Kenneth Risenhoover
3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form). YES ☒ NO ☐
4. Acres Irrigated: 0 | Average Farm Size: 264
5. Major Crop(s): Wheat
6. Farmable Land in Government Jurisdiction: Acres: 372,281 % 36
7. Amount of Farmland As Defined in FPPA: Acres: 230,041 % 23
8. Name Of Land Evaluation System Used: LeFlore Co. LESA
9. Name of Local Site Assessment System: None
10. Date Land Evaluation Returned by NRCS: 6/14/05

PART III *(To be completed by Federal Agency)*

	Alternative Corridor For Segment			
	Corridor A	Corridor B	Corridor C	Corridor D
A. Total Acres To Be Converted Directly	81			
B. Total Acres To Be Converted Indirectly, Or To Receive Services	0			
C. Total Acres In Corridor	81	0	0	0
PART IV *(To be completed by NRCS) Land Evaluation Information*				
A. Total Acres Prime And Unique Farmland	45			
B. Total Acres Statewide And Local Important Farmland	—			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted	.004			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value	1.3			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)*	100			

PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))*	Maximum Points				
1. Area in Nonurban Use	15	15.			
2. Perimeter in Nonurban Use	10	10.			
3. Percent Of Corridor Being Farmed	20	20			
4. Protection Provided By State And Local Government	20	0			
5. Size of Present Farm Unit Compared To Average	10	4			
6. Creation Of Nonfarmable Farmland	25	0			
7. Availablility Of Farm Support Services	5	5			
8. On-Farm Investments	20	5			
9. Effects Of Conversion On Farm Support Services	25	0			
10. Compatibility With Existing Agricultural Use	10	0			
TOTAL CORRIDOR ASSESSMENT POINTS	160	59	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland (From Part V)	100	100			
Total Corridor Assessment (From Part VI above or a local site assessment)	160				
TOTAL POINTS *(Total of above 2 lines)*	260	159			

1. Corridor Selected:
2. Total Acres of Farmlands to be Converted by Project:
3. Date Of Selection:
5. Reason For Selection:

If you have any questions, please call me at (918) 647-2992 Ext. 3.

Thanks,
Kenneth Risenhoover
Dist. Cons.
Poteau F.O.

Signature of Person Completing this Part:

NOTE: Complete a form for each segment with more than one Alternate Corridor

Farmland Conversion Impact Rating Form AD-1006 from Muskogee Field Service Center.

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*	3. Date of Land Evaluation Request 5/23/05	4. Sheet 1 of _____
1. Name of Project **Arkansas River Navigation Study EIS**	5. Federal Agency Involved **U.S. Army Corps of Engineers - Little Rock and Tusla District**	
2. Type of Project **Navigation**	6. County and State **Muskogee County, Oklahoma**	
PART II *(To be completed by NRCS)*	1. Date Request Received by NRCS May 25, 2005	2. Person Completing Form Steven Clark
3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form). YES ☒ NO ☐		4. Acres Irrigated 86 / Average Farm Size 202
5. Major Crop(s) Soybean, Wheat, Corn	6. Farmable Land in Government Jurisdiction Acres: 159 % 100	7. Amount of Farmland As Defined in FPPA Acres: 159 %100
8. Name Of Land Evaluation System Used LESA	9. Name of Local Site Assessment System LESA	10. Date Land Evaluation Returned by NRCS June 23, 2005

PART III *(To be completed by Federal Agency)*	Alternative Corridor For Segment _____			
	Corridor A	Corridor B	Corridor C	Corridor D
A. Total Acres To Be Converted Directly	159			
B. Total Acres To Be Converted Indirectly, Or To Receive Services	0			
C. Total Acres In Corridor	159	0	0	0
PART IV *(To be completed by NRCS) Land Evaluation Information*				
A. Total Acres Prime And Unique Farmland	144.6			
B. Total Acres Statewide And Local Important Farmland	0			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted	0.043			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value	45%			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)*	Refer to	Reasons for	Selection	
PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))* — Maximum Points				
1. Area in Nonurban Use — 15				
2. Perimeter in Nonurban Use — 10				
3. Percent Of Corridor Being Farmed — 20				
4. Protection Provided By State And Local Government — 20				
5. Size of Present Farm Unit Compared To Average — 10	Refer to	Reasons for	Selection	
6. Creation Of Nonfarmable Farmland — 25				
7. Availablility Of Farm Support Services — 5				
8. On-Farm Investments — 20				
9. Effects Of Conversion On Farm Support Services — 25				
10. Compatibility With Existing Agricultural Use — 10				
TOTAL CORRIDOR ASSESSMENT POINTS — 160	0	0	0	0
PART VII *(To be completed by Federal Agency)*				
Relative Value Of Farmland (From Part V) — 100				
Total Corridor Assessment (From Part VI above or a local site assessment) — 160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)* — 260	0	0	0	0

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:	4. Was A Local Site Assessment Used? YES ☐ NO ☐

Part V
5. Reason For Selection:
Site A – 88.66
Site B – 93.76
Site C – 66.61
Site D – 74.64
Site E – 100
Site F – 79.57

Part VI #5
Site A – 1.3
Site B – 2.2
Site C – 1.7
Site D – 1.5
Site E – 1
Site F – 1

Signature of Person Completing this Part: DATE

NOTE: Complete a form for each segment with more than one Alternate Corridor

Farmland Conversion Impact Rating Form AD-1006 from Wagoner Field Service Center.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
1900 West Will Rogers Circle, Suite A
Claremore, OK 74017
(918) 341-3222

RECEIVED
JUN 2 7 2005
PARSONS
ST. LOUIS

June 23, 2005

Richard E Hall
Parsons
400 Woods Mill Road South, Suite 330
St. Louis, MO 63017

Re: Environmental Impact Statement

Dear Mr. Hall:

I have attached soil maps, a Prime Farmland list for Wagoner County, Oklahoma, and a listing of soils indicating whether the soils are prime or not.

The Form NRCS-CPA-106 was designed to compare alternate sites. Prime farmland is included in areas A and E, however the site was not rated because of lack of alternate sites.

The soils on site "A" are:

BaF- Barge silty clay loam, 0 to 30 percent slopes Not Prime Farmland
(This soil is loamy material excavated from the waterway)

Ra- Radley silt loam, 0 to 1 percent slopes, occasionally flooded Prime Farmland

The soils on site "B" are:

BaF Not Prime Farmland
Os- Osage silty clay loam, 0 to 1 percent slopes, occasionally flooded Not Prime Farmland
Oy- Osage clay, 0 to 1 percent slopes, occasionally flooded Not Prime Farmland

The soils on site "C" are:

Os- Not Prime Farmland
Oy- Not Prime Farmland

The soils on site "D" are:

Os- Not Prime Farmland
Oy- Not Prime Farmland

The soils on site "E" are:

Ra- Prime Farmland
Ma- Mason silt loam, 0 to 1 percent slopes Prime Farmland
Mo- Moreland clay, 0 to 1 percent slopes, occasionally flooded Not Prime Farmland

If you have questions, please contact me.

Sincerely,

Richard T. McCright

Richard T. McCright
Resource Soil Scientist

The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

An Equal Opportunity Provider and Employer

Wagoner County, Oklahoma
Table Y.--Prime Farmland

Print date: 06/22/2005

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name.)

Map symbol	Soil name
BbB	Bates fine sandy loam, 1 to 3 percent slopes
BbC	Bates fine sandy loam, 3 to 5 percent slopes
Cd	Choska silt loam, 0 to 1 percent slopes, occasionally flooded
ChB	Choteau silt loam, 1 to 3 percent slopes
DnB	Dennis silt loam, 1 to 3 percent slopes
DnC	Dennis silt loam, 3 to 5 percent slopes
KfC	Kamie fine sandy loam, 1 to 5 percent slopes
Ko	Kiomatia fine sandy loam, 0 to 1 percent slopes, occasionally flooded
LnB	Linker fine sandy loam, 1 to 3 percent slopes
LuB	Lula silt loam, 1 to 3 percent slopes
Ma	Mason silt loam, 0 to 1 percent slopes, rarely flooded
NeB	Newtonia silt loam, 1 to 3 percent slopes
NeC	Newtonia silt loam, 3 to 5 percent slopes
OaB	Okay loam, 1 to 3 percent slopes
OaC	Okay loam, 3 to 5 percent slopes
OkA	Okemah silt loam, 0 to 1 percent slopes
PaA	Parsons silt loam, 0 to 1 percent slopes
Ra	Radley silt loam, 0 to 1 percent slopes, occasionally flooded
RbcA	Roebuck clay, 0 to 1 percent slopes, rarely flooded
SuB	Summit silty clay loam, 1 to 3 percent slopes
SuC	Summit silty clay loam, 3 to 5 percent slopes
TaA	Taloka silt loam, 0 to 1 percent slopes
TaB	Taloka silt loam, 1 to 3 percent slopes

2
WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 2
N
R. 15 E.
R. 16 E.
ROGERS COUNTY
2 705 000 FEET
430 000 FEET
T. 19 N.
(Joins sheet 1)
(Joins sheet 4)
(Joins inset, sheet 5)
2 685 000 FEET
420 000 FEET
1 Mile
5000 Feet
Scale 1:20000
Salt Creek
VERDIGRIS RIVER
BIG BOTTOM
ROGERS COUNTY
site A
WAGONER COUNTY, OKLAHOMA NO. 2
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 8
8
N
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 15)
R. 16 E.
R. 17 E.
ROGERS COUNTY
T. 18 N.
2 730 000 FEET
400 000 FEET
385 000 FEET
2 710 000 FEET
1 Mile
5000 Feet
Scale 1:20000
GOODHOPE BOTTOM
GUINN BOTTOM
OX BOWS OF THE VERDIGRIS RIVER
VERDIGRIS RIVER
NEWT GRAHAM LOCK (LOCK AND DAM NO 18)
Old River Channel
Coal Creek
Little Long Lake
Legas Lake
water
Tract B
WAGONER COUNTY, OKLAHOMA NO. 8
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
WAGONER COUNTY, OKLAHOMA NO. 9

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 15

WAGONER COUNTY, OKLAHOMA NO. 14

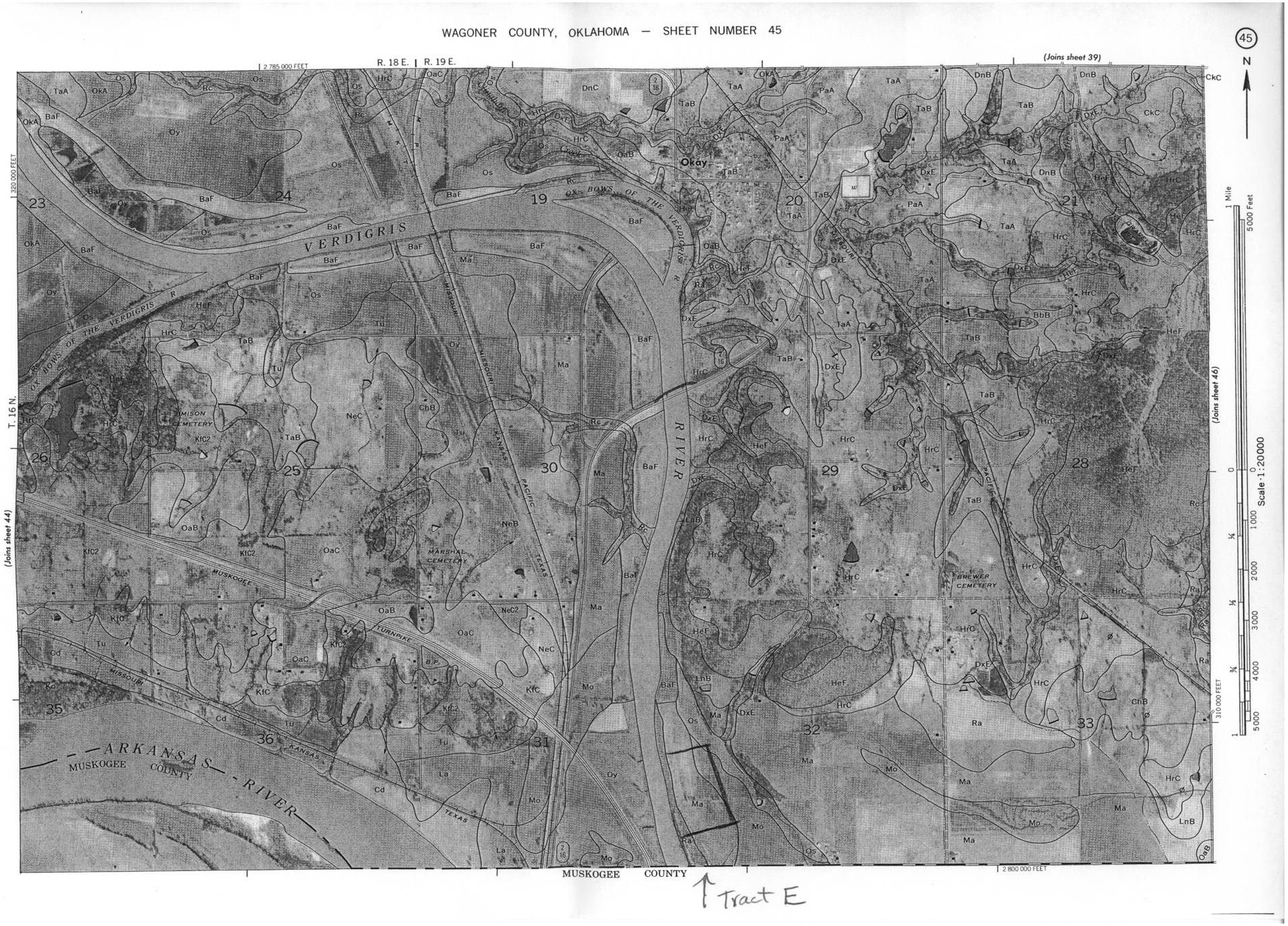
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

22
WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 22
N
(Joins sheet 15)
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 29)
R. 16 E.
R. 17 E.
T. 17 N.
2 730 000 FEET
365 000 FEET
355 000 FEET
2 715 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
OX BOWS OF THE VERDIGRIS RIVER
VERDIGRIS
RIVER
Horseshoe Bend
Fite Creek
Gar Creek
BORROW PIT
TURNPIKE
B.P.
site D
WAGONER COUNTY, OKLAHOMA NO. 22
WAGONER COUNTY, OKLAHOMA NO. 23

WAGONER COUNTY, OKLAHOMA NO. 44

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
This map is compiled on 1972 Oklahoma State Plane Coordinate System, North Zone. Other agencies and organizations may use other coordinate systems and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 45



Farmland Conversion Impact Rating Form AD-1006 from DeWitt Field Service Center.

U.S. DEPARTMENT OF AGRICULTURE
Natural Resources Conservation Service

NRCS-CPA-106
(Rev. 1-91)

FARMLAND CONVERSION IMPACT RATING FOR CORRIDOR TYPE PROJECTS

PART I *(To be completed by Federal Agency)*	3. Date of Land Evaluation Request 5/24/05 — 4. Sheet 1 of _____
1. Name of Project: Arkansas River Navigation Study EIS	5. Federal Agency Involved: U.S. Army Corps of Engineers - Little Rock and Tulsa Dist.
2. Type of Project: Navigation	6. County and State: Arkansas County, Arkansas

PART II *(To be completed by NRCS)*	1. Date Request Received by NRCS: 5/26/05	2. Person Completing Form: Marshall Handback
3. Does the corridor contain prime, unique statewide or local important farmland? YES ☒ NO ☐ (If no, the CPPA does not apply - do not complete additional parts of this form).		4. Acres Irrigated Average Farm Size: 800
5. Major Crop(s): Rice and Soybeans	6. Farmable Land in Government Jurisdiction: Acres: %	7. Amount of Farmland As Defined in CPPA: Acres: 412,906 %
8. Name of Land Evaluation System Used: LESA	9. Name of Local Site Assessment System: Published County Soil Survey	10. Date Land Evaluation Returned by NRCS: 6/28/05

PART III *(To be completed by Federal Agency)*	Alternative Corridor For Segment _____			
	Corridor A	Corridor B	Corridor C	Corridor D
A. Total Acres To Be Converted Directly	308			
B. Total Acres To Be Converted Indirectly, Or To Receive Services	0			
C. Total Acres In Corridor	308	0	0	0
PART IV *(To be completed by NRCS) Land Evaluation Information*				
A. Total Acres Prime And Unique Farmland	308			
B. Total Acres Statewide And Local Important Farmland	176,628			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted	.174			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value	.074			
PART V *(To be completed by NRCS) Land Evaluation Information Criterion Relative Value Of Farmland To Be Serviced Or Converted (Scale Of 0 - 100 Points)*	84.5			

PART VI *(To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))*	Maximum Points				
1. Area In Nonurban Use	15				
2. Perimeter In Nonurban Use	10				
3. Percent Of Corridor Being Farmed	20				
4. Protection Provided By State And Local Government	20	4			
5. Size of Present Farm Unit Compared To Average	10				
6. Creation Of Nonfarmable Farmland	25				
7. Availability Of Farm Support Services	5				
8. On-Farm Investments	20				
9. Effects Of Conversion On Farm Support Services	25				
10. Compatibility With Existing Agricultural Use	10				
TOTAL CORRIDOR ASSESSMENT POINTS	160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland (From Part V)	100				
Total Corridor Assessment (From Part VI above or a local site assessment)	160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	0	0	0	0

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:	4. Was A Local Site Assessment Used? YES ☐ NO ☐

5. Reason For Selection:

Signature of Person Completing this Part: DATE

NOTE: Complete a form for each segment with more than one Alternate Corridor