APPENDIX L: RAPID GEOMORPHIC ASSESSMENTS (RGA) CONDUCTED FOR THE PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE IN 2008 AND 2016

L-1: RAPID GEOMORPHIC ASSESSMENT OF BOIS D'ARC CREEK AND ITS TRIBUTARIES FOR THE LOWER BOIS D'ARC CREEK RESERVOIR PROJECT (2008)

L-2: SUPPLEMENTAL RAPID GEOMORPHIC ASSESSMENT DATA COLLECTION AT THE PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE (2016)

Phase I

Rapid Geomorphic Assessment of Bois d'Arc Creek and its Tributaries for the Lower Bois d'Arc Creek Reservoir Project

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Rapid Geomorphic Assessment of Bois d'Arc Creek and its Tributaries
for the
Lower Bois d'Arc Creek Reservoir Project

Table of Contents

Executive Summary i

1.0 Introduction 1

2.0 Basin History 3
- **2.1 Ecoregions** 3
- **2.2 Geologic Setting** 5
- **2.3 Soils** 7
- **2.4 Historical Land Use Practices** 8

3.0 Incised Channel Evolution Model 10

4.0 Methods 13
- **4.1 Field Collected Data** 13
- **4.2 Channel Stability Variables** 20
- **4.3 Channel Stability Rating** 24

5.0 Results 26
- **5.1 Bois d'Arc Creek** 26
- **5.2 Honey Grove Creek** 47
- **5.3 Ward Creek** 53
- **5.4 Bullard Creek** 58
- **5.5 Sandy Creek** 63
- **5.6 Summary of Stream Classification** 68

Appendix A – Rapid Assessment Classification Forms

Appendix B - References

Appendix C – Glossary of Terms

List of Figures:

Figure 1.1 – Location Map 1
Figure 2.2 – Geologic Map 4
Figure 3.1 – Incised Channel Evolution Model 9
Figure 4.1 – Data Collection Points 1
Figure 4.2 – Data Collection Sheet 2
Figure 4.3 – Bank Stability Form 3
Figure 4.4 –Channel Stability Form 1
Figure 4.5 – Rapid Assessment Classification Sheet 6
Figure 5.1 – Bois d'Arc Creek Reach Locations 9
Figure 5.2 – Bois d'Arc Creek Longitudinal Profile 9
Figure 5.2 – Bois d'Arc Creek Longitudinal Profile 10
Figure 5.3 – Bois d'Arc Creek Longitudinal Profile 11
Figure 5.4 - Comparison of Historic to Existing Channel Alignment for Reach 1 of Bois d'Arc Creek 12
Figure 5.5 - Reach 1 of Bois d'Arc Creek. 13
Figure 5.6 - Chute Cutoff in Reach 2 of Bois d'Arc Creek 13
Figure 5.7 - Reach 2 of Bois d'Arc Creek during winter 14
Figure 5.8 - Reach 2 of Bois d'Arc Creek during summer 14
Figure 5.8b - Reach 2 of Bois d'Arc Creek showing the formation of an inner berm. 15
Figure 5.9 - Comparison of Historic to Existing Channel Alignment for Reach 3 of Bois d'Arc Creek 16
Figure 5.10 - Reach 3 of Bois d'Arc Creek during summer. 16
Figure 5.11 - Reach 3 of Bois d'Arc Creek during winter. 17
Figure 5.12 - Comparison of Historic to Existing Channel Alignment for Reach 4 of Bois d'Arc Creek 18
Figure 5.13 - Reach 4 of Bois d'Arc Creek during winter 18
Figure 5.14 - Reach 4 of Bois d'Arc Creek after summer rain event 19
Figure 5.15 - Comparison of Historic to Existing Channel Alignment for Reach 5 of Bois d'Arc Creek 20
Figure 5.16 - A "poor" rated reach on Reach 5 of Bois d'Arc Creek. 21
Figure 5.17 - A "fair" rated reach on Reach 5 of Bois d'Arc Creek. 21
Figure 5.18 - A "poor" rated reach on Reach 5 of Bois d'Arc Creek. 22
Figure 5.19 - A "fair" rated reach on Reach 5 of Bois d'Arc Creek. 22

Figure 5.20 – Bois d'Arc Creek Classification 24
Figure 5.21 – Bois d'Arc Creek Classification 25
Figure 5.22 – Bois d'Arc Creek Classification 26
Figure 5.23 – Bois d'Arc Creek Classification 27
Figure 5.24 - Comparison of Historic to Existing Channel Alignment on Honey Grove Creek. 28
Figure 5.25 – Honey Grove Creek Longitudinal Profile 30
Figure 5.26: Poor rated section of Honey Grove Creek along lower reach. 31
Figure 5.27: Fair rated section of Honey Grove Creek along lower reach. 31
Figure 5.28: Fair rated section of Honey Grove Creek along upper reach. 32
Figure 5.29 – Honey Grove Creek Classification 33
Figure 5.30 - Comparison of Historic to Existing Channel Alignment on Ward Creek. 34
Figure 5.31 – Ward Creek Longitudinal Profile 35
Figure 5.32 – Typical view of Ward Creek 36
Figure 5.33 - View of Ward Creek with evidence of mass wasting. 36
Figure 5.34 – Ward Creek Classification 38
Figure 5.35 - Comparison of Historic to Existing Channel Alignment on Bullard Creek. 39
Figure 5.36 – Bullard Creek Longitudinal Profile 40
Figure 5.37 - A "poor" rated stream on Bullard Creek. 41
Figure 5.38 - A "fair" rated stream on Bullard Creek 41
Figure 5.39 – Bullard Creek Classification 43
Figure 5.40 - Comparison of Historic to Existing Channel Alignment on Sandy Creek. . 44
Figure 5.41 – Sandy Creek Longitudinal Profile 46
Figure 5.42: Typical View of Sandy Creek with vertical side slopes. 47
Figure 5.43: Typical view of Sandy Creek with flatter side slopes. 47
Figure 5.44 – Sandy Creek Classification 48

List of Tables:

Table 4.1 - Field Data Points 1
Table 5.1 - Summary of Lower Bois d'Arc Creek Reach Information 7
Table 5.2 – Channel Classification 50

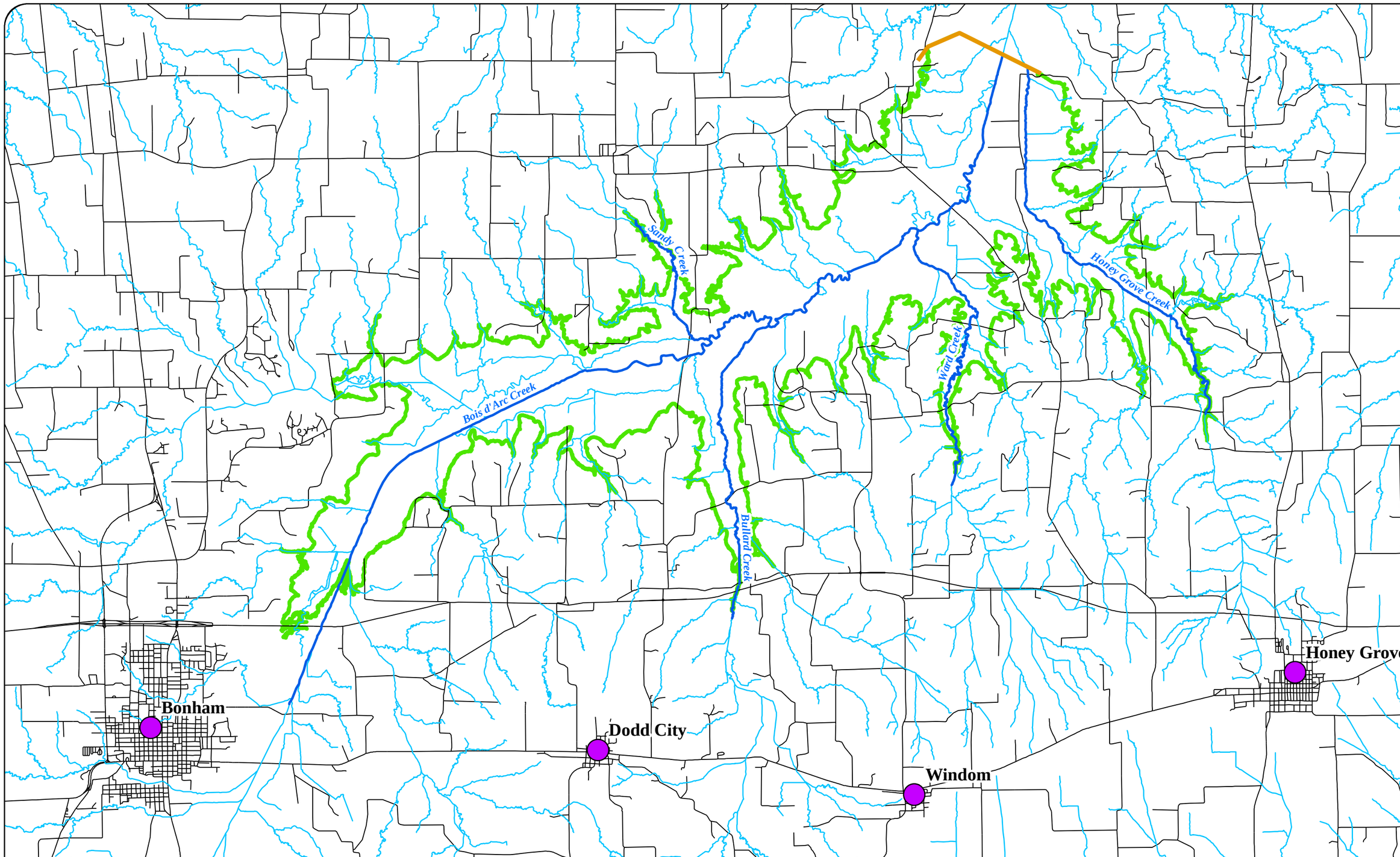
Executive Summary

Introduction

The North Texas Municipal Water District (NTMWD) is proposing to build an approximately 367,600 acre-foot water supply reservoir (Lower Bois d'Arc Creek Reservoir) on Bois d'Arc and Honey Grove Creeks approximately 15 miles northeast of Bonham in Fannin County, Texas. The primary objective of this study is to perform a rapid geomorphic stability assessment of Bois d'Arc Creek and four major tributaries (Honey Grove Creek, Sandy Creek, Ward Creek, and Bullard Creek) within the inundation pool of the proposed reservoir (Figure ES-1). In terms of reconnaissance and information evaluation, this rapid assessment is similar to Step 1 of the "Texas Instream Flow Studies: Technical Overview" (TWDB, 2008). The results of this geomorphic assessment will be used in conjunction with the environmental report and habitat assessment developed by Freese and Nichols, Inc. (FNI) to describe the existing conditions of the riverine system.

The stream channel patterns and characteristics of the Bois d'Arc system are greatly influenced by the geologic lithology and structure occurring in Fannin County. In general, the streams and creeks in Fannin County, including Bois d'Arc Creek, flow in channels cut through alluvium and fluviatile terrace deposits which were deposited by larger streams during the Pleistocene and Holocene Epochs of the Quaternary Period (USDA, 2001). The alluvial deposits in the channels of Bois d'Arc Creek, Sandy Creek, Bullard Creek, Ward Creek, and Honey Grove Creek were derived from Upper Cretaceous bedrock which lies directly beneath the alluvium (USDA, 2001). This Upper Cretaceous bedrock is also visible at the surface on either side of the respective stream channels (BEG, 1967).

According to a historical map dated circa 1915 and aerial photography dated 1950, 1970, and 2005, the land surrounding the Bois d'Arc Creek system remains largely undeveloped, rural land predominantly used for agricultural purposes. There is evidence by the historical data that landowners have modified the terrain by digging drainage channels through their property, bypassing and sometimes abandoning the natural riverine system. This channelization has resulted in the creeks incising, causing down cutting of the channel bottom throughout the reaches.



Stream
Road
Proposed Reservoir
Rapid Assessment Reach
Proposed Dam

0 1.25 2.5 5 Miles

FN PROJECT NO. ABC07999
DATE September 2008
DATUM & COORDINATE SYSTEM NAD83 State Plane TX Central
FILE Fig1o1_Location.mxd
PREPARED BY JM

North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Location

Freese and Nichols
10814 Jollyville Road
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Fax: (512) 617-3101

FIGURE
ES-1

Objectives

The primary objective of this study is to perform a rapid geomorphic stability assessment of Bois d'Arc Creek and four major tributaries (Honey Grove Creek, Sandy Creek, Ward Creek, and Bullard Creek) within the inundation pool of the proposed reservoir. The results of this rapid assessment will be used in conjunction with the environmental report and habitat assessment developed by Freese and Nichols, Inc. (FNI) to describe the existing conditions of the riverine system. The rapid geomorphic assessment will be based on general stream stability, riparian vegetation, and potential for instream habitat.

This assessment is the first step to further studies that will be required for instream flow determinations, sediment transport analysis, and eventually evaluating downstream mitigation and restoration opportunities. The results of this study will be used to classify the study reaches as good, fair, or poor for use in conjunction with the environmental report, habitat assessment, and 404 permit application to aide in describing the existing conditions of the riverine system upstream of the dam.

Methodology

The existing physical characteristics of the main stem of Bois d'Arc Creek and its major tributaries were developed using a combination of field collected data, current one-foot LIDAR generated topography, current two-foot aerial topography, and both current and historic aerial photography/mapping. The channel classification procedure used for this phase of analysis is based on a rapid assessment of the stream geomorphic properties and characteristics of the main stem of Bois d'Arc Creek (upstream of the proposed dam) and four (4) major tributaries: Honey Grove Creek, Ward Creek, Bullard Creek, and Sandy Creek.

The rapid assessments were based on both anthropogenic and natural factors observed in the field and through comparison of the existing and historic channel pattern and geometry.

Four forms were used to complete the Rapid Assessment at each site. The Data Collection Form was used to collect general stream information related to channel size and location. Specific data included channel geometry, identification of substrate material, identification of debris jams or blockages, identification of potential in-stream cover, and information regarding the riparian zone. The Bank Stability Form was used to record bank geometry, information regarding riparian vegetation and rooting depths, and general bank armoring. The Channel Stability Form was used to collect a variety of information related to the condition of the upper

slopes, lower slopes, and channel bed. Data collected on the field forms were consolidated into a Rapid Assessment Classification Form.

The data collected for the preliminary assessment include general, quantitative parameters as well as qualitative measurements of physical geomorphic features. The parameters utilized for this assessment were selected after review of multiple rapid assessment and data collection worksheets and selecting the parameters appropriate for this level of the stream assessment. Sources for selecting appropriate parameters included the "Watershed Assessment of River Stability & Sediment Supply" (Rosgen, 2006), "Texas Instream Flow Studies: Technical Overview" (TWDB, 2008), "Montgomery County Rapid Stream Assessment Technique" (Montgomery County, 1992), and the "Vermont Rapid Stream Assessment" (Vermont, 2007).

Channel Evolution

Based on field observations of Bois d'Arc Creek and the studied tributaries, the morphological adjustments of each creek can be described using a general incised channel evolution model. A number of studies of incised channels in alluvial materials in the United States have shown that following channelization, the altered channel geometry changes through a predictable sequence of channel evolution. (Ireland et al., 1939; Schumm et all., 1984; Harvey and Watson, 1986; Simon and Hupp, 1986; Simon, 1989). These channel evolution sequences / models provide a method for interpreting the current stage of the channel morphology by evaluating the existing channel form and geomorphic processes.

The channel evolution model identifies the stages of channel form beginning with the channelized section, which disrupts the dynamic equilibrium, through major stages of disequilibrium and channel evolution back to a state of dynamic equilibrium. The model shows the channel to incise, then widen as a result of bank failure and mass wasting. As the channel becomes over-widened it will begin to aggrade because the stream power will be insufficient to carry the existing sediment load. Eventually a new channel will form within the over-widened section with sufficient stream power to carry the total sediment supply and a new dynamic equilibrium will be reached.

Based on the rapid assessment of Bois d'Arc Creek and the four studied tributaries, all of the reaches have been impacted and none of the reaches have reached a new state of dynamic

equilibrium; however, there are reaches in which new channels are beginning to form within the over-widen channels and the creek is in the process of recovering.

Conclusions

Table ES.1 summarizes the results of the rapid assessment reaches analyzed for the Rapid Geomorphic Assessment.

- The majority of Bois d'Arc Creek (54%) was classified as "poor" with the remainder (46%) being classified as "fair."
- The majority of Honey Grove Creek (86%) was classified as "fair" with the remainder being classified as "good" (8%) or "poor" (6%).
- The majority of Ward Creek (84%) was classified as "fair" with the remainder (16%) being classified as "poor."
- The majority of Bullard Creek (82%) was classified as "poor" with the remainder (18%) being classified as "fair."
- The majority of Sandy Creek (83%) was classified as "poor" with the remainder (17%) being classified as "fair."

Table ES.1
Channel Classification

Name	Classification	Reach Length (ft)	Percentage
Bois d'Arc Creek Reach 1	**Total Reach**	**7,000**	**100%**
	Good	-	0%
	Fair	3,587	51%
	Poor	3,413	49%
Bois d'Arc Creek Reach 2	**Total Reach**	**12,000**	**100%**
	Good	-	0%
	Fair	5,419	45%
	Poor	6,581	55%
Bois d'Arc Creek Reach 3	**Total Reach**	**5,000**	**100%**
	Good	-	0%
	Fair	50	1%
	Poor	4,950	99%
Bois d'Arc Creek Reach 4	**Total Reach**	**24,500**	**100%**
	Good	-	0%
	Fair	17,084	70%
	Poor	7,416	30%
Bois d'Arc Creek Reach 5	**Total Reach**	**40,800**	**100%**
	Good	-	0%
	Fair	15,200	37%
	Poor	25,600	63%
Bois d'Arc Creek Total	**Total Reach**	**89,300**	**100%**
	Good	-	0%
	Fair	41,340	46%
	Poor	47,960	54%
Honey Grove Creek	**Total**	**35,700**	**100%**
	Good	2,700	8%
	Fair	30,700	86%
	Poor	2,300	6%
Ward Creek	**Total**	**27,900**	**100%**
	Good	-	0%
	Fair	23,500	84%
	Poor	4,400	16%
Bullard Creek	**Total**	**25,900**	**100%**
	Good	-	0%
	Fair	4,600	18%
	Poor	21,300	82%
Sandy Creek	**Total**	**14,150**	**100%**
	Good	-	0%
	Fair	2,400	17%
	Poor	11,750	83%

Rapid Geomorphic Assessment of Bois d'Arc Creek and its Tributaries for the Lower Bois d'Arc Creek Reservoir Project

1.0 Introduction

The North Texas Municipal Water District (NTMWD) is proposing to build an approximately 367,600 acre-foot water supply reservoir (Lower Bois d'Arc Creek Reservoir) on Bois d'Arc and Honey Grove Creeks approximately 15 miles northeast of Bonham in Fannin County, Texas (Figure 1.1). Bois d'Arc Creek and its tributaries, upstream of the proposed reservoir, are incised and eroding. Current conditions of the creeks are the result of channelization and straightening of the natural, meandering creeks and loss of vegetation along bank slopes due to agricultural (farming and ranching) practices.

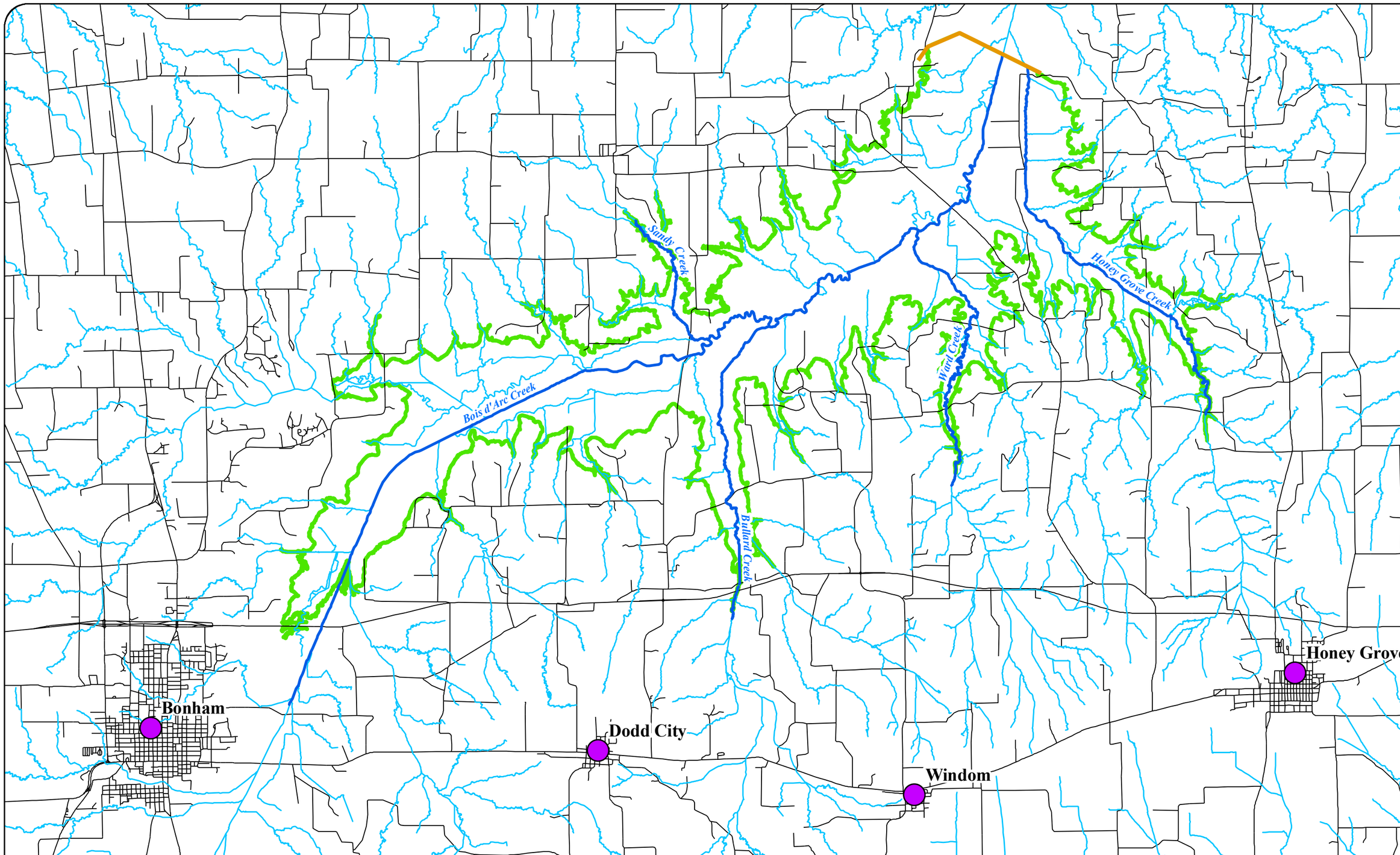
The primary objective of this study is to perform a rapid geomorphic assessment of Bois d'Arc Creek and four major tributaries (Honey Grove Creek, Sandy Creek, Ward Creek, and Bullard Creek) within the inundation pool of the proposed reservoir. The results of this preliminary geomorphic assessment will be used in conjunction with the environmental report and habitat assessment developed by Freese and Nichols, Inc. (FNI) to describe the existing conditions of the riverine system. The geomorphic assessment will be based on general stream stability, riparian vegetation, and the potential for developing aquatic habitat features.

This assessment is similar to Step 1 of the "Texas Instream Flow Studies: Technical Overview (TWDB, 2008) and is the first step to further studies that will be required for instream flow determinations and eventually evaluating mitigation and restoration. The results of this study will be used to classify the study reaches as good, fair, or poor for use in the 404 permit application to help describe the existing conditions of the riverine system.

Data and information used in this investigation included:

- Mapping / Aerial Photography from 1915, 1950, 1970, and 2007
- 1-foot LIDAR data from January 2007
- 2004 2-foot aerial contour data from Dallas Aerial Survey
- Geologic Maps of Texas
- Soil Survey of Fannin County
- Field Data (Section 4.0 Methodology)

A description of how this information was applied to the analysis is described in Section 4.0 Methods.



Stream
Road
Proposed Reservoir
Rapid Assessment Reach
Proposed Dam

0 1.25 2.5 5 Miles

FN PROJECT NO. ABC07999
DATE September 2008
DATUM & COORDINATE SYSTEM NAD83 State Plane TX Central
FILE Fig1o1_Location.mxd
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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Location

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FIGURE
1.1

2.0 Basin History

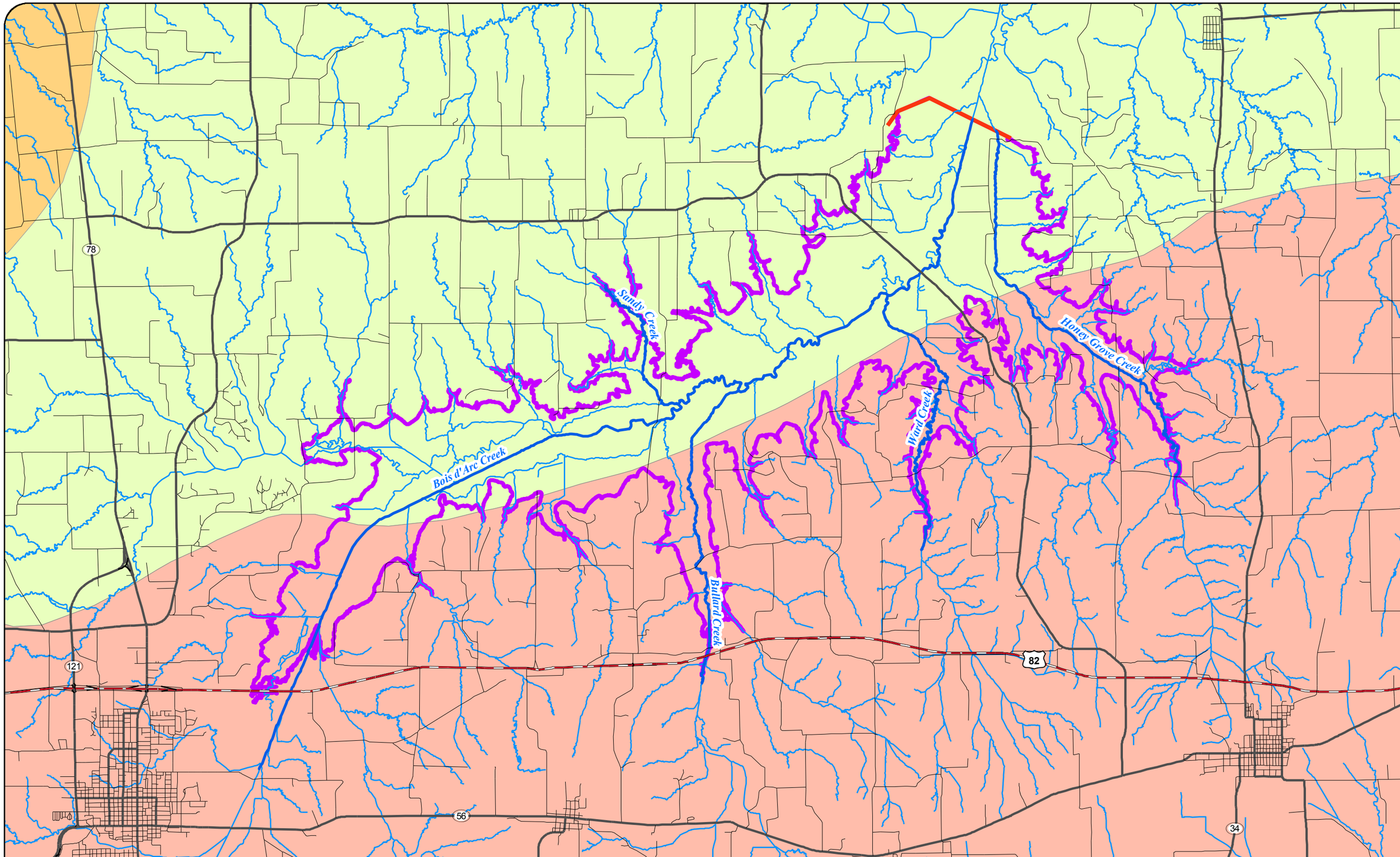
2.1 Ecoregions

The proposed Lower Bois d'Arc Creek Reservoir is located in two Level IV ecoregions as mapped and described by Griffith et. al. (2004). The southern portion of the reservoir and the associated streams are in the Northern Blackland Prairie Ecoregion (Level IV) of the Texas Blackland Prairies (Level III), while the northern portion is in the Northern Post Oak Savannah (Level IV) Ecoregion within the East Central Texas Plains region (Level III) (Figure 2.1). Beginning approximately six miles downstream of the proposed dam site, Bois d'Arc Creek Creek flows through the Pleistocene Fluvial Terraces (Level IV) of the South Central Plains Ecoregion (Level III) and eventually converges with the Red River in the Red River Bottomlands (Level IV) of the South Central Plains Ecoregion.

This diverse ecological, including topographical, soil, and geological characteristics, influences the vegetation, wildlife, and hydrological characteristics of the area. An understanding of these features can help put the results of the geomorphic assessment of stream condition into regional context.

The Northern Blackland Prairie Ecoregion encompasses most of Honey Grove Creek, Ward Creek, Bullard Creek, and the upstream portion of Bois d'Arc Creek. The soils of this ecoregion are characterized by mostly fine-textured, dark, calcareous, and productive Vertisols. These soils are underlain by interbedded chalks, marls, limestones, and shales of the Cretaceous age.

The northern part of Lower Bois d'Arc Creek Reservoir, Sandy Creek and other tributaries entering Bois d'Arc Creek to about six miles downstream of the proposed dam are within the Northern Post Oak Savannah Ecoregion. This region is characterized by fine textured loam soils with a udic moisture regime, underlain mostly by Eocene and Paleocene-age formations.



Texas Eco-Regions

- Northern Blackland Prairie
- Northern Post Oak Savanna
- Pleistocene Fluvial Terraces
- Rapid Assessment Reach
- Stream
- Proposed Dam
- Proposed Reservoir

0 1.25 2.5 5 Miles

FN PROJECT NO. NTD06128
DATE September 2008
DATUM & COORDINATE SYSTEM NAD83 State Plane TX Central
FILE Eco_Regions.mxd
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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Eco-Regions

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FIGURE
2.1

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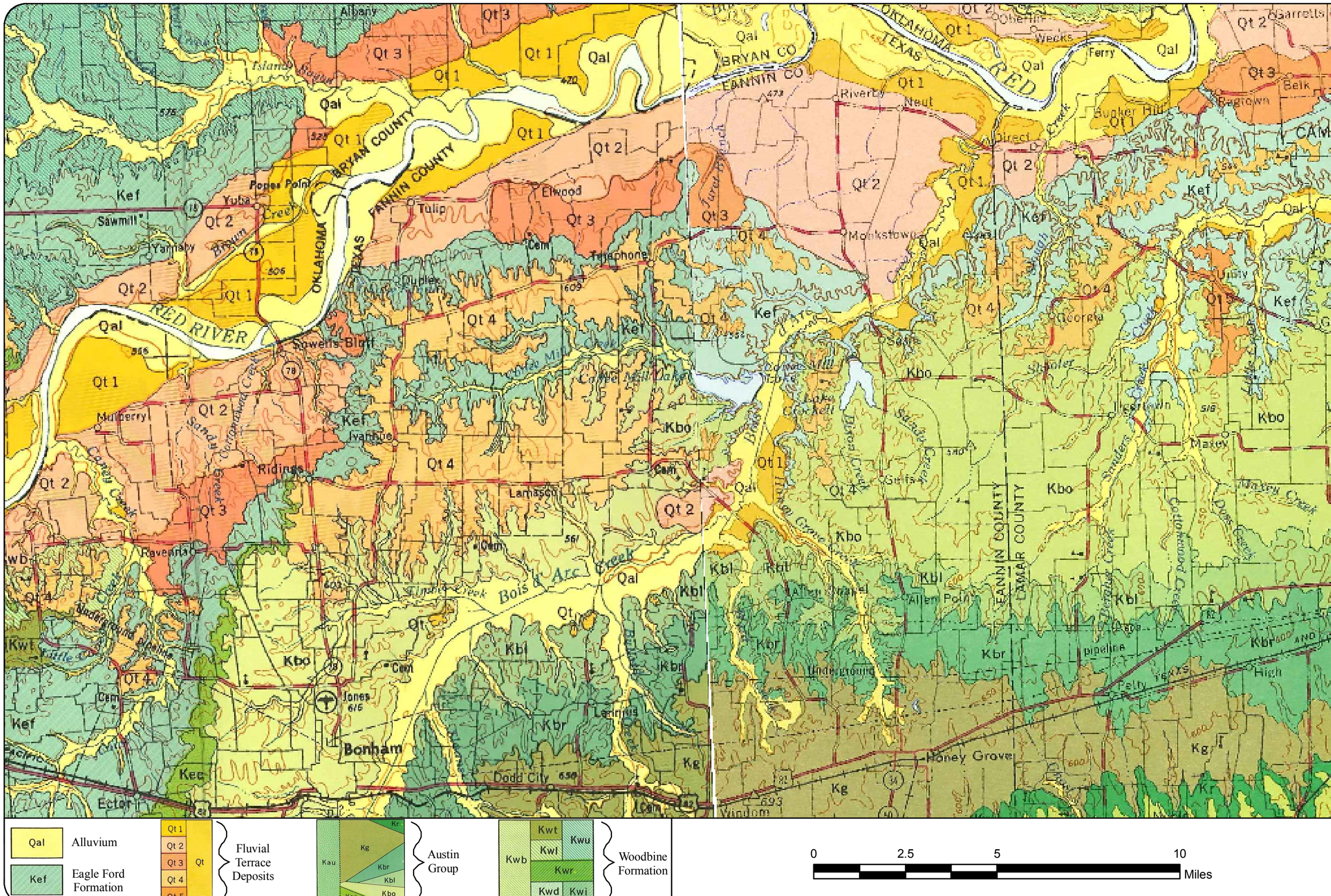
2.2 Geologic Setting

The stream channel patterns and characteristics of the Bois d'Arc system are greatly influenced by the geologic lithology and structure occurring in Fannin County (Figure 2.2). In general, the streams and creeks in Fannin County, including Bois d'Arc Creek, flow in channels cut through alluvium and fluviatile terrace deposits which were deposited by larger streams during the Pleistocene and Holocene Epochs of the Quaternary Period (USDA, 2001). The alluvial deposits in the channels of Bois d'Arc Creek, Sandy Creek, Bullard Creek, Ward Creek, and Honey Grove Creek were derived from Upper Cretaceous bedrock which lies directly beneath the alluvium (USDA, 2001). This Upper Cretaceous bedrock is also visible at the surface on either side of the respective stream channels (BEG, 1967).

The Upper Cretaceous bedrock visible along Bois d'Arc Creek formed in shallow seas that extended inland from the Gulf of Mexico. All of the originally flat-lying strata now strikes east-northeast and dips south-southeast at a rate of approximately 30 to 35 feet per mile (USDA, 2001). However, the dip rate increases to 300 feet per mile on the southeastward-plunging ridge of the Preston Anticline (TDWR, 1982). The Preston Anticline is a broad arch located in the western portion of Fannin County that trends northwest-southeast and plunges southeastward. Due to the presence of this structure, bedrock, stream channels, and soils are deflected southeastward as they pass over the axis of the anticline (TDWR, 1982; USDA, 2001).

The surficial deposits on the northwestern side of Bois d'Arc Creek, and along Sandy Creek and portions of Honey Grove Creek, consist of poorly to thinly bedded silty marl and waxy clay of the Bonham Marl of the Austin Group (BEG, 1967; USDA, 2001). The marl has a maximum thickness of approximately 400 feet and weathers to yellowish green at its type locality (USDA, 2001). The marl becomes increasingly calcareous as it continues westward and merges with the undivided Austin Chalk in Grayson County (USDA, 2001). Eastward, it is less calcareous and becomes increasingly marly. The surface of the Bonham Marl outcrop is a gently rolling plain (USDA, 2001).

The formations visible on the southeastern side of Bois d'Arc Creek, and along Bullard Creek, Ward Creek, and portions of Honey Grove Creek, are the Blossom Sand and the Brownstone Marl of the Austin Group. The Blossom Sand typically consists of very fine-grained to fine-grained, calcareous, ferruginous quartz sand that grades westward into clay (BEG, 1967;



North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Regional Geologic Landscape

FIGURE

2.2

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FN PROJECT NO.	ABC07999
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane TX Central
FILE	Fig2o1_Geologic.mxd
PREPARED BY	JM

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USDA, 2001). The Blossom Sand outcrop in Fannin County ranges from 0.25 mile to 2.75 miles in width, and weathers to brown and red at the surface (USDA, 2001). The Blossom Sand is approximately 20 feet thick, but thickens eastward and feathers out westward. The sand eventually merges with the Bonham Marl, east of the City of Bonham (BEG, 1967; USDA, 2001). On the surface, the Blossom Sand is a gently rolling plain with broad divides between stream valleys (USDA, 2001).

The Brownstone Marl of the Austin Group outcrops to the south of the Blossom Sand on the southeastern side of Bois d'Arc Creek, and along Bullard Creek, Ward Creek, and portions of Honey Grove Creek. The Brownstone Marl typically consists of medium yellowish grey, poorly bedded, calcareous marl and clay with glauconite present at the base of the marl (BEG, 1967; USDA, 2001). The marl ranges in thickness from 80 to 175 feet, but feathers out westward near the City of Bonham where it merges with the Bonham Marl; eastward, the Brownstone Marl thickens (USDA, 2001). The Brownstone Marl outcrop is roughly 1.5 to 4.0 miles wide in Fannin County. It is very susceptible to water erosion and mass wasting, and the weathered outcrop tends to be light yellowish grey in color (USDA, 2001). The outcrop of the Brownstone Marl is dissected by several stream channels, and only a few flat surfaces are present between the stream channels (USDA, 2001).

2.3 Soils

The mainstem of Bois d'Arc Creek from upstream of Bonham and downstream to about three miles above the confluence with the Red River traverses the Tinn soil series (Soil Survey of Fannin County, Texas, United States Department of Agriculture, 1988). This series consists of moderately well drained, very slowly permeable, clayey soils on floodplains. The series has a "very high" shrink swell potential and an *Erosion factor K* value of 0.32.

Tributaries flowing into the proposed Bois d'Arc Creek Reservoir on the north side upstream of Sandy Creek flow through the Normangee-Wilson-Bonham series group (Soil Survey of Fannin County, Texas, United States Department of Agriculture, 1988) consisting of loamy and clayey, moderately acid to neutral soils. Normangee and Bonham series have moderate to high shrink swell potential and an *Erosion factor K* ranging from 0.31-0.37, while the Wilson series has low to high shrink swell and an *Erosion factor K* ranging from 0.37-0.43.

From approximately the mouth of Sandy Creek to near FM 100 downstream of the proposed dam soils adjacent to the floodplain Tinn series are in the Whakana-Porum-Freestone series (Soil Survey of Fannin County, Texas, United States Department of Agriculture, 1988) that are loamy, very strongly acid to neutral soils on terraces. Freestone series has low to high shrink swell potential and an *Erosion factor K* ranging from 0.32-0.37; the Porum series has low to high shrink swell and an *Erosion factor K* ranging from 0.32-0.43; and the Whakana series has low to moderate shrink swell and an *Erosion factor K* of 0.32.

On the south side of the proposed reservoir, Honey Grove, Bullard, and Sloans creeks are in the Frioton series (Soil Survey of Fannin County, Texas, United States Department of Agriculture, 1988) that is clayey and loamy, moderately alkaline soils on floodplains. This series has a high shrink swell potential and an *Erosion factor K* of 0.32.

The majority of the remaining drainages on the south side of the reservoir consist of the Ellis-Crockett series (Soil Survey of Fannin County, Texas, United States Department of Agriculture, 1988) of loamy and clayey, moderately acid to neutral soils on uplands. The Crockett series has low to high shrink swell potential and an *Erosion factor K* ranging from 0.32-0.43 and the Ellis series has high shrink swell potential and an *Erosion factor K* ranging from 0.32.

2.4 Historical Land Use Practices

According to a historical map dated circa 1915 and aerial photography dated 1950, 1970, and 2005, the land surrounding the Bois d'Arc Creek system remains largely undeveloped, rural land predominantly used for agricultural purposes. There is evidence by the historical data that landowners have modified the terrain by digging drainage channels through their property, bypassing and sometimes abandoning the natural riverine system. This channelization has resulted in the creeks incising, causing down cutting of the channel bottom throughout the reaches.

Due to crop rotation or change of land owners throughout the area, the riparian vegetation buffer alongside the creeks is constantly changing. According to the 1950 aerial, it was common to see a 2,000 to 4,000 foot vegetative buffer around Bois d'Arc Creek; but over time, the buffer has come closer to the channel. In some areas the vegetation has been cleared up to the creek banks, which in turn causes bank instability due to the loss of rooting mass.

However, on Honey Grove, Bullard, and Ward Creeks on the south side of Bois d'Arc Creek, the buffer has increased over time. Referencing the 1950 aerial, very rarely was there vegetation on both sides of the creek and the vegetation that was there was no more than 50 feet wide. The 2007 aerials show that due to changes in agricultural practices (i.e. clearing up to the stream banks) the vegetative buffer along these creeks has increased from almost nothing to more than 500 feet wide with only short reaches of stream where the clearing extends to the creek.

On the north side of Bois d'Arc Creek, the vegetation buffer along Sandy Creek has remained fairly constant over the last 50 years.

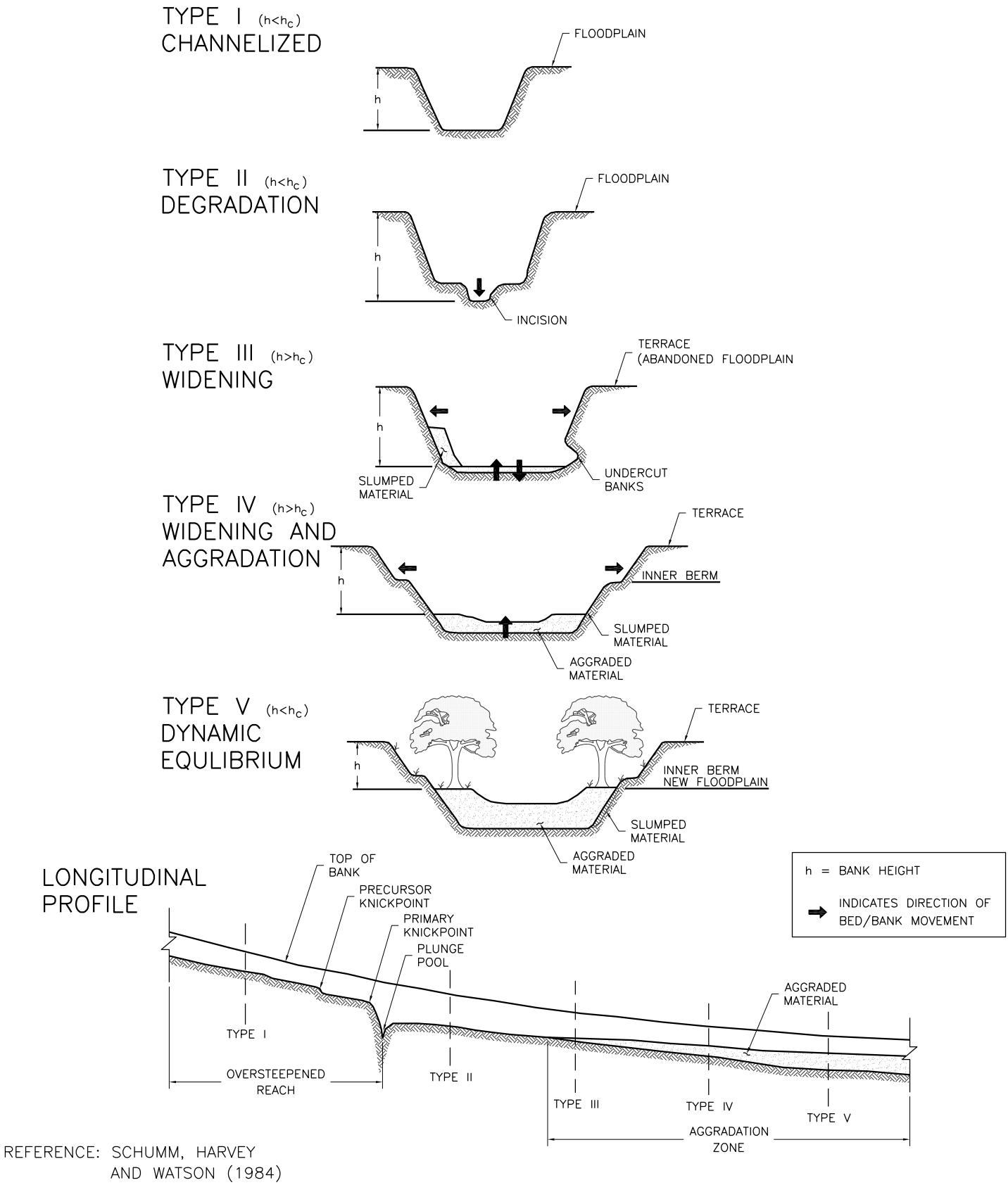
For a description of specific historical changes for each reach, refer to Section 5.0 in this report.

3.0 Incised Channel Evolution Model

Significant portions of the Bois d'Arc Creek system was channelized over the years, with some alterations to the natural stream channel occurring before 1915. Based on historical aerial photographs, stream channelization continued within the Bois d'Arc Creek system into the 1970's. As part of the assessment of the quality of the current Bois d'Arc Creek system, it is important to know if the system has re-established equilibrium since the time it was channelized and the riparian vegetation buffer has changed. Determining the state of the channel is therefore a function of determining if the channel is in dynamic equilibrium or if the sediment supply and stream power are still out of balance. A number of studies of incised channels in alluvial materials in the United States have shown that following channelization, the altered channel geometry changes through a predictable sequence of channel evolution. (Ireland et al., 1939; Schumm et all., 1984; Harvey and Watson, 1986; Simon and Hupp, 1986; Simon, 1989). These channel evolution sequences / models provide a method for interpreting the current stage of the channel morphology by evaluating the existing channel form and geomorphic processes. The evolution model also provides a means for predicting future channel evolution / channel processes.

The five stage Incised Channel Evolution Model (ICEM), developed by Schumm, Harvey and Watson (1984) describes the evolution of a channelized stream or river and was applied to this analysis to describe the conditions of the Bois d'Arc Creek system. The changes in channel geometry resulting from channelization will extend upstream and downstream from the altered reach as the stream system works to re-establish dynamic equilibrium. The effects of channelization can impact tributaries that are forced to adjust through down cutting and erosion to re-attain equilibrium.

The channel evolution model shown as Figure 3.1 identifies the stages of channel form beginning with the channelized section, which disrupts the dynamic equilibrium, through major stages of disequilibrium and channel evolution back to a state of dynamic equilibrium. As shown, the channel incises then widens as a result of bank failure and mass wasting. As the channel becomes over-widened it will begin to aggrade because the stream power will be insufficient to carry the existing sediment load. Eventually a new channel will form within the over-widened section with sufficient stream power to carry the total sediment supply and a new dynamic equilibrium will be reached.



REFERENCE: SCHUMM, HARVEY
AND WATSON (1984)

Freese and Nichols
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NORTH TEXAS MUNICIPAL WCID

LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

INCISED CHANNEL EVOLUTION PROCESS

F&N JOB NO.	NTD06128
DATE	JAN. 2008
SCALE	N.T.S.
DESIGNED	JWS
DRAFTED	GAL
FILE	Figure 3.dwg

3.1
FIGURE

ACAD Rel 17.1s (LMS Tech) User: GAL
[NTD06128][AUSTIN1]N:\WR\REPORT\FIGURE 3.DWG LAYOUT: Layout1
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Date: Feb 19, 2008 - 2:28pm User: gal File: N:\wr\Report\Figure 3.dwg

The characteristics of the five stages of the channel evolution model and the morphological adjustments of the channel through time can be summed up as follows:

- Type I – channel upstream of channel incision, prior to morphological adjustments
- Type II – actively incising but the banks are stable (no mass wasting)
- Type III – rapidly widening channel due to undercutting and mass wasting of banks, signs of some aggradation are apparent due to excess sediment load and over widened channel
- Type IV – channel widening continues but at a reduced rate, signs that recovery has begun to emerge in the form of inner berms and emergent vegetation
- Type V – dynamic equilibrium re-established, new stable channel formed within the old channel with new floodplain, old floodplain becomes an abandoned terrace.

This model explains the general morphology of the Bois d'Arc Creek system. Bois d'Arc Creek and portions of its tributaries have been altered and, as expected, the channelized sections are following the predicted channel evolution. A similar sequence of channel evolution has been observed on Mill Creek, a tributary of Chambers Creek in the Blackland Prairie Region of Texas (Allen, 2006). The North Sulphur River and tributaries exhibited a similar channel evolution sequence while the channels were located in alluvium but became more complicated when the underlying shale was exposed (Mussetter Engineering, 2006).

The application of the channel evolution model to the Bois d'Arc Creek system within the project area is one component of the rapid assessment used for this study. Further discussions of the channel evolution types by stream reach are presented in Section 5.0.

As stated above, an important aspect of this assessment is making a preliminary determination as to whether or not the Bois d'Arc Creek system is in dynamic equilibrium. One of the major impacts of disequilibrium is that the reaches will, at best, provide only transitory habitat features and have little, if any, permanent habitat features. Previous studies have indicated that channelized streams in the humid, southwest United States can take forty to fifty years to complete the channel evolution process (Schumm et Al. 1984; Schumm 1999; Simon 1989); however, channelized streams in the semi-arid southwest can take more than 100 years to complete the cycle (Gellis et al., 1995).

4.0 Methods

This section describes the rapid assessment protocols and methods utilized to assess individual stream segments. The existing physical characteristics of the mainstem of Bois d'Arc Creek and the major tributaries were developed using a combination of field collected data, current one-foot LIDAR generated topography, current two-foot aerial topography, and both current and historic aerial photography/mapping. The channel classification procedure used for this phase of analysis is based on a rapid assessment of the stream geomorphic properties and characteristics of the main stem of Bois d'Arc Creek and four (4) major tributaries: Honey Grove Creek, Ward Creek, Bullard Creek, and Sandy Creek.

The rapid assessments were based on both anthropogenic and natural factors observed in the field and through comparison of the existing and historic channel pattern and geometry. The major factors evaluated were channel stability, vegetation/armoring, and potential in-stream habitat features. A brief description of the components used to develop the rapid stream assessments is presented below.

4.1 Field Collected Data

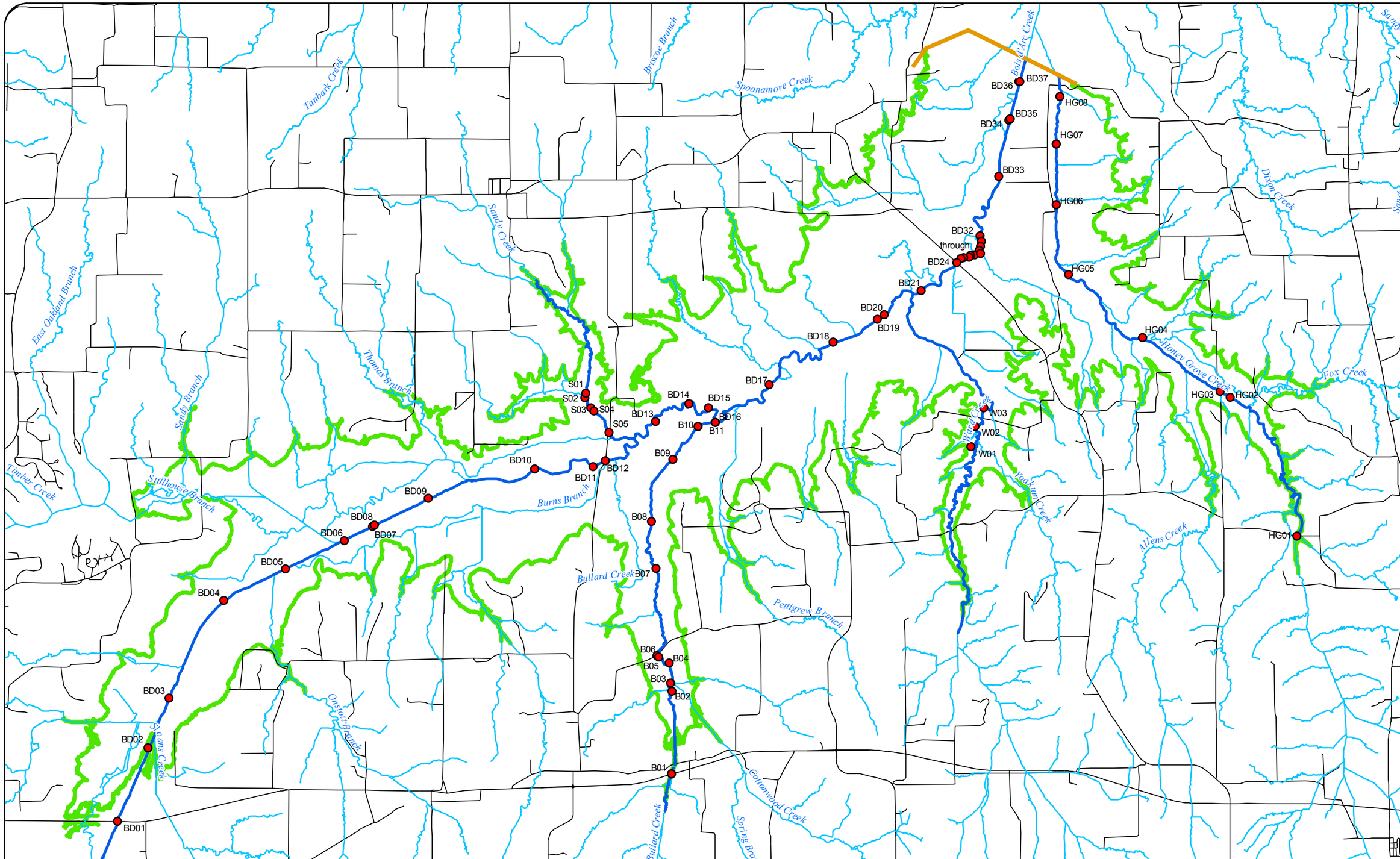
Freese and Nichols collected data at 82 sites throughout the riverine system (Figure 4.1). Table 4.1 provides a list of the data points and coordinates.

Three forms were used to record information at each site. The Data Collection Sheet (Figure 4.2) includes general stream information related to channel size and location. Specific data includes channel geometry, identification of substrate material, identification of debris jams or blockages, identification of potential in-stream cover, and information regarding the riparian zone. The Bank Stability form (Figure 4.3) was used to record general bank geometry, information regarding riparian vegetation and rooting depths, and general bank armoring. The Channel Stability form (Figure 4.4) was used to collect a variety of information related to the condition of the upper slopes, lower slopes, and channel bed. Data collected on the field forms were consolidated into a Rapid Assessment Classification Sheet for each data point as discussed in Section 4.3 of this report.

The data collected for the preliminary assessment include general, quantitative parameters as well as qualitative measurements of physical geomorphic features. The parameters utilized for this assessment were selected after reviewing multiple rapid assessment and data collection worksheets and selecting the parameters appropriate for this level of the stream assessment.

Sources for selecting the parameters included the “Watershed Assessment of River Stability & Sediment Supply” (Rosgen, 2006), “Texas Instream Flow Studies: Technical Overview” (TWDB 2008), “Montgomery County Rapid Stream Assessment Technique” (Montgomery County, 1992), and the “Vermont Rapid Stream Assessment” (Vermont, 2007).

There were several sites where FNI was unable to access the creeks due to the steep terrain of the channel banks or property access. For these sites, FNI relied on visual inspection from the upper banks or the road crossing.



Rapid Assessment Reach Field Data Points
Rapid Assessment Reach
Proposed Dam
Road
Stream
Proposed Reservoir

0 1.25 2.5 5 Miles

FN PROJECT NO. ABC07999
DATE September 2008
DATUM & COORDINATE SYSTEM NAD83 State Plane TX Central
FILE Fig4o1_DataPts.mxd
PREPARED BY JM

North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Data Collection Points

Freese and Nichols
Engineers, Planners
Building 4, Suite 100
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Phone: (512) 617-3100
Fax: (512) 617-3101

FIGURE
4.1

Table 4.1 - Field Data Points

Stream Reach	Point Label	Northing	Easting	Stream Reach	Point Label	Northing	Easting
Bois d'Arc	BD01	7,274,144.27	2,687,002.14	Bullard	B01	7,276,285.80	2,717,369.59
Bois d'Arc	BD02	7,278,145.35	2,688,752.73	Bullard	B02	7,280,798.40	2,717,458.22
Bois d'Arc	BD03	7,280,848.00	2,689,935.46	Bullard	B03	7,281,268.63	2,717,389.30
Bois d'Arc	BD04	7,286,143.28	2,693,018.75	Bullard	B04	7,282,358.63	2,717,328.56
Bois d'Arc	BD05	7,287,813.20	2,696,415.61	Bullard	B05	7,282,684.77	2,716,777.18
Bois d'Arc	BD06	7,289,326.22	2,699,647.41	Bullard	B06	7,282,766.22	2,716,671.38
Bois d'Arc	BD07	7,290,071.71	2,701,211.60	Bullard	B07	7,287,533.23	2,716,692.09
Bois d'Arc	BD08	7,290,142.81	2,701,312.31	Bullard	B08	7,290,103.56	2,716,491.78
Bois d'Arc	BD09	7,291,564.36	2,704,282.31	Bullard	B09	7,293,487.77	2,717,698.06
Bois d'Arc	BD10	7,293,088.93	2,710,119.18	Bullard	B10	7,295,273.67	2,719,113.00
Bois d'Arc	BD11	7,293,151.48	2,713,327.28	Bullard	B11	7,295,484.23	2,720,058.19
Bois d'Arc	BD12	7,293,475.68	2,714,007.43	Honey Grove	HG01	7,288,779.21	2,751,792.11
Bois d'Arc	BD13	7,295,576.73	2,716,776.36	Honey Grove	HG02	7,296,419.87	2,748,241.54
Bois d'Arc	BD14	7,296,516.49	2,718,637.33	Honey Grove	HG03	7,296,753.12	2,747,713.71
Bois d'Arc	BD15	7,296,295.79	2,719,705.30	Honey Grove	HG04	7,299,779.68	2,743,492.87
Bois d'Arc	BD16	7,295,484.23	2,720,058.19	Honey Grove	HG05	7,303,272.73	2,739,505.84
Bois d'Arc	BD17	7,297,520.65	2,723,040.78	Honey Grove	HG06	7,307,108.47	2,738,897.20
Bois d'Arc	BD18	7,299,766.05	2,726,561.16	Honey Grove	HG07	7,310,437.58	2,738,945.43
Bois d'Arc	BD19	7,300,987.41	2,729,020.00	Honey Grove	HG08	7,313,032.52	2,739,175.52
Bois d'Arc	BD20	7,301,225.30	2,729,391.76	Sandy	S01	7,297,191.01	2,712,996.32
Bois d'Arc	BD21	7,302,525.09	2,731,427.30	Sandy	S02	7,296,941.64	2,712,935.55
Bois d'Arc	BD22	7,304,013.76	2,733,411.89	Sandy	S03	7,296,374.77	2,713,254.50
Bois d'Arc	BD23	7,304,250.85	2,733,618.21	Sandy	S04	7,296,207.53	2,713,430.06
Bois d'Arc	BD24	7,304,281.60	2,733,790.57	Sandy	S05	7,295,013.26	2,714,221.97
Bois d'Arc	BD25	7,304,304.94	2,734,075.40	Ward	W01	7,293,948.00	2,734,035.92
Bois d'Arc	BD26	7,304,404.01	2,734,145.46	Ward	W02	7,295,040.70	2,734,273.39
Bois d'Arc	BD27	7,304,423.33	2,734,372.58	Ward	W03	7,296,053.00	2,734,758.27
Bois d'Arc	BD28	7,304,491.43	2,734,705.42				
Bois d'Arc	BD29	7,304,667.69	2,734,626.31				
Bois d'Arc	BD30	7,304,893.73	2,734,702.74				
Bois d'Arc	BD31	7,305,179.74	2,734,765.87				
Bois d'Arc	BD32	7,305,486.61	2,734,700.11				
Bois d'Arc	BD33	7,308,704.51	2,735,765.95				
Bois d'Arc	BD34	7,311,767.27	2,736,362.73				
Bois d'Arc	BD35	7,311,842.62	2,736,441.78				
Bois d'Arc	BD36	7,313,884.66	2,736,947.53				
Bois d'Arc	BD37	7,313,879.46	2,737,008.28				

Figure 4.2 – Data Collection Sheet

Data Collection Sheet			
			Sheet No.
Date:		Stream Name:	
Project Name:	Lower Bois d'Arc Creek Reservoir Phase II	Coordinates:	
Project Number:	NTD06128	Field Crew:	

Channel Characteristics:				Stream Size: Category (Bankfull Width, ft)					
Average Bank Width:		OHWM Width:		S-1 (<1)	❑	S-6 (50-75)	❑	S-11 (350-500)	❑
Average Bank Depth:		Circle: Perennial, Intermittent, or Ephemeral		S-2 (1-5)	❑	S-7 (75-100)	❑	S-12 (500-1000)	❑
Average Stream Bed Depth:				S-3 (5-15)	❑	S-8 (100-150)	❑	S-13 (>1000)	❑
Average Water Width:		Circle: Clear or Turbid		S-4 (15-30)	❑	S-9 (150-250)	❑		
Average Water Depth:		Water Color:		S-5 (30-50)	❑	S-10 (250-350)	❑		
Maximum Water Depth:									

Substrate:				Debris/Blockages:				*B.D.= Beaver Dams	
Silt/Clay	❑	Boulder (>10")	❑	D1: None	❑	D5: Extensive	❑	D9: B.D. - Abandoned	❑
Sand	❑	Bedrock	❑	D2: Infrequent	❑	D6: Dominating	❑		
Gravel (.25"-2.5")	❑	Concrete	❑	D3: Moderate	❑	D7: B.D. - Few	❑	D10 - Human Influences	❑
Cobble (2.5"-10")	❑	Organic	❑	D4: Numerous	❑	D8: B.D. - Frequent	❑		

Instream Cover:				Riparian Zone:			
Undercut Banks	❑	Deep Pools	❑	Forest	❑	Scrub/Shrub	❑
Shallows	❑	Overhanging Vegetation	❑	Pasture	❑	Row-Crop	❑
Boulders	❑	Emergent/Submergent Vegetation	❑	Paved	❑	Residential	❑
Oxbows	❑	Logs/Brush	❑	Old-Field/ROW	❑	Width of Riparian Zone	

Riparian Vegetation:

Category	Percent Aerial Cover	Percent Site Coverage	Species Composition	Percent of Total
Canopy Layer				
Shrub Layer				
Herbaceous				
Leaf or Needle Litter				
Bare Ground				

Photos:	Additional Notes:

Figure 4.3 – Bank Stability Form

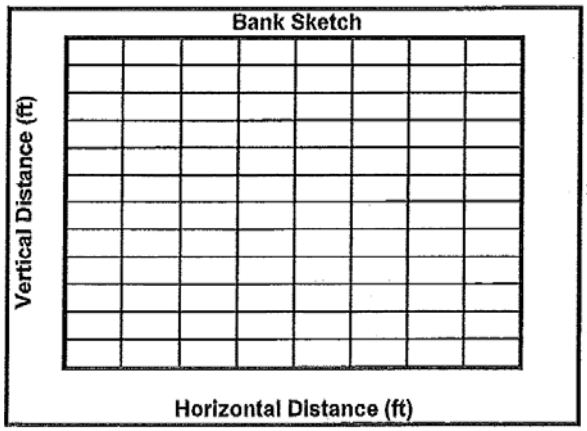
BEHI Variable Worksheet

Stream:	Reach:	Cross Section:
Observers:		Date:

						BEHI Score
Bank Height/Max Depth Bankfull (C)						
Study Bank Height (ft)	(A)	Bankfull Height (ft)	(B)	(A)/(B) =	(C)	
Root Depth/Bank Height (E)						
Root Depth (ft)	(D)	Study Bank Height (ft)	(A)	(D)/(A) =	(E)	
Weighted Root Density (F)						
Root Density (%)	(F)					
Bank Angle (G)						
Bank Angle (Degrees)	(G)					
Surface Protection (H)						
Surface Protection (%)	(H)					

Bank Material Adjustment		
Bedrock (Overall Very Low BEHI) Boulders (Overall Low BEHI)	⇨ **Bank Materials Adjustment**	
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust Gravel (Add 5-10 points depending percentage of bank material that is composed of sand) Sand (Add 10 points) Silt Clay (no adjustment)	**Stratification Adjustment** Add 5-10 points, depending on position of unstable layers in relation to bankfull stage	

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME		
						⇨ **ADJECTIVE RATING** and	
5 - 9.5	10 - 19.5	20 - 29.5	30 - 39.5	40 - 45	46 - 50	**TOTAL SCORE**	



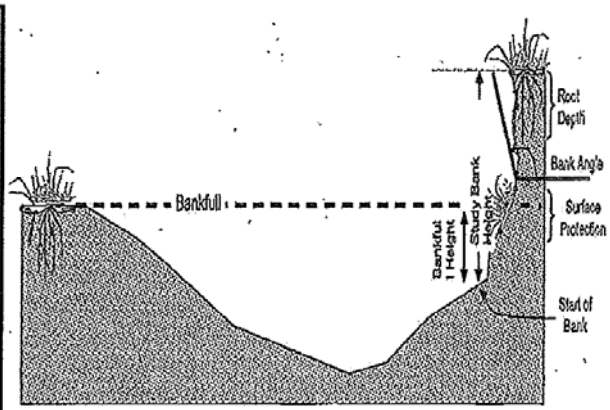


Figure 4.4 –Channel Stability Form

Pfankuch Channel Stability Form

Stream: _____ Reach: _____ Date: _____ Observers: _____ Comments: _____

Location	Key	Category	Excellent Description	Excellent Rating	Good Description	Good Rating	Fair Description	Fair Rating	Poor Description	Poor Rating
Upper Banks	1	Landform Slope	Bank slope gradient <30%.	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient 60%+.	8
	2	Mass Wasting	No evidence of past or future mass wasting.	3	Infrequent. Mostly healed over. Low future potential.	6	Frequent or large, causing sediment nearly year long.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
	3	Debris Jam Potential	Essentially absent from immediate channel area.	2	Present, but mostly small twigs and limbs.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8
	4	Vegetative Bank Protection	90%+ plant density. Vigor and variety suggest a deep, dense soil binding root mass.	3	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	6	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9	<50% density plus fewer species & less vigor indicating poor, discontinuous, and shallow root mass.	12
Lower Banks	5	Channel Capacity	Ample for present plus some increases. Peak flows contained. (W/D)/(W/Dref) < 1.1, BHR = 1.0 - 1.1	1	Adequate. Bank overflows are rare. (W/D)/(W/Dref) = 1.1 - 1.2, BHR = 1.1 - 1.3	2	Barely contains present peaks. Occasional overbank floods. (W/D)/(W/Dref) = 1.2 - 1.6, BHR = 1.3 - 1.5	3	Inadequate. Overbank flows common. (W/D)/(W/Dref) > 1.6, BHR > 1.5	4
	6	Bank Rock Content	65%+ w/ large angular boulders. 12"+ common.	2	40-65%. Mostly boulders and small cobbles 6-12".	4	20-40%. With most in the 3-6" diameter class.	6	<20% rock fragments of gravel sizes, 1-3" or less.	8
	7	Obstructions to Flow	Rocks and logs firmly embedded. Flow pattern w/o cutting or deposition. Stable bed.	2	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occuring.	8
	8	Cutting	Little or none. Infrequent raw banks <6".	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	8	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
	9	Deposition	Little or no enlargement of channel or point bars.	4	Some new bar increase, mostly from coarse gravel.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfaces rough.	1	Rounded corners and edges, surfaces smooth, flat.	2	Corners and edges well rounded in 2 dimensions.	3	Well rounded in all dimensions, surfaces smooth.	4
	11	Brightness	Surfaces dull, dark or stained. Generally not bright.	1	Mostly dull, but may have <35% bright surfaces.	2	Mixture dull and bright, i.e. 35-65% mixture range.	3	Predominantly bright, 65%+, exposed or scoured surfaces.	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping.	2	Moderately packed with some overlapping.	4	Mostly loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%.	4	Distribution shift light. Stable material 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.	12	Marked distribution change. Stable materials 0-20%.	16
	14	Scouring and Deposition	<5% of bottom affected by scour or deposition.	6	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial, in swift water, too.	1	Common. Algae forms in low velocity and pool areas. Moss here, too.	2	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
				Excellent Total =		Good Total =		Fair Total =		Poor Total =

The following sections of the report discuss the data collected and process used to complete the Phase I rapid geomorphic assessment.

4.2 Channel Stability Variables

Channel stability, or channel state, is the primary focus of the Phase I rapid assessment to determine general quality of the streams to be inundated by the Lower Bois d'Arc Creek Reservoir for use in the 404 Permit Application. The adverse consequences of stream channel instability are increased sediment supply, land loss, habitat deterioration, changes in the long- and short-term channel evolution, and loss of both physical and biological functions of the stream.

Channel stability was determined from field inspections, measurements of stream channel characteristics, and by comparing existing stream conditions to historic maps and aerial photography. Specific categories and variables included in the evaluations are riparian vegetation, sediment deposition patterns, erosion potential, debris occurrence, and altered states due to manmade disturbances.

Compare Historic Maps and Aerial Photography

A map of the Bois d'Arc Creek system dating from circa 1915 was used along with aerial photography from 1950, 1976, and 2007 to evaluate changes in stream patterns, land use practices, and riparian vegetation. The impacts of these changes on the channel pattern and profile were evaluated and documented.

Riparian Vegetation

Riparian vegetation performs several functions in a stream system including bank stabilization, water quality protection, fish and wildlife habitat, and thermal cover for the stream. For the purpose of the rapid geomorphic assessment, the bank stabilization potential was the key reason for collecting the riparian buffer information; however, the additional information collected may be helpful in supplementing data collected for the environmental report, habitat evaluation, and 404 permit application.

Bank stabilization and water quality are improved with good riparian buffers because the roots of trees and shrubs help hold stream banks in place, preventing erosion. Riparian vegetation also traps sediment and pollutants.

The field data collected includes information on the general type and condition of the riparian vegetation including an estimate of the percentage of the channel that has trees, shrubs, and grasses. Rooting depth, root density and the percentage of the bank protected by vegetation are specific measurements that were taken at each data point. This information is used in both the preliminary bank stability and channel stability classifications.

Bank Stability Rating Process

The Bank Stability parameters include several related to the riparian vegetation and the bank angle. Although we did not use the Bank Erosion Hazard Index (BEHI) scoring system, we did reference the system for help in determining the key parameters to be evaluated in relation to the channel erosion potential (Rosgen, 2006). Riparian vegetation, as discussed above, plays a key role in bank stabilization. Banks with dense, deep rooting zones and in-channel vegetative cover in alluvium generally have stable banks while shallow, sparse roots and no in-stream vegetation result in unstable banks that are subject to mass wasting. Erosion potential related to bank angle, or slope steepness, generally ranges from very low for flat slopes to extreme for steep slopes; however, there is a correction factor associated with bank angle to take into consideration the bank material (i.e. bedrock can be very stable at steep angles while sand and clay are not).

Channel Stability Rating Process

The channel stability rating system utilized for this assessment is based on the measurement of up to 15 variables that are specific to the channel bottom, the lower banks within the channel, and the upper banks of the channel. Although we did not use the Rosgen-Pfankuch rating system, we did reference the system for help in determining the key parameters to be evaluated in relation to the channel stability (Rosgen, 2006). The channel stability rating process evaluates the upper banks, lower banks, and streambed for evidence of excessive erosion or deposition, which are indicative of disequilibrium and can be used to identify potential aquatic habitat within a stream. The system quantitatively evaluates the potential for mass wasting of the channel banks, the detachability of bank and bed materials, channel capacity, and evidence of either excessive erosion or deposition. The process provides a means for estimating general channel stability.

The upper bank variables considered are the general slope of the upper bank, evidence of mass wasting, size and volume of debris jams, and vegetative bank protection. Bank slope and mass wasting are clear indicators of bank stability and potential sediment load input into the stream.

Steep slopes and mass wasting are evidence of lateral migration. Debris jams, as opposed to in-stream cover, provide evidence of the mass wasting process and loss of large amounts of riparian vegetation due to lateral migration of the streambank. An over abundance of woody debris can profoundly affect stream channel stability by affecting sediment transport (can become a knick point forcing head cutting or down cutting), local bank stability, and channel form.

The lower bank variables consider the ability of the channel to carry bankfull discharges, material makeup of the bank, flow obstructions, and evidence of cutting and deposition. Channel capacity is a measure of entrenchment and the ability of the stream pattern and profile to carry the stream forming flows. While bank materials (sand, clay, rock, etc.) identify the potential of the banks to withstand near bank stress without failing, the flow obstructions are a means for identifying objects such as debris and large rocks that could cause erosive cross currents and bank cutting. Bank cutting is perhaps one of the most critical variables identified in the lower bank region of a stream because undercutting results in sloughs and mass wasting that can introduce large amounts of sediment into the stream while increasing the width and lateral migration of the channel. Depositional patterns are easily observed channel features that can be used to interpret the overall condition of the stream. These patterns can provide insight into the sediment supply, channel adjustments caused by lateral migration or widening, and changes in flow regime.

The variables evaluated for the channel bottom included rock angularity, brightness of the channel material, particle consolidation and size distribution, and aquatic vegetation. Angularity of the bed material provides a means for estimating the stream power required to carry bed load. Rounded and smooth bed material will require lower shear stress and stream power to move the sediment than if it has sharp edges and rough surfaces. Brightness of the bed material is a simple means for determining if small materials such as silt and clay are being deposited. Deposition of this material can indicate a lack of stream power and excess sediment load in the system; moreover, the deposition of this material can lead to the filling of pools and riffles resulting in the lack of in-stream habitat. Scour and deposition are clear indicators of whether or not the stream has either too much, or too little sediment to maintain dynamic equilibrium. Aquatic vegetation, an important component for biological activity, is a measure of stability within the channel bottom because it indicates if the material is being mined or buried (i.e. if the vegetation is permanent or transitory in nature).

Channel Depositional Features

The description of depositional features utilized for this study is from Mollard (1973) and Galay et. al. (1973) as modified by Rosgen (2006). Depositional features are often an indicator of channel aggradation and that the channel is not in equilibrium; however, as shown in the Channel Evolution sequence in Section 3.0 – Incised Channel Evolution Model, deposition is also a major component of a channelized system recovering to a state of dynamic equilibrium.

Field observations and interpretations of the depositional patterns were used in determining the overall state of the channel. Depositional patterns in altered or degraded channel reaches aided in determining if the stream channel was beginning to recover or not.

In-stream Habitat Potential

As dying or uprooted trees fall into the stream, their trunks, root wads, and branches slow the flow of water. Large snags create fish habitat by forming pools and riffles in the stream. However, excess debris can result in the creation of temporary dams that can change both the sediment transport and hydraulic geometry of localized reaches.

Riffles are areas in a stream where shallow water flows swiftly over substrate to produce surface agitation. Channel instability, particularly mass wasting of the channel banks and the continued widening of the channel, results in an excessive sediment load that can bury riffles and fill pools (deep, flat sections of stream) destroying potential habitat.

Cool stream temperatures maintained by riparian vegetation are essential to the health of aquatic species. A dense tree canopy over a creek assists in protecting against elevated water temperatures. The denser the canopy the more protection the creek receives.

Photographs

In addition to the data discussed above, photographs were taken at each data collection point to record visual observations. Photographs looking upstream and downstream were taken at each data point and, at some locations, photographs of the right and left banks were also taken. Representative photographs are included on the Classification Sheets in Appendix A.

4.3 Channel Stability Rating

All of the variables discussed in Section 4.2 were assessed for each data point and consolidated into a Rapid Assessment Classification Sheet (Figure 4.5). The data were then used to determine a general stability rating (good, fair, or poor) for that portion of the creek. These classification sheets were then used in conjunction with field notes, aerial photographs, one-foot LIDAR generated topography and two-foot aerial topography to relate the measured and observed sections of the study reaches to other sections of the creeks to determine their stability rating.

The stability rating system was developed by Freese and Nichols to provide an objective means for assigning values to the six major parameters identified in Figure 4.5. In order to provide a quantitative measurement of the six evaluation factors, the system relies on the physical parameters measured and recorded on the data collection sheet, bank stability form, and channel stability form. Data are first recorded in the field on those forms and select photographs are attached for future reference. Finally, the information on those three forms is used to complete the Rapid Assessment Classification form. The weighting and scoring system was developed to provide an objective means for interpreting the data and classifying the stream reaches.

A rating of “Good” indicates that the channel reach provide stable channel sections and the sediment transport capacity is balanced with sediment supply. The riparian vegetation consists of a variety of species that provide good stream bank coverage (armoring) and a dense root system. A rating of good also means the reach provides good, permanent, in-stream habitat. (Type V of ICEM).

A rating of “Fair” indicates that the channel is not completely stable. Fair reaches provide moderately stable channel sections but are still subject to some bank erosion and sediment transport capacity has not yet balanced with sediment supply. However, inner berms and emergent vegetation are present and the reach is recovering, and both the riparian and in-stream habitat is still somewhat transitional. (Type IV of ICEM).

“Poor” rated reaches are still in a state of disequilibrium. These reaches are continuing to erode and are subject to mass wasting. As a result of the disequilibrium these sections do not contain stable channel sections, riparian vegetation, or in-stream habitat. (Type II and III of ICEM).

The following section summarizes the characteristics and stability ratings of each of the five study reaches.

Figure 4.5 – Rapid Assessment Classification Sheet

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: _____

Rapid Assessment Stream Stability Rating			
O Excellent	O Good	O Fair	O Poor

Field Data Point	Station	
	To	From

Extrapolated Stations		
To	From	Reasoning

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		0		0		0

Description:

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	0

5.0 Results

The present day Bois d'Arc Creek system is characterized by the previous channel straightening, changing vegetated buffer, current incision, and the incision induced widening of the main stem of Bois d'Arc Creek and its' major tributaries. The following sections present the results of the rapid assessment and classification of Bois d'Arc Creek and the four studied tributaries.

5.1 Bois d'Arc Creek

There are approximately 89,300 feet (16.9 miles) of Bois d'Arc Creek within the proposed inundation pool of Lower Bois d'Arc Reservoir. Due to the extent of the creek and large variability of channel morphology, Bois d'Arc Creek was separated and analyzed as five separate reaches. Table 5.1 summaries the stationing for each reach and Figure 5.1 shows the location of each reach along the creek.

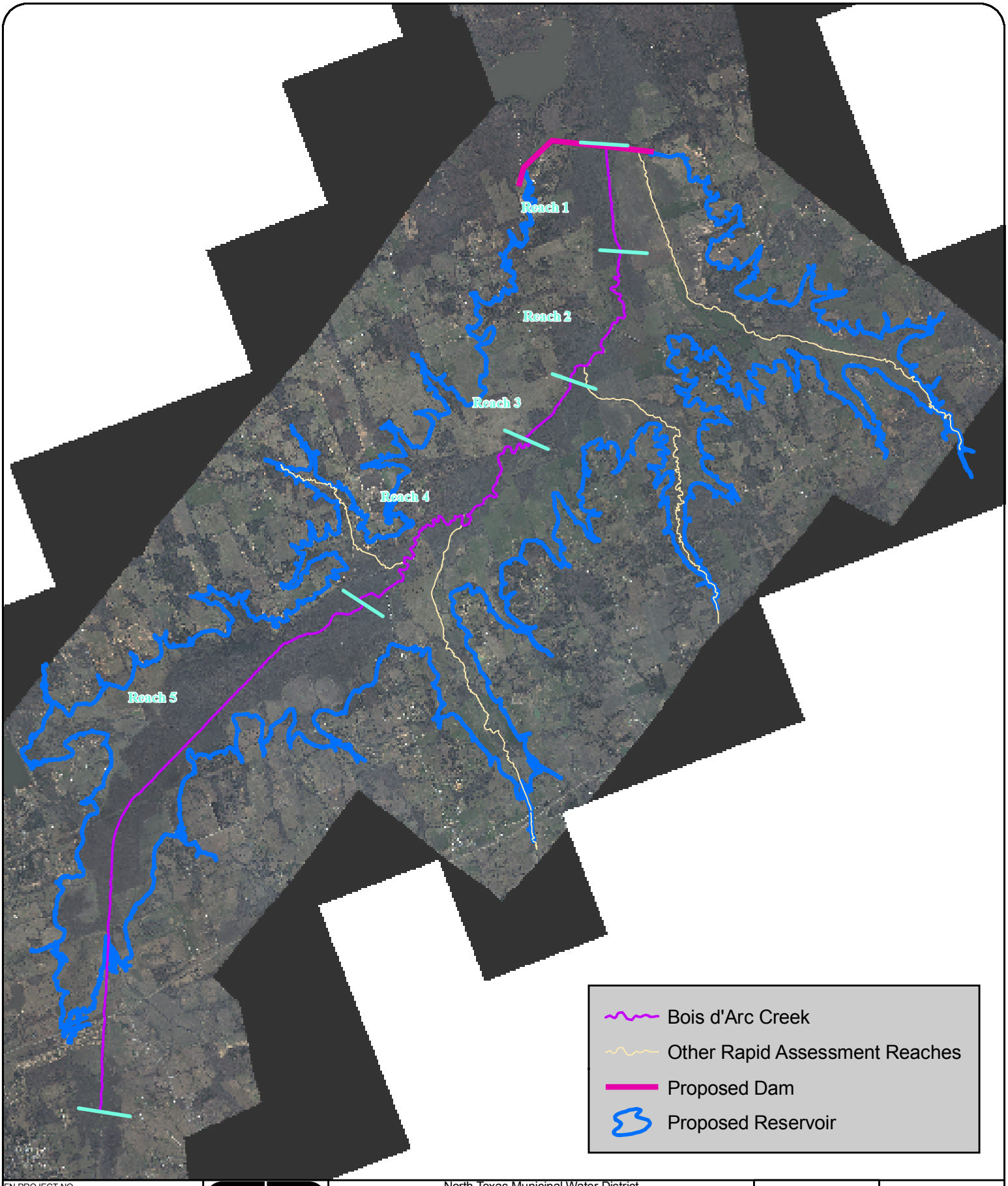
Table 5.1
Summary of Lower Bois d'Arc Creek Reach Information

Reach	Station
1	0+00 – 70+00
2	70+00 – 190+00
3	190+00 – 240+00
4	240+00 – 486+00
5	486+00 – 893+00

Approximately sixty-two percent (62%) of the main stem of Bois d'Arc Creek within the proposed reservoir was channelized. Reaches 1, 3, and 5 represent the channelized reaches. Figures 5.4, 5.9, and 5.15 provide examples of the typical channelization that took place along the creek. By comparing the historical map circa 1915 to the aerial imagery of 1950, we concluded that most of the channelization to the creek occurred between 1915 and 1950. Since 1950, several road crossings have been constructed where approximately 3,000 additional feet has been straightened. Due to the manmade alterations to the creek, the flowline has downcut causing a headcut effect propagating up the creek. Evidence of the down cutting can be seen in the longitudinal profiles for Bois d'Arc Creek in Figures 5.2 and 5.3.

The dominant channel material for Bois d'Arc Creek is clay with accumulations of shale, gravel, sand, and silt in the depositional features throughout the reaches. Each segmented reach of

Bois d'Arc Creek is very diverse in its physical characteristics, vegetation, and overall stability. The following sections describe each reach in detail. The Rapid Assessment Classification sheets for each reach are found in Appendix A.



FN PROJECT NO.	NTD06128
DATE	July 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o1_AllBDCreek.mxd
PREPARED BY	JM

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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Bois d'Arc Creek

0 0.5 1 2 Miles

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FIGURE 5.1

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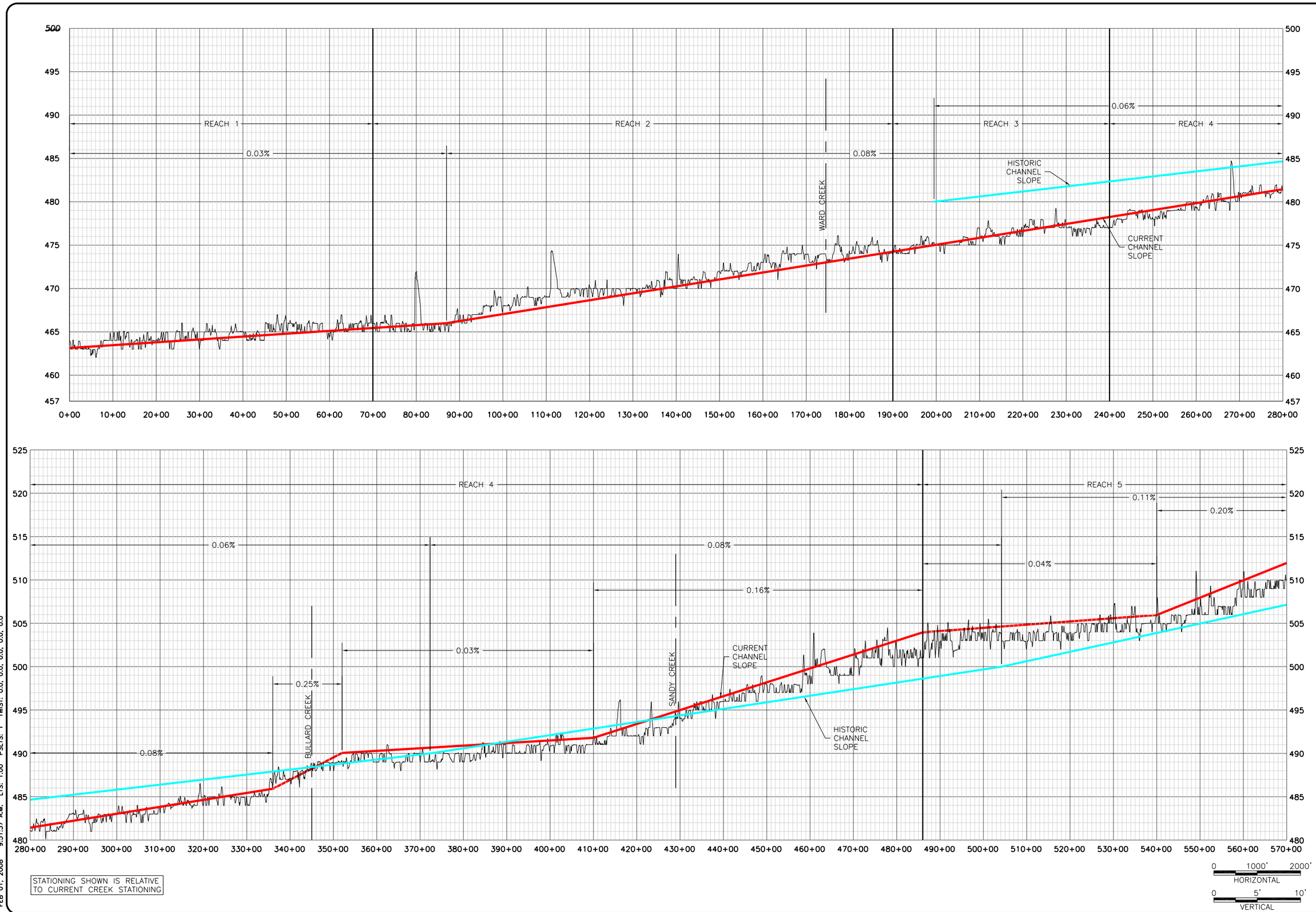

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LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

BOIS D'ARC CREEK

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Austin, Texas 78759
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5.2

FIGURE

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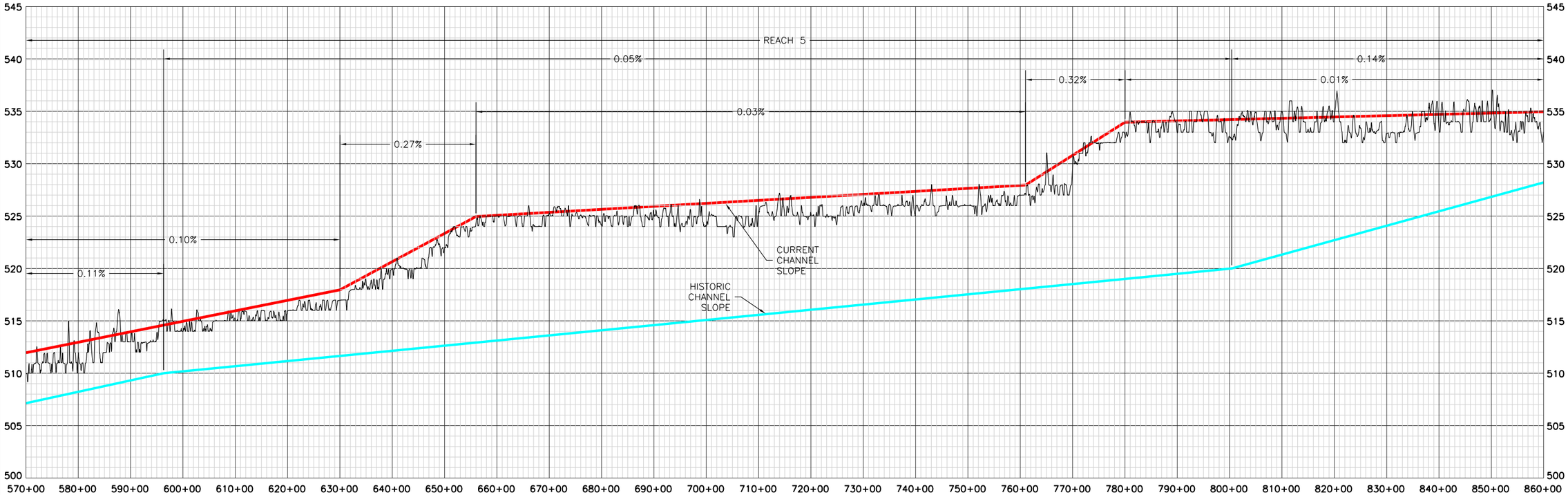

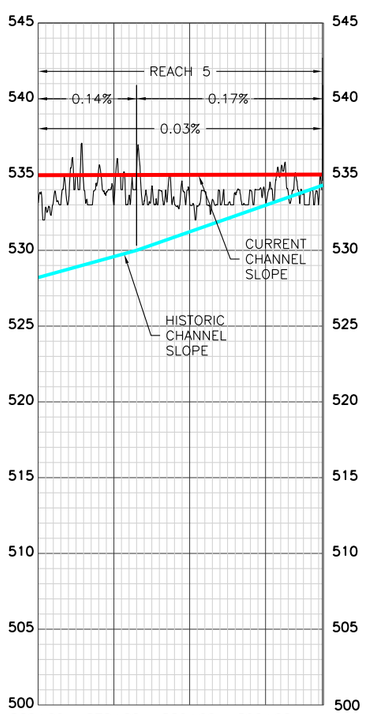

STATIONING SHOWN IS RELATIVE TO CURRENT CREEK STATIONING

0 1000' 2000'
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0 5' 10'
VERTICAL

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LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

BOIS D'ARC CREEK

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5.3
FIGURE

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Reach 1

Reach 1 of Bois d'Arc Creek (Figure 5.1) is the most downstream reach of the study area, accounting for approximately 8% of the total stream length. Comparing the alignment of this reach today to the circa 1915 map, shows that the entire 7,000 feet of the reach has been straightened. An example of the channelization of this reach is shown in Figure 5.4.

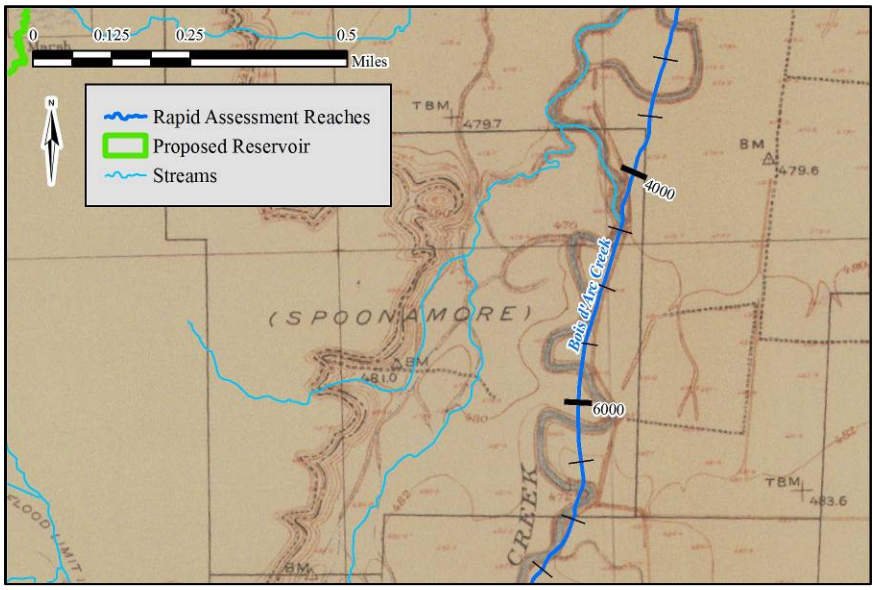


Figure 5.4 - Comparison of Historic to Existing Channel Alignment for Reach 1 of Bois d'Arc Creek

As shown in Figure 5.2, the channelization of Reach 1 has propagated upstream to Station 87+00 with an average channel slope of 0.03%. Figure 5.5 provides a typical view of Reach 1 of Bois d'Arc Creek. This reach has an average top width of 140 feet, average depth of 15 feet, with almost vertical side slopes. The riparian vegetation along the banks is moderate, with a mix of grasses along the mid slope and small trees and grasses on the upper slope. The lower banks have little to no vegetation providing little bank protection. Due to the absence of woody shrub species along the slopes, there is a limited root zone causing undercut stream banks. Depositional side bar features are common due to high sediment load from the steep banks and the shallow channel slope. Streambank erosion rates in some areas appear to be high due to undercut banks and mass wasting. There is little habitat potential in this reach, with very little shade over the creek and incised channel banks.

In terms of the rapid assessment classification of Reach 1 of Bois d'Arc Creek, this reach seems to be in Type III of the channel evolution process. The stability of this reach is evenly split, with approximately 51% of the reach given a "fair" rating and the other 49% a "poor" rating. The

rapid geomorphic classification for this reach is presented as Figure 5.20 at the end of this section.

Figure 5.5 - Reach 1 of Bois d'Arc Creek.

Reach 2

Reach 2 of Bois d'Arc Creek (Figure 5.1) stretches from Station 70+00 to 190+00, covering approximately 13% of the total stream length. Most of this reach has not been straightened and matches quite closely to the 1915 meandering alignment. However, 1,500 feet of the reach was straightened between 1950 and 1976 to accommodate F.M. 1396. There are two locations along the reach where a chute cutoff has formed (near Sta. 127+00 and 178+00), making the chutes the main stem of the creek and abandoning the original alignment over time. Figure 5.6 provides an example of one of the chute cutoffs.

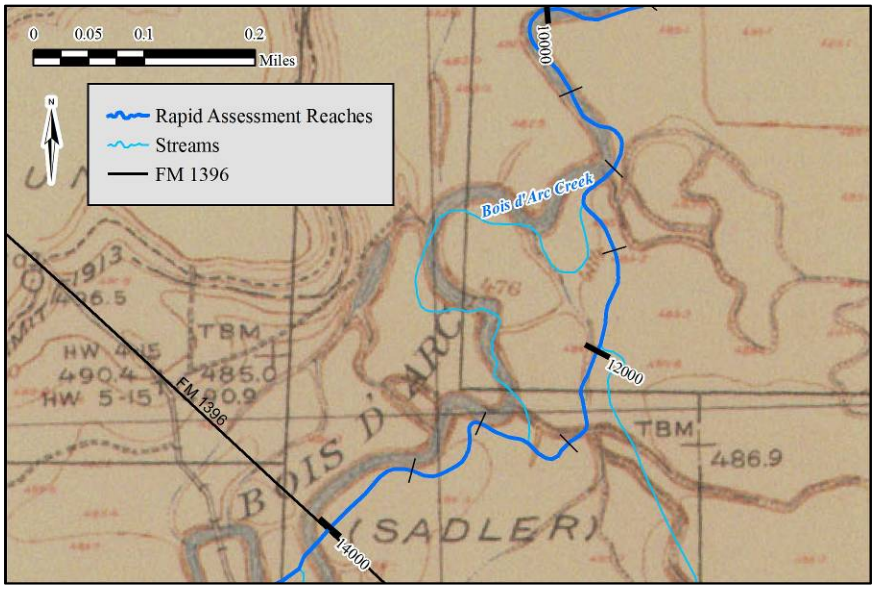


Figure 5.6 - Chute Cutoff in Reach 2 of Bois d'Arc Creek

As shown in Figure 5.2, Reach 2 has an average channel slope of 0.08%, but channelization of the downstream reach is causing a headcut into this reach. Figures 5.7 and 5.8 provide typical views of Reach 2 of Bois d'Arc Creek.

Figure 5.7 - Reach 2 of Bois d'Arc Creek during winter

Figure 5.8 - Reach 2 of Bois d'Arc Creek during summer

The physical characteristics of this reach are very similar to that of Reach 1, except that this reach is very sinuous. Reach 2 has an average top width of 140 feet, average depth of 15 feet, with almost vertical side slopes. The riparian vegetation along the banks is scarce, with a mix of grasses along the mid slope and small trees and grasses on the upper slope. The lower banks

have little to no vegetation providing little bank protection. Due to the absence of woody shrub species along the slopes, there is a limited root zone causing undercut stream banks. Depositional side bars, point bars, and mid-channel bars are common due to high sediment load from the steep banks and the shallow channel slope. Streambank erosion rates in some areas appear to be high due to undercut banks and mass wasting. There is little habitat potential for this reach, with very little shade over the creek and incised channel banks.

In terms of the rapid assessment classification of Reach 2 of Bois d'Arc Creek, the upper reaches of this creek seem to be in Type III of the channel evolution process. Downstream of F.M. 1396, the creek seems to be in transition between Types III and IV, with an inner berm forming inside the channel (Figure 5.8b). The stability of this reach is predominantly poor, with approximately 45% of the reach given a "fair" rating and the other 55% a "poor" rating. The rapid geomorphic classification for this reach is presented as Figure 5.20 at the end of this section.

Figure 5.8b - Reach 2 of Bois d'Arc Creek showing the formation of an inner berm.

Reach 3

Reach 3 of Bois d'Arc Creek (Figure 5.1) stretches from Station 190+00 to 240+00, covering approximately 6% of the total stream length. Comparing the alignment of this reach today to the circa 1915 map, shows that the entire 5,000 feet of the reach has been straightened. An example of the channelization of this reach is shown as Figure 5.9.

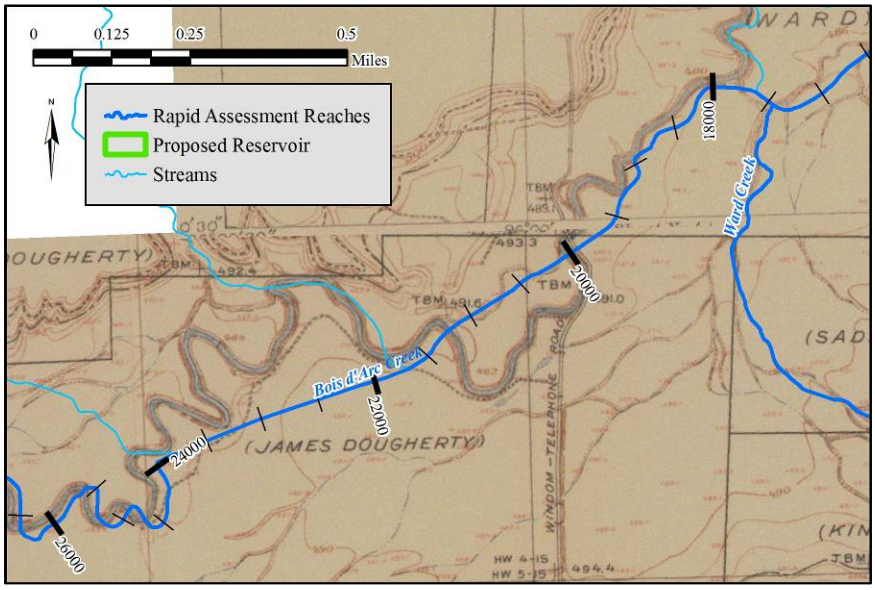


Figure 5.9 - Comparison of Historic to Existing Channel Alignment for Reach 3 of Bois d'Arc Creek

As shown in Figure 5.2, Reach 3 has an average channel slope of 0.08%. Figures 5.10 and 5.11 provide typical views of Reach 3 of Bois d'Arc Creek.

Figure 5.10 - Reach 3 of Bois d'Arc Creek during summer.

Figure 5.11 - Reach 3 of Bois d'Arc Creek during winter.

The physical characteristics of this reach are very similar to that of Reach 1. This reach has an average top width of 140 feet, average depth of 15 feet, with almost vertical side slopes. The riparian vegetation along the banks is scarce, with a mix of grasses along the mid slope and large trees and grasses on the upper slope. The lower banks have little to no vegetation providing little bank protection. Due to the absence of woody shrub species along the slopes, there is a limited root zone causing undercut stream banks. Depositional side bar features are common due to high sediment load from the steep banks and the shallow channel slope. Streambank erosion rates appear to be very high due to undercut banks and mass wasting (Figure 5.11), especially from Station 203+00 to 240+00. There is little habitat potential for this reach, with very little shade over the creek and incised channel banks.

In terms of the rapid assessment classification of Reach 3 of Bois d'Arc Creek, this reach seems to be in transition between Types III and IV, with an inner berm forming inside the channel. The stability of this reach is very poor, with 99% of the reach given a "poor" rating and 1% of the reach given a "fair" rating. The rapid geomorphic classification for this reach is presented as Figure 5.21 at the end of this section.

Reach 4

Reach 4 of Bois d'Arc Creek (Figure 5.1) stretches from Station 240+00 to 486+00, covering approximately 27% of the total stream length. Most of this reach has not been straightened and resembles quite closely the 1915 meandering alignment. However, 1,500 feet of the reach was straightened between 1915 and 1950 to accommodate County Road 2945 (Figure 5.12).

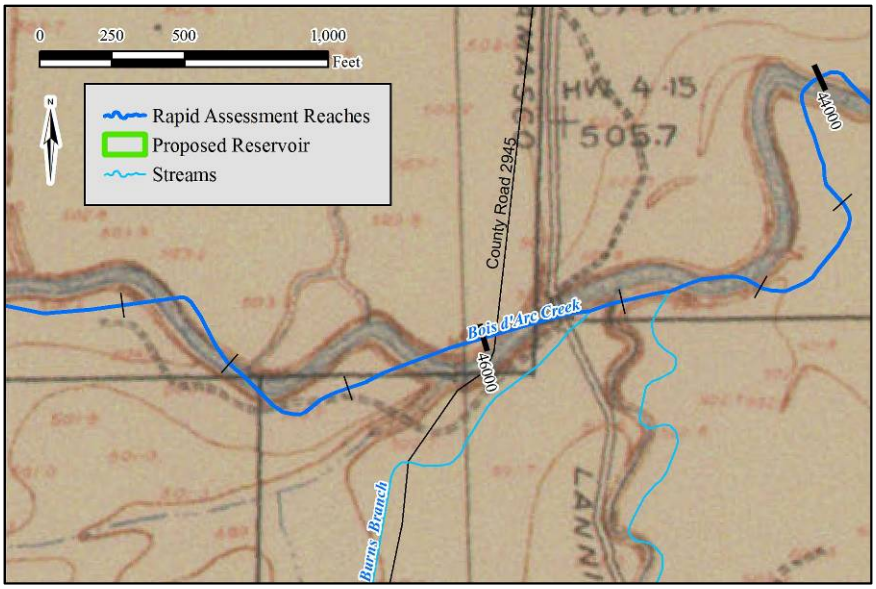


Figure 5.12 - Comparison of Historic to Existing Channel Alignment for Reach 4 of Bois d'Arc Creek

There is one location along the reach where a chute cutoff has formed (Sta. 300+00), making the chute the main stem of the creek and abandoning the original alignment over time. Figures 5.13 and 5.14 provide typical views of Reach 4 of Bois d'Arc Creek.

Figure 5.13 - Reach 4 of Bois d'Arc Creek during winter

Figure 5.14 - Reach 4 of Bois d'Arc Creek after summer rain event

The physical characteristics of Reach 4 are very different from that of the lower reaches. For the portion of the reach downstream of the confluence with Bullard Creek (approximately Station 240+00 to 345+00), the average top with is 110 feet, average depth is 12 feet, with an average channel slope of 0.08%. For the portion of the reach between the confluences of Bullard Creek and Sandy Creek with Bois d'Arc Creek (approximately Sta. 345+00 to 429+00), the average top width is 110 feet, average depth of 8 feet, with an average channel slope of 0.03%. For the portion of the reach upstream of Sandy Creek (approximately Station 429+00 to 485+00), the average top width is 50 feet, average depth is 4 feet, with an average channel slope of 0.16%. All of the stream segments have almost vertical side slopes. The channel dimensions for each stream segment coincide with the introduction of tributaries along Bois d'Arc Creek.

The riparian vegetation and stream cover for this reach is very different from that of the lower reaches. The vegetation along the banks is minimal, with a mix of grasses and dense tree roots covering approximately 20% of the slope. Due to the absence of woody shrub species along the slopes, there is a limited root zone causing undercut stream banks. However, there is new growth along the slopes providing evidence that the banks are trying to recover. Along the upper banks of the reach, there are good stands of trees providing good stream cover and rooting depth. Depositional side bars, point bars, and mid-channel bars are common due to high sediment load from the eroding banks. Streambank erosion rates appear to be high due to

undercut banks. There is moderate habitat potential for this reach, with ample stream cover and deep pools.

In terms of the rapid assessment classification of Reach 4 of Bois d'Arc Creek, this reach seems to be in Type III of the channel evolution process. The stability of this reach is predominantly fair, with approximately 70% of the reach given a "fair" rating and the other 30% given a "poor" rating. The rapid geomorphic classification for this reach is presented as Figure 5.21 at the end of this section.

Reach 5

Reach 5 of Bois d'Arc Creek (Figure 5.1) is the most upstream reach of the study area, covering approximately 46% of the total stream length. The entire 40,700 feet of the reach has been straightened. An example of the channelization of this reach is shown as Figure 5.15.

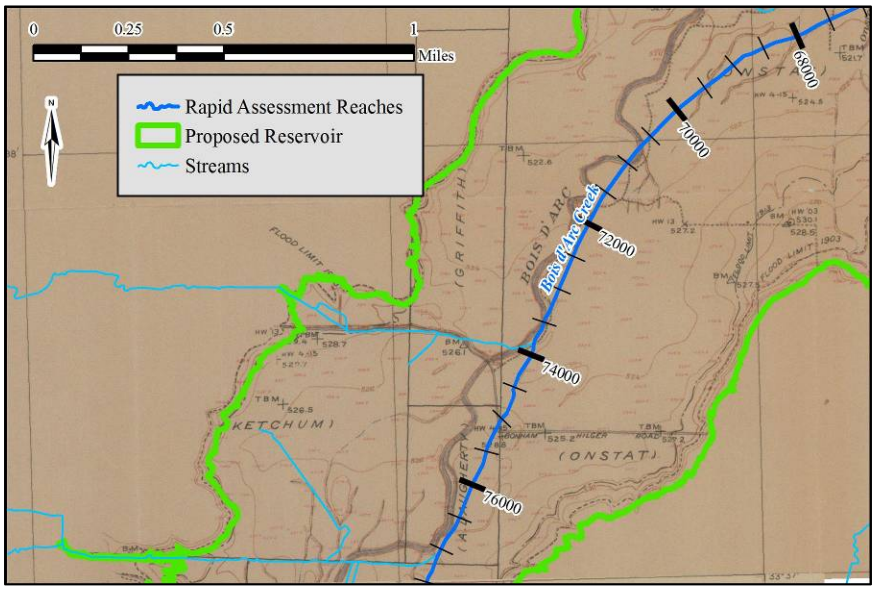


Figure 5.15 - Comparison of Historic to Existing Channel Alignment for Reach 5 of Bois d'Arc Creek

The channel dimensions vary greatly throughout the reach. Approximately 25% of the reach (Sta. 635+00 to 690+00 and 780+00 to 830+00) has limited channel capacity, with flood flows overtopping the banks during minor flood events, creating a wide expansive floodplain. Figure 5.16 shows an example of a stream segment in this area classified as "poor." Figure 5.17 shows an example of a stream segment in this area classified as "fair."

As depicted in Figure 5.16, there is a very established root zone lining the banks of this reach creating habitat and stabilization for the banks. However, these roots cover approximately 20%

of the banks, with the remaining percentage left as barren slopes. In addition, the side slopes are vertical, causing undercut banks. Channel slopes for this segment of reach average 0.01%.

Figure 5.16 - A "poor" rated reach on Reach 5 of Bois d'Arc Creek.

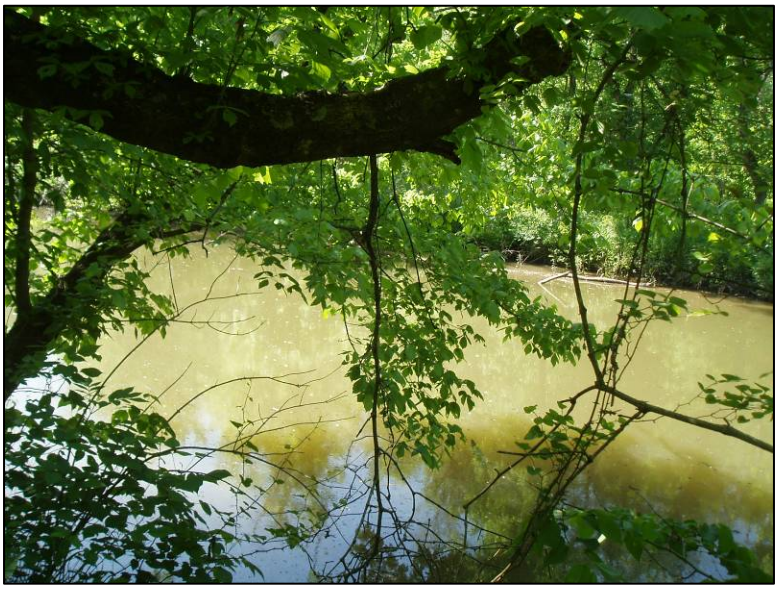


Figure 5.17 - A "fair" rated reach on Reach 5 of Bois d'Arc Creek.

Conversely, Figure 5.17 represents a stream segment along Reach 5 classified as "fair." Even though the stream has little capacity, the banks are stable with a variety of woody species. Channel slopes for this segment of reach average 0.03%.

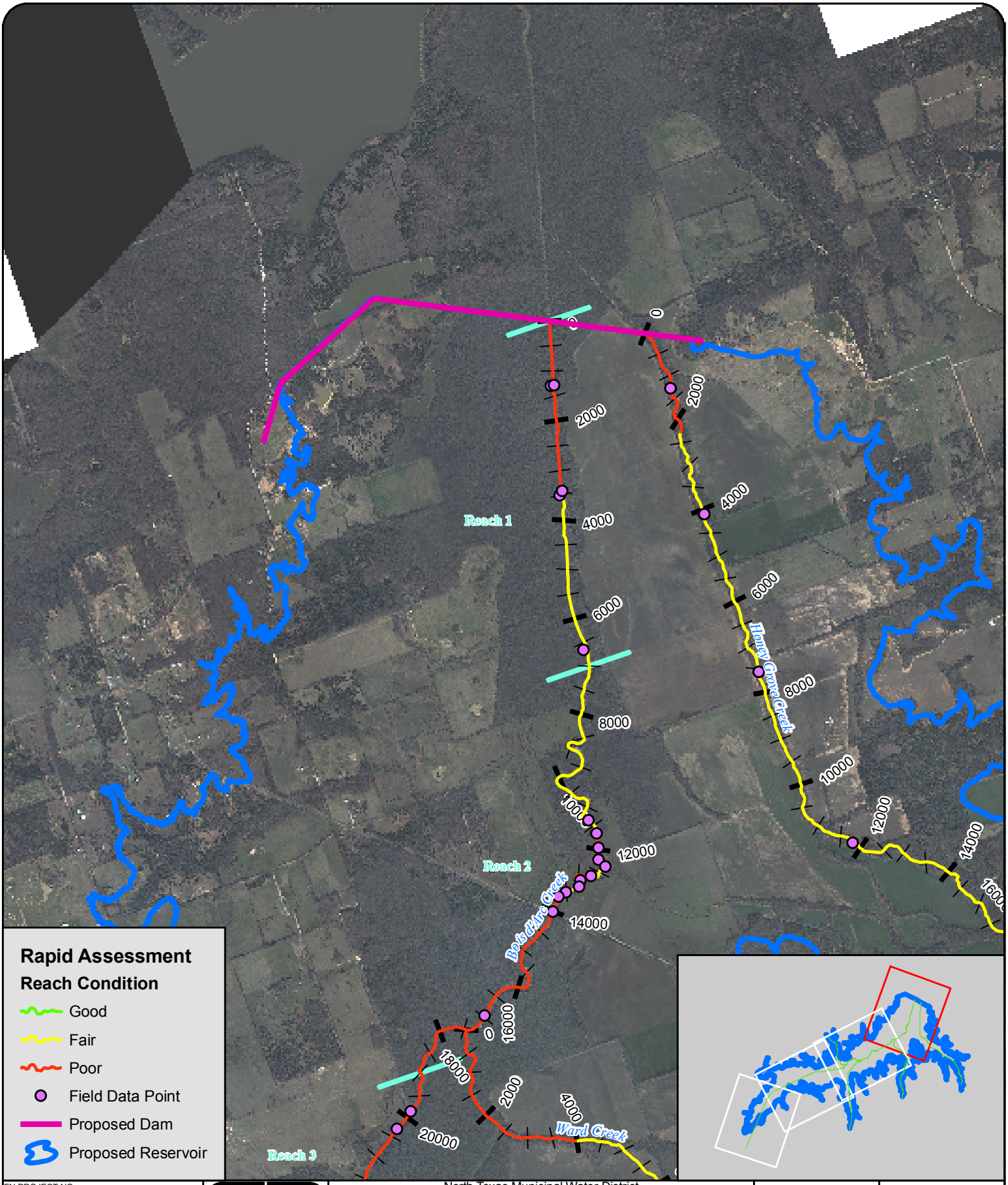
Outside of this low lying area, the channel dimensions vary from a top width of 50 feet to 70 feet and a channel depth of three feet to eight feet as you move downstream. Channel slopes for this segment of reach average 0.10%. Figure 5.18 shows an example of a stream segment in this area classified as "poor." Figure 5.19 shows an example of a stream segment in this area classified as "fair."

Figure 5.18 - A "poor" rated reach on Reach 5 of Bois d'Arc Creek.

Figure 5.19 - A "fair" rated reach on Reach 5 of Bois d'Arc Creek.

As depicted in Figure 5.18, there is potential for stream cover during the spring and summer months; however, the side slopes are vertical and there is little to no vegetation along the slopes. Conversely, Figure 5.19 has adequate stream cover, laid back side slopes and 70-80% bank cover throughout the section.

In terms of the rapid assessment classification of Reach 5 of Bois d'Arc Creek, this reach is predominantly in poor stability conditions, with approximately 37% of the reach given a "fair" rating and the other 63% given a "poor" rating. The rapid geomorphic classification for this reach is presented in Figures 5.22 and 5.23 at the end of this section.



FN PROJECT NO.	NTD06128
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o20_BDCreek1.mxd
PREPARED BY	JM

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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Bois d'Arc Creek

0 0.25 0.5 1 Miles

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FIGURE 5.20

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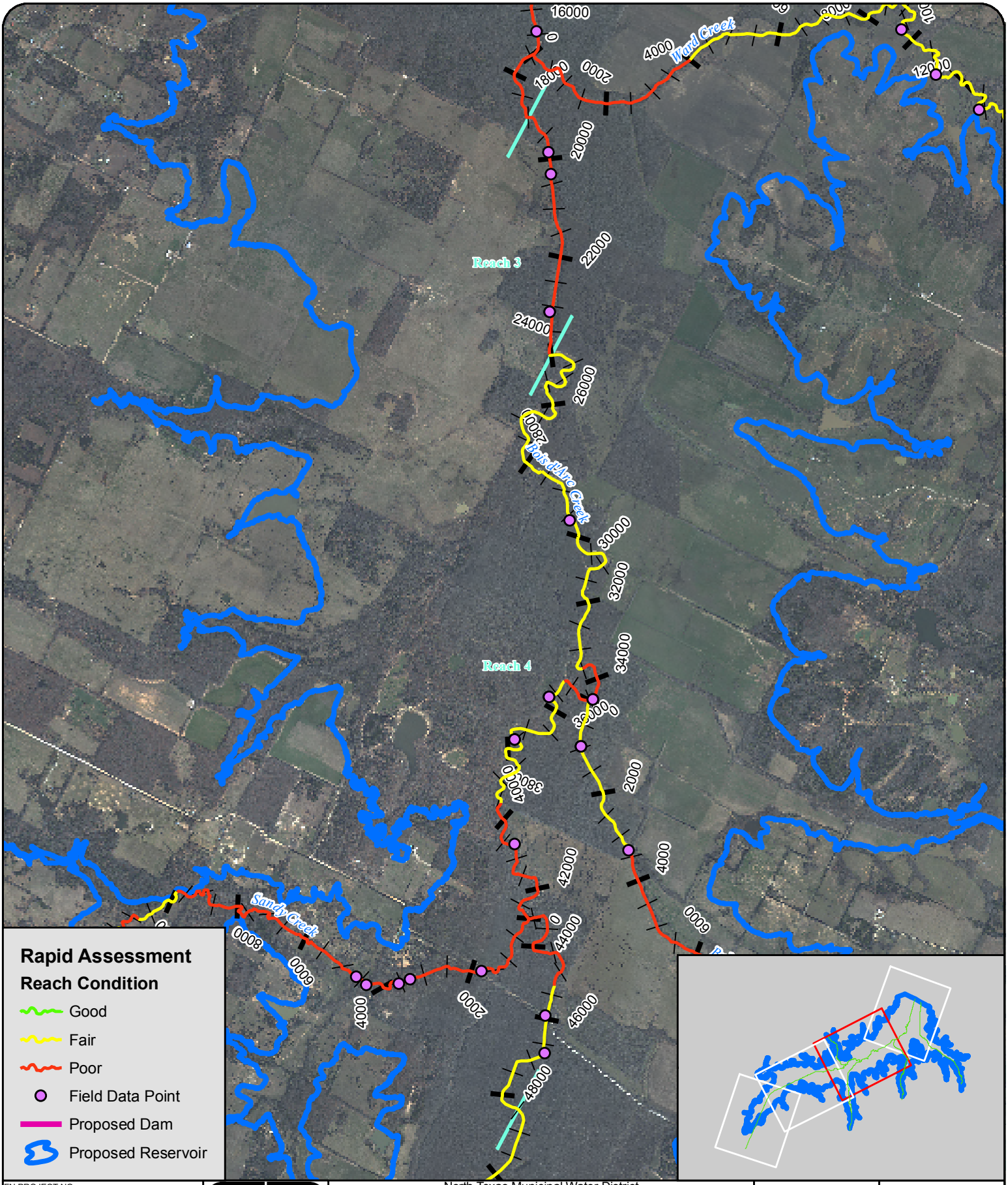
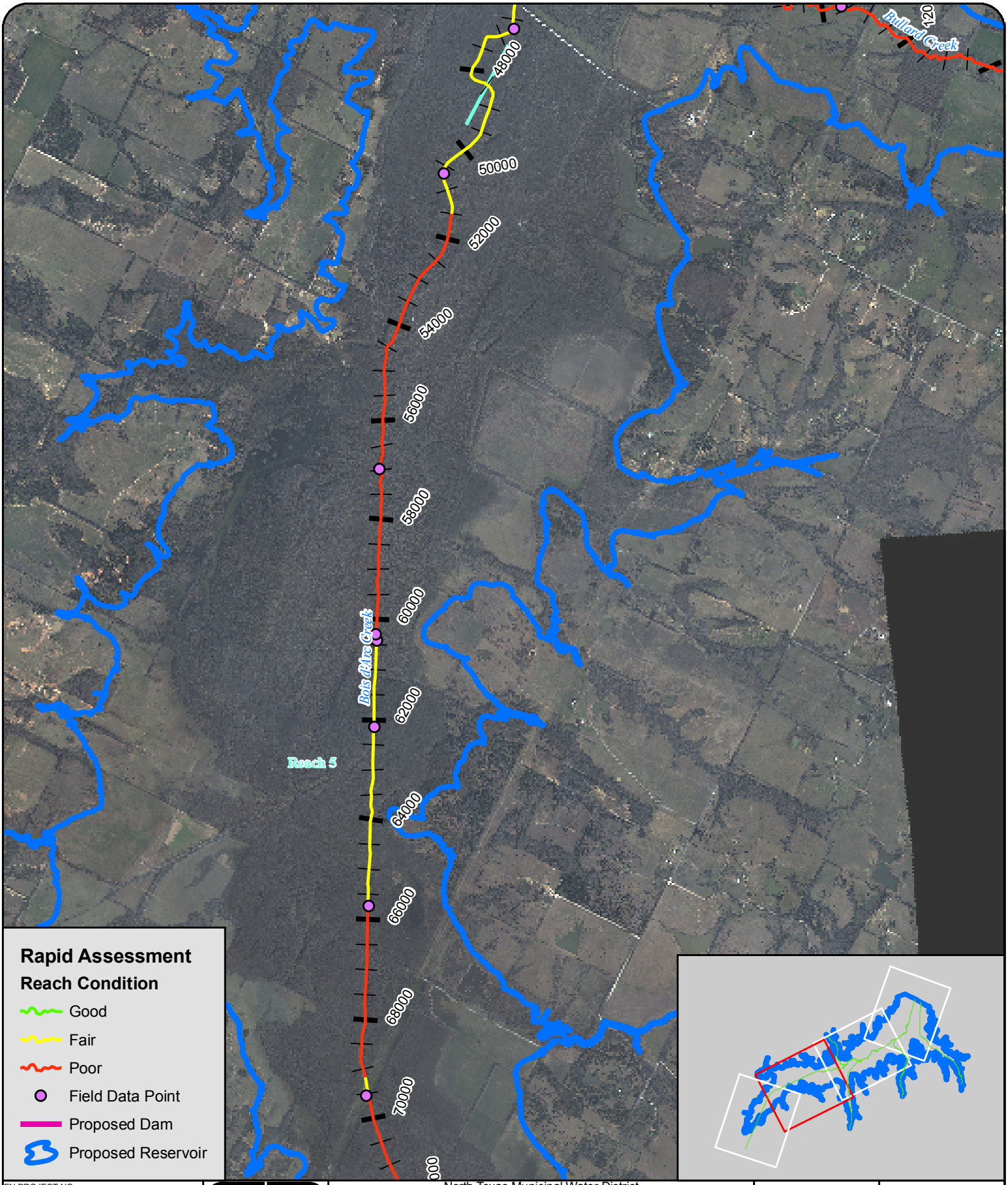


FN PROJECT NO. NTD06128	Freese and Nichols, 10814 Jollyville Road, Building 4, Suite 100, Austin, TX 78759, Phone: (512) 617-3100, Fax: (512) 617-3101	North Texas Municipal Water District Proposed Lower Bois d'Arc Reservoir Project Bois d'Arc Creek	FIGURE 5.21
DATE September 2008		0 0.25 0.5 1 Miles	
DATUM & COORDINATE SYSTEM NAD83 State Plane			
FILE Fig5o21_BDCreek2.mxd			
PREPARED BY JM			

Date: Tuesday, September 02, 2008 1:21 PM Prepared By: jm File: H:\STORMWATER\FINAL_EXHIBITS\Fig5o21_BDCreek2.mxd



FN PROJECT NO.	NTD06128
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o22_BDCreek3.mxd
PREPARED BY	JM

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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

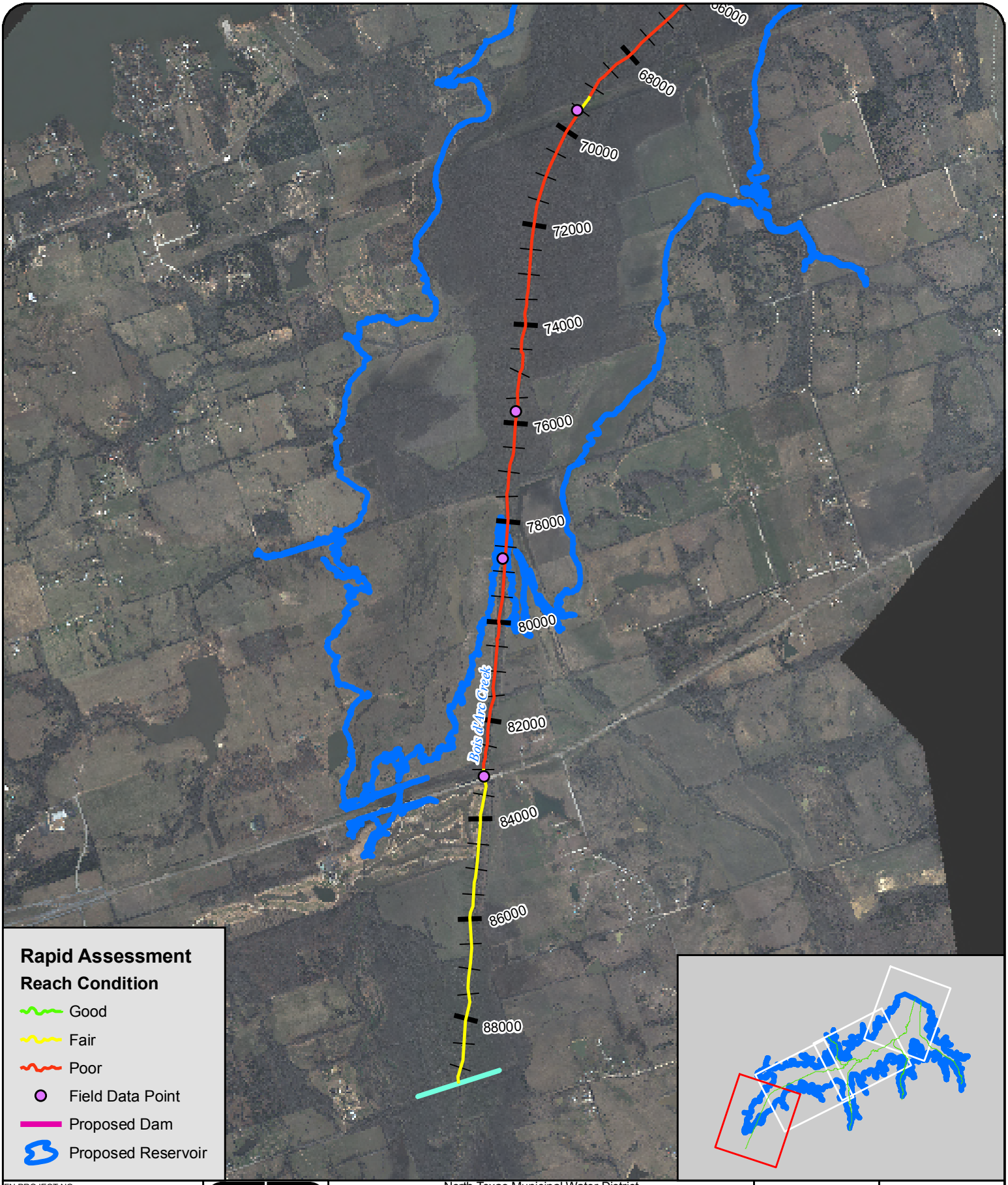
Bois d'Arc Creek

0 0.25 0.5 1 Miles

N

FIGURE 5.22

Date: Tuesday, September 02, 2008 1:22 PM Prepared By: jm File: H:\STORMWATER\FINAL_EXHIBITS\Fig5o22_BDCreek3.mxd



FN PROJECT NO.	NTD06128
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o23_BDCreek4.mxd
PREPARED BY	JM

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Proposed Lower Bois d'Arc Reservoir Project

Bois d'Arc Creek

0 0.25 0.5 1 Miles

N

FIGURE 5.23

Date: Tuesday, September 02, 2008 1:22 PM Prepared By: jm File: H:\STORMWATER\FINAL_EXHIBITS\Fig5o23_BDCreek4.mxd

5.2 Honey Grove Creek

Honey Grove Creek is a large tributary of Bois d'Arc Creek; however, the confluence of the two streams is located approximately 2,000 feet downstream of the proposed dam. Approximately 35,700 feet (6.8 miles) of Honey Grove Creek is in the proposed inundation pool of Lower Bois d'Arc Creek Reservoir.

Based on the 1915 map of the streams, it appears that approximately 9,500 linear feet of Honey Grove Creek (nearly 30%), within the reservoir, were channelized prior to 1915. Figure 5.24 shows a portion of the reach that was channelized. Our interpretation that this portion of Honey Grove Creek was channelized is evidenced by depiction of the lower end of the present day creek down to the confluence with Bois d'Arc Creek, as a small localized tributary of the main stem with a small ridge between Bois d'Arc Creek and what appears to be an unfinished channel. It appears that the original Honey Grove Creek channel can still be seen in the 1915 map with its confluence with Bois d'Arc Creek at approximate Bois d'Arc Creek Station 74+00 (Figure 5.24).

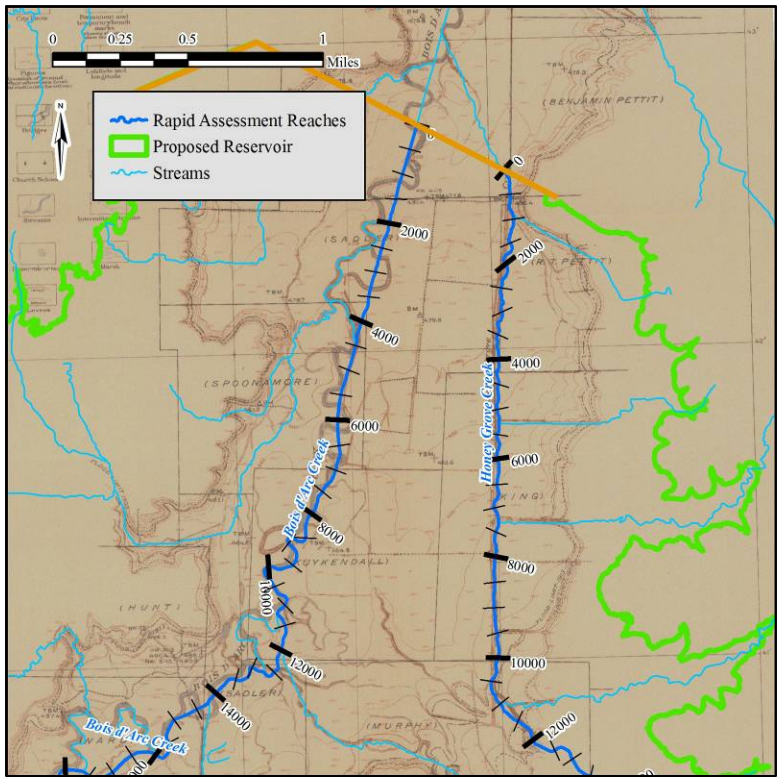


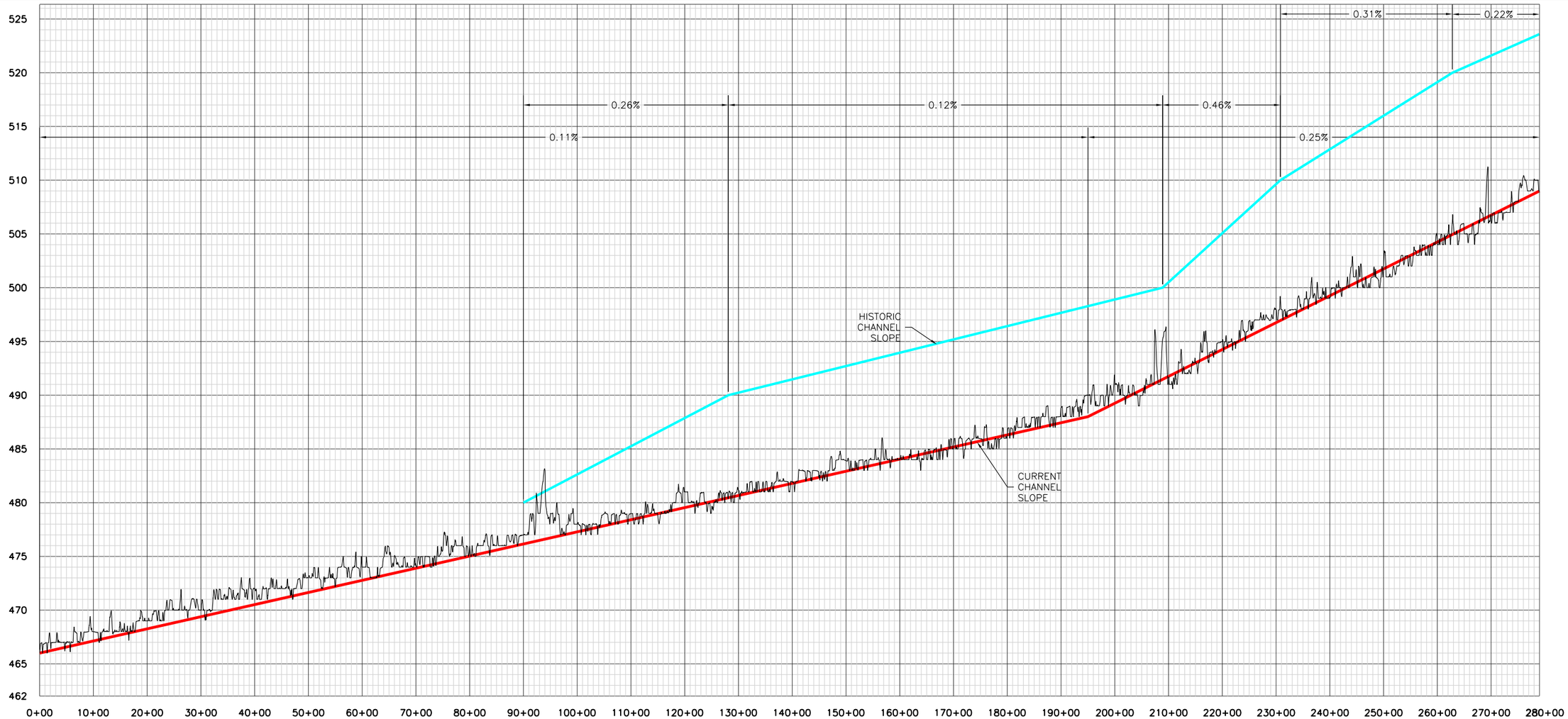
Figure 5.24 - Comparison of Historic to Existing Channel Alignment on Honey Grove Creek.

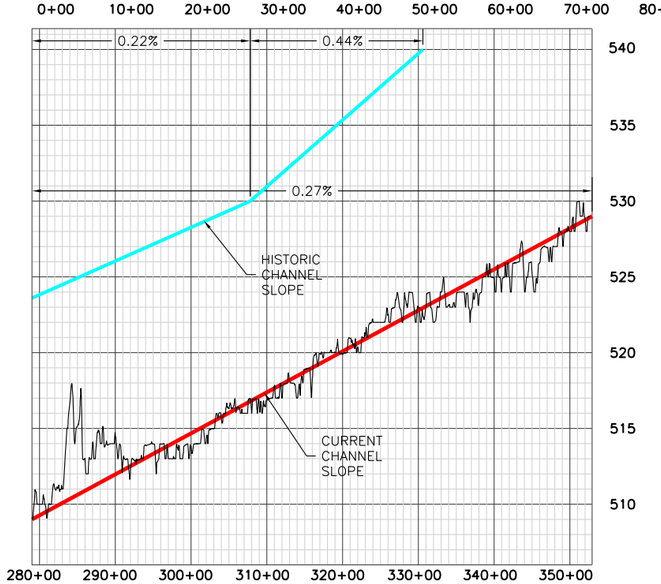
Portions of the original channel remain discernable through the 2007 aerial photographs although portions appear to have been filled in and converted to farm land. Comparing the 1915 maps to the 1950 aerial shows that the lower 3,000 feet of the present day Honey Grove Creek (downstream of the reservoir) is a manmade channel and the natural channel has been removed for agricultural reasons. We conclude that most of the channelization to the creek occurred between 1915 and 1950. Due to the manmade alterations to the creek, the flowline has downcut causing a headcut to propagate up the creek. Evidence of the down cutting can be seen in the longitudinal profile for Honey Grove Creek in Figure 5.25.

The dominant channel material is sand with minor components of shale gravel in some bars in the lower reach. There is a distinct break in the slopes of the upper half of the stream and the lower half of the stream. With the exception of the lower reach of this creek, there is little variation in terms of physical characteristics, vegetation, and overall stability along Honey Grove Creek.

As shown in the longitudinal profile, the headcutting has propagated upstream to Station 195+00 with an average slope of approximately 0.11%. This lower reach (Sta. 0+00 -195+00) has an average top width of 100 feet, an average depth of 12 feet, and steep side slopes. The riparian vegetation along the banks is moderate, with a mix of grasses along the middle slope and trees and grasses on the upper slope. The lower banks have little to no vegetation in most locations providing little bank protection. Due to the absence of woody shrub species along the slopes, there is a limited root zone causing undercut stream banks. Depositional side bar features are common due to high sediment load from the banks. These depositions are loosely packed and are transitory. There is no evidence that the channel is forming inner berms or a new floodplain at this time. Streambank erosion rates in some areas, particularly the downstream 2,300 feet of the channel, appear to be high due to undercut banks and mass wasting. There is little habitat potential for this reach, with very little shade over the creek and incised channel banks. Figures 5.26 and 5.27 show typical examples of the poor and fair rated stream segments along the lower reach, respectively.

In terms of the rapid assessment classification, the lower reach of Honey Grove Creek appears to be a Type III within the channel evolution process. Although this reach of the channel does not exhibit characteristics of equilibrium, the classification for 87% of the lower reach is a “fair” rating while only the downstream 2,300 feet (13%) is rated “poor” (Figure 5.29).





STATIONING SHOWN IS RELATIVE TO CURRENT CREEK STATIONING

0 1000' 2000'
HORIZONTAL

0 5' 10'
VERTICAL

F&N JOB NO. OFF21021
DATE SEPT. 2001
SCALE AS SHOWN
DESIGNED JWS
DRAFTED GAL
FILE HoneyGroveHistoricOverlay.dwg

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LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

HONEY GROVE CREEK

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5.25

FIGURE

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[NTD06128][AUSTIN3]N:\WR\REPORT\HONEYGROVEHISTORICOVERLAY.DWG LAYOUT: Layout1
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Figure 5.26: Poor rated section of Honey Grove Creek along lower reach.

Figure 5.27: Fair rated section of Honey Grove Creek along lower reach.

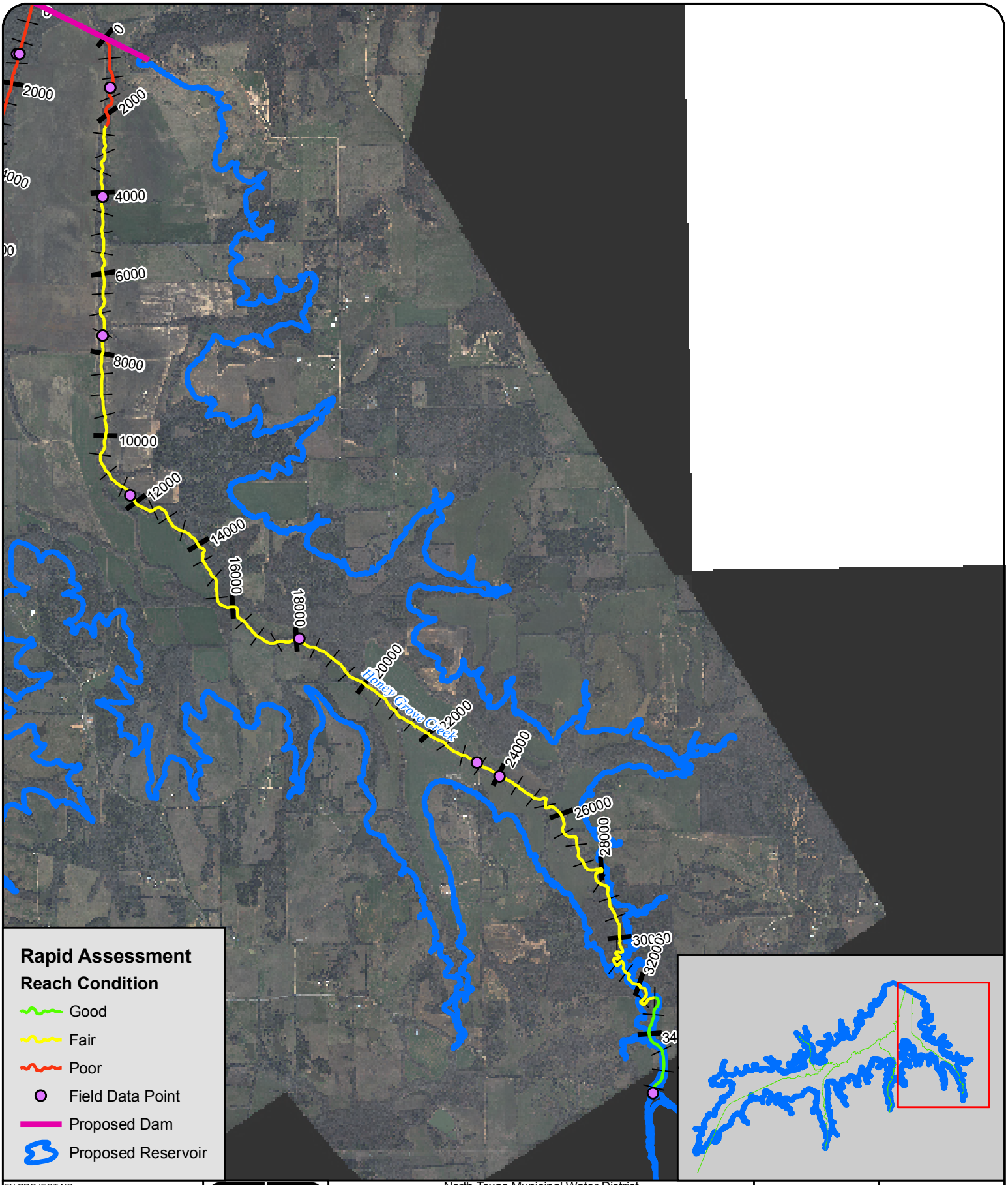
The upper reach of Honey Grove Creek (Sta. 195+00 – 357+00) has an average top width of 132 feet, an average depth of 18 feet, and steep side slopes. The riparian vegetation along the banks is moderate, with a mix of grasses along the mid slope and trees and grasses on the upper slope. The lower banks have varying amounts of grass and small brush throughout this reach. The presence of the vegetation along the slopes is evident by the lack of undercut and sloughing banks. Depositional side bar features are common due to high sediment load from the

banks. There is little habitat potential for most of this reach, with very little shade over the creek and incised channel banks. Figure 5.28 shows a typical view of this fair rated stream segment.

Figure 5.28: Fair rated section of Honey Grove Creek along upper reach.

In terms of the rapid assessment classification, the upper reach of Honey Grove Creek appears to be a Type III, with some segments of Type IV, within the channel evolution process. Although this reach does not exhibit characteristics of equilibrium, the classification for 2,700 feet (15%) of the upper reach is a “good rating”, while the remaining 85% of the reach is a “fair” rating (Figure 5.29).

The classification of the entire reach is predominantly fair, with approximately 86% of the reach given a “fair” rating, 8% a “good” rating, and the remaining 6% a “poor” rating. The rapid geomorphic classification for this reach is presented as Figure 5.29.



FN PROJECT NO.	NTD06128
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o29_HoneyGrove.mxd
PREPARED BY	JM

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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Honey Grove Creek

0 0.25 0.5 1 Miles

N

FIGURE 5.29

Date: Tuesday, September 02, 2008 1:23 PM Prepared By: jm File: H:\STORMWATER\FINAL_EXHIBITS\Fig5o29_HoneyGrove.mxd

5.3 Ward Creek

Ward Creek is a large tributary of Bois d'Arc Creek with the stream confluence at approximate Station 174+00 on Bois d'Arc Creek. Approximately 27,900 feet (5.4 miles) of Ward Creek are within the proposed inundation pool of Lower Bois d'Arc Reservoir.

Comparing the 1950 aerial photograph to the 1915 map of Ward Creek show that approximately 3,500 to 4,000 feet (approximately 10%) of this steam was channelized between approximate Stations 25+00 and 60+00 (Figure 5.30). Although this section was channelized, it should be noted that the changes in the pattern of this stream were much less aggressive than the alterations to segments of Bois d'Arc Creek and Honey Grove Creek discussed above, as this section of Ward Creek had low sinuosity prior to the channelization.

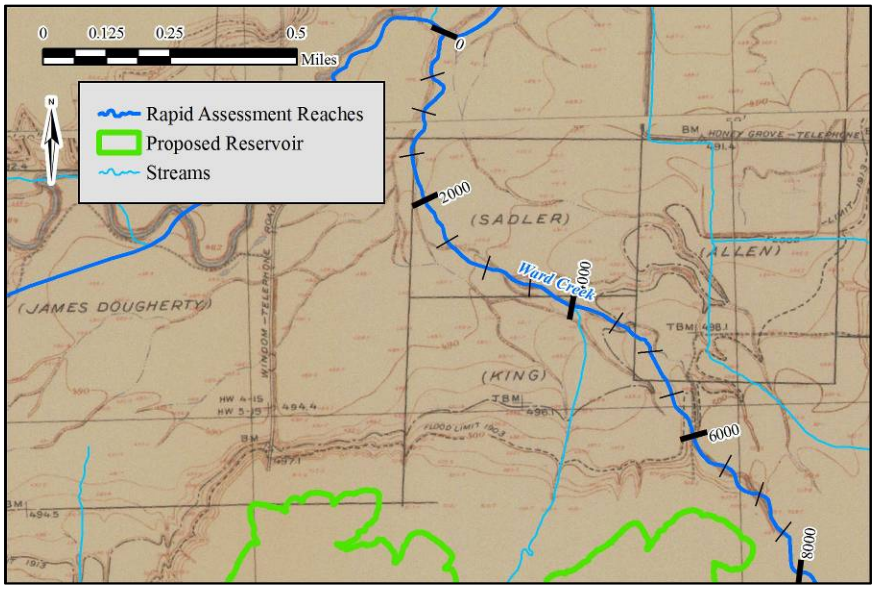
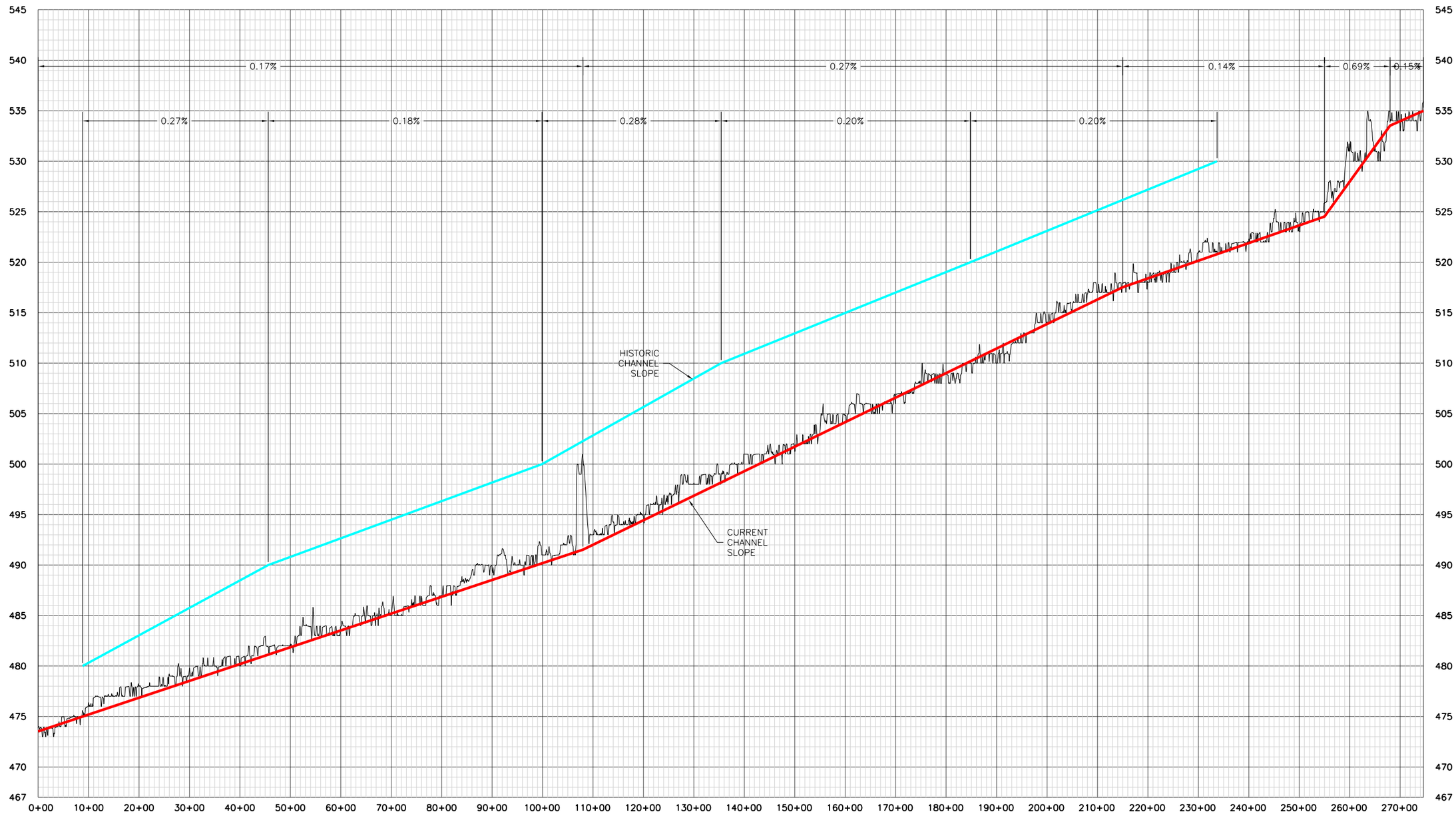


Figure 5.30 - Comparison of Historic to Existing Channel Alignment on Ward Creek.

As shown in Figure 5.31, Ward Creek has downcut from the confluence with Bois d'Arc Creek upstream to Station 255+00 with an average channel slope of 0.20%. The down cutting and widening of the stream through this reach is evident by comparing the 2007 aerial photographs with the 1950 aerials. There is a much steeper reach near the end of the proposed inundated portion of Ward Creek with a slope of nearly 0.70%. Depositional side bars are common and, where the stream has downcut, there are signs that a new floodplain is beginning to develop with the channel (Figure 5.32). Streambank erosion rates in some reaches appear to be very high due to mass wasting (Figure 5.33); however, there are long reaches that appear to be recovering with the formation of inner berms and emergent vegetation.



STATIONING SHOWN IS RELATIVE TO CURRENT CREEK STATIONING

F&N JOB NO. NTD06128
DATE 1/25/08
SCALE AS SHOWN
DESIGNED JWS
DRAFTED CJE/GAL
FILE WardHistoricOverlay.dwg

NORTH TEXAS MUNICIPAL WCID

LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

WARD CREEK

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5.31

FIGURE

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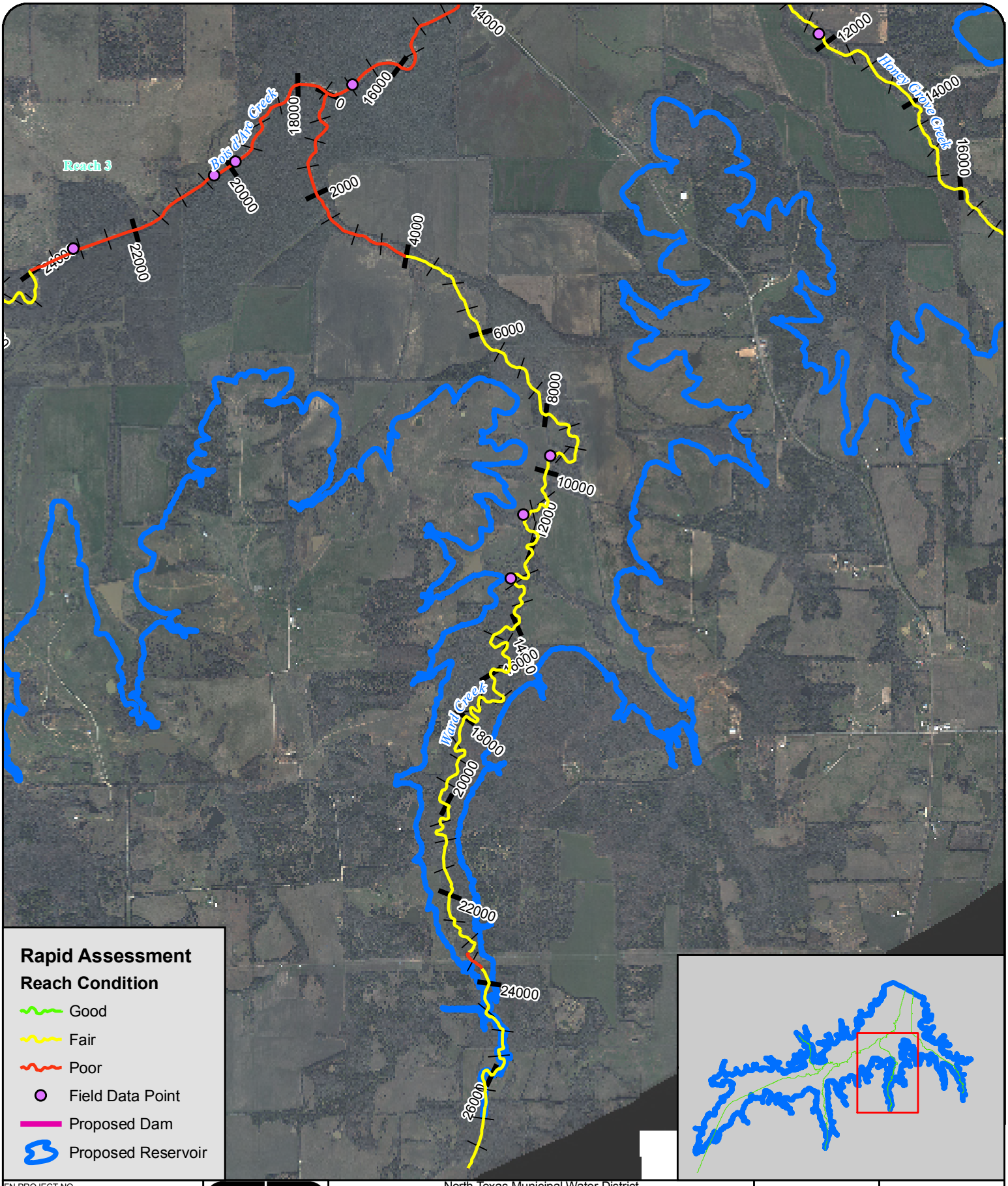
Figure 5.32 – Typical view of Ward Creek

Figure 5.33 - View of Ward Creek with evidence of mass wasting.

The dominant channel material is sand with some shale and gravel accumulations in the bar depositions. Between Stations 0+00 and 210+00, Ward Creek has an average top width of 115 feet, an average depth of 14 feet, with almost vertical side slopes. The riparian vegetation along the banks is dense, with a mix of small vines, brush, and trees along the lower and mid slopes and trees and grasses on the upper slope. Depositional side bars and point bars are common due to high sediment load but most of the reach is recovering and mass wasting is intermittent. There is good habitat potential along segments of this reach with 70% – 80% shade over the creek, in-stream vegetation and formation of a new floodplain within the channel. The remaining segments of the Creek have little habitat potential due to the lack of stream cover or shade. Upstream of Station 210+00 the average width of the channel is 80 feet with an average depth of 10 feet. With the exception of the segments from 233+00 to 237+00 and 255+00 to 268+00, the upper reach is similar to the lower reach. The 400 foot segment at Station 233+00 has been completely cleared for an overhead power easement and the 2007 aerial photographs indicate that the banks are actively wasting into the channel. The segment from Station 255+00 to 268+00 is between a knickpoint (a location in a river or channel where there is a sharp change in channel slope) in the channel profile and the upstream end of the channel incision. There is no physical barrier that forms the knickpoint, such as a culvert, and only riparian vegetation appears to be slowing the head cutting.

In terms of the rapid assessment classification of Ward Creek, the majority of the reaches of this creek appear to be in Type III or Type IV of the channel evolution process with inner berms forming within the channel. The downstream segment of this creek appears to be in Type III and continues to react to the changes in Bois d'Arc Creek. A major impact on this segment of the creek was the apparent meander cutoff at the confluence. The overhead electric easement and section downstream of the knickpoint are in Type III and Type II, respectively of the evolution process. The classification of this reach is predominantly fair, with approximately 84% of the reach given a "fair" rating and the remaining 16% a "poor" rating. The rapid geomorphic classification for this reach is presented as Figure 5.34.



FN PROJECT NO. NTD06128	Freese and Nichols, 10814 Jollyville Road, Building 4, Suite 100, Austin, TX 78759, Phone: (512) 617-3100, Fax: (512) 617-3101	North Texas Municipal Water District Proposed Lower Bois d'Arc Reservoir Project Ward Creek	FIGURE 5.34
DATE September 2008		0 0.25 0.5 1 Miles	
DATUM & COORDINATE SYSTEM NAD83 State Plane			
FILE Fig5o34_Ward.mxd			
PREPARED BY JM			

Date: Tuesday, September 02, 2008 1:24 PM Prepared By: jm File: H:\STORMWATER\FINAL_EXHIBITS\Fig5o34_Ward.mxd

5.4 Bullard Creek

Bullard Creek is a large tributary of Bois d'Arc Creek with the stream confluence at approximate Station 345+00 on Bois d'Arc Creek. There are approximately 25,900 feet (4.9 miles) of Bullard Creek in the proposed inundation pool of Lower Bois d'Arc Reservoir. The 1915 map does not encompass the entire reach of Bullard Creek so we could not determine how much of the stream segment was channelized and straightened. However, estimates were made from the information available. Nearly 4,500 linear feet (20%) of Bullard Creek was channelized prior to 1950 (Figure 5.35). This channelization project actually redirected the lower reach of Bullard Creek through a minor tributary resulting in the abandonment of approximately 4,000 linear feet of the original Bullard Creek. The net effect was to channelize and enlarge approximately 8,000 linear feet (30%) of the existing Bullard Creek.

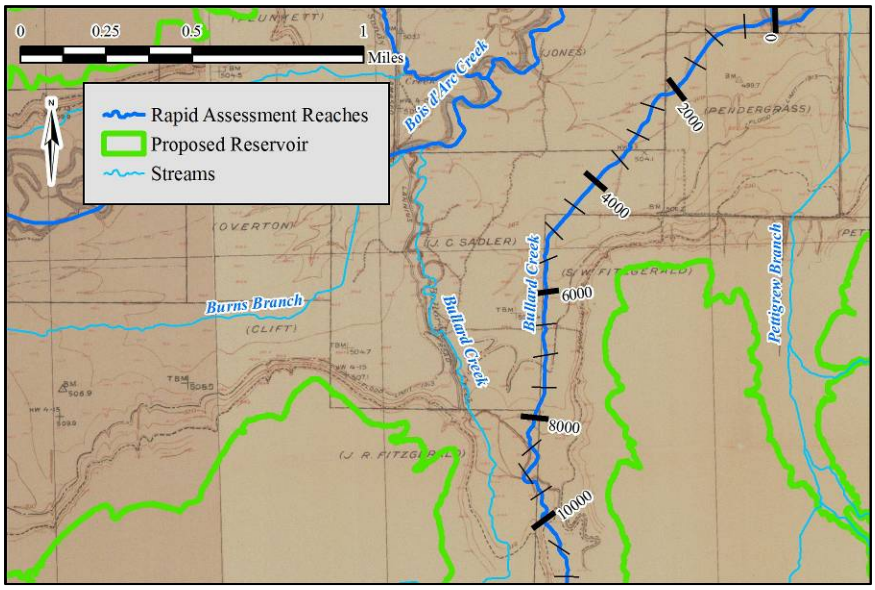
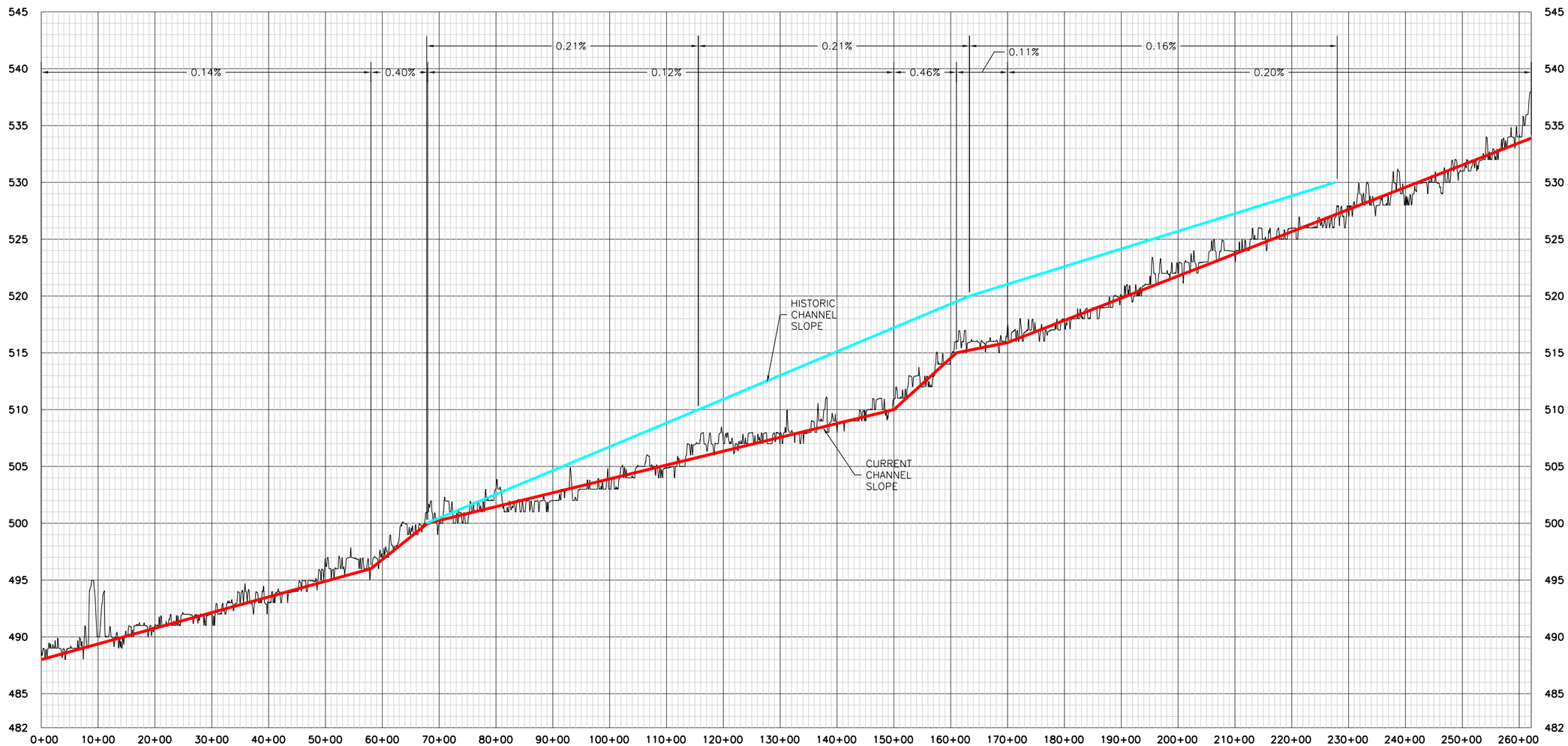


Figure 5.35 - Comparison of Historic to Existing Channel Alignment on Bullard Creek.

As depicted in Figure 5.36, the average slope of Bullard Creek is approximately 0.18% with variations from 0.11% to approximately 0.46%. There are two distinct knickpoints (STA. 68+00 and STA. 161+00) in the Bullard Creek longitudinal profile and field observations suggest that this creek is down cutting in response to the Bullard Creek diversion and down cutting within Bois d'Arc Creek proper.

The average top width of Bullard Creek is 90 feet with an average depth of 10 feet. The dominant channel material is clayey silt with some sand and gravel in the bars along the entire reach. Side bars and point bars are common with some mid-channels bars due to the moderate



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FILE BullardHistoricOverlay.dwg

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LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

BULLARD CREEK

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5.36

FIGURE

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to high sediment load from the stream banks. Streambank erosion rates in some reaches appear to be very high due to mass wasting from the near vertical side slopes; however, there are some reaches that appear to be recovering with the formation of inner berms and emergent vegetation. Figure 5.37 shows an example of a stream segment classified as “poor.” Figure 5.38 shows an example of a stream segment in this area classified as “fair.”

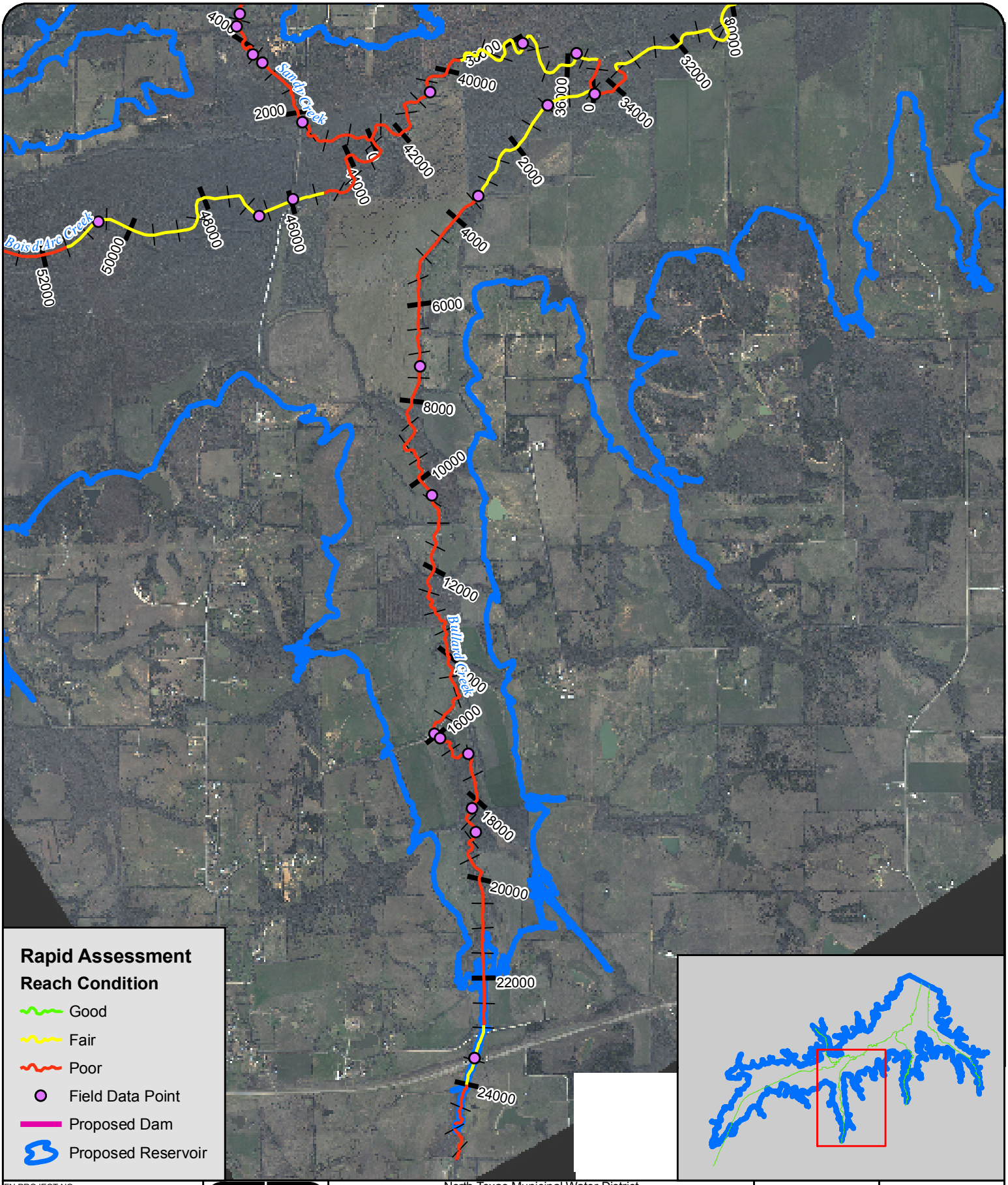
Figure 5.37 - A “poor” rated stream on Bullard Creek.

Figure 5.38 - A “fair” rated stream on Bullard Creek

As depicted in Figure 5.37, this channel is deeply incised with near vertical banks. There is limited vegetation along the side slopes but a dense stand of trees along the upper banks providing good stream cover. This reach seems to be in transition between Types II and III.

The stream conditions shown in Figure 5.37 look very similar to those shown in Figure 5.38; however this “fair” rated stream is showing signs of recovery by the development of the inner berm and floodplain and vegetation along the banks. This reach seems to be in Type IV.

The rapid geomorphic classification for Bullard Creek is presented as Figure 5.39. Bullard Creek is predominantly in fair stability conditions, with approximately 18% of the reach given a “fair” rating and the other 82% given a “poor” rating.



FN PROJECT NO.	NTD06128
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o39_Bullard.mxd
PREPARED BY	JM

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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Bullard Creek

0 0.25 0.5 1 Miles

N

FIGURE 5.39

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5.5 Sandy Creek

Sandy Creek is the only one of the four tributaries studied that is on the north side of Bois d'Arc Creek. Its confluence is at approximate Station 430+00 of Bois d'Arc Creek. Nearly 14,200 feet (2.7 miles) of Sandy Creek will be inundated by the proposed Lower Bois d'Arc Creek Reservoir.

The 1915 map does not encompass the entire reach of Sandy Creek so it was difficult to determine how much of the stream segment was channelized/straightened. From the 1950 aerial photographs, we estimated that approximately 2,200 linear feet (15%) of Sandy Creek, from Station 43+00 to 65+00 was channelized between 1915 and 1950 (Figure 5.40).

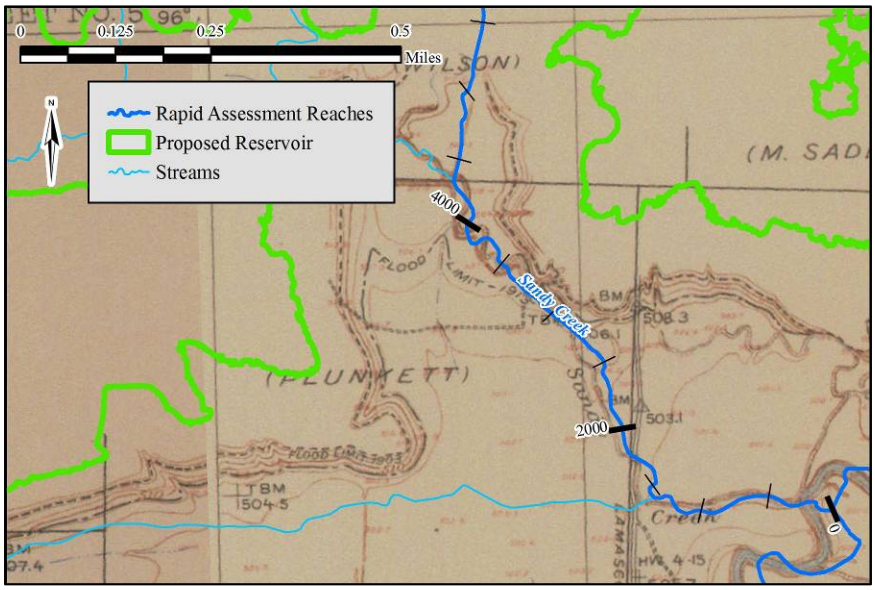
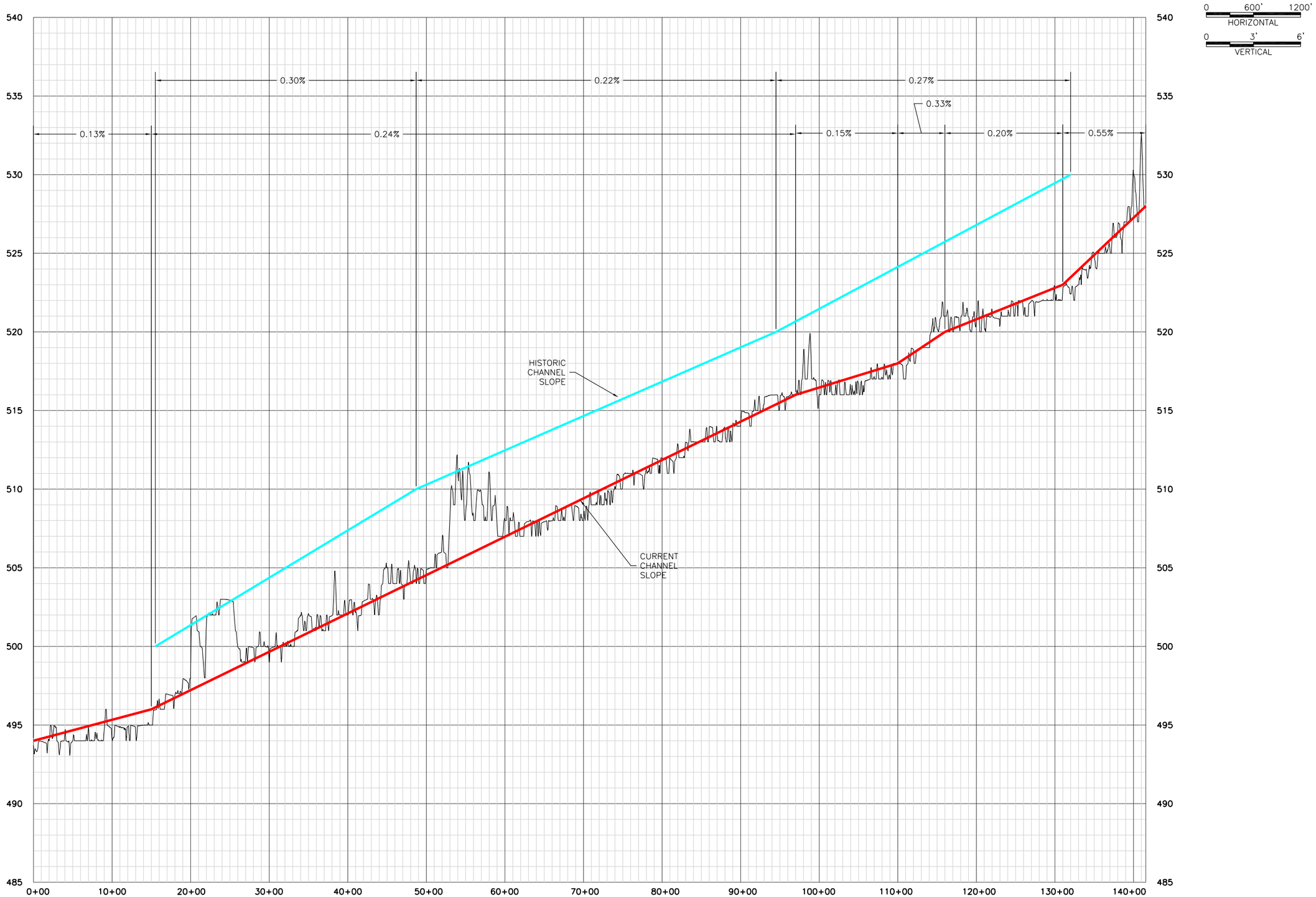


Figure 5.40 - Comparison of Historic to Existing Channel Alignment on Sandy Creek.

The dominant channel material is sand with some minor deposits of shale. There is a minor component of gravel material present on bars in the lower reach of the channel; however, it was unclear if this material was wash material from the channel or if it was gravel from the roads within the basin. Although there is some clay in the material along Sandy Creek, it appears to be a smaller component than the other tributaries and Bois d'Arc Creek. As observed in the aerial photographs, the channelization of Bois d'Arc Creek and alterations of Sandy Creek have resulted in down cutting from the confluence with Bois d'Arc Creek to well beyond the upstream end of the inundated reach of Sandy Creek. Aerial photographs show the head cut has extended to upstream of F.M. 1396, nearly 1.50 miles upstream of the proposed inundation pool.

The average slope of Sandy Creek is approximately 0.26% with variations from approximately 0.15% to approximately 0.43% (Figure 5.41). The average top width of Sandy Creek is 35 feet and the average depth is 8 feet, with the exception of two short segments from Station 97+00 to 108+00 and from Station 114+00 to 127+00. The average depth in these reaches is 8 feet like the rest of Sandy Creek but the top widths average 90 feet wide. The banks of the 35 foot wide stream segments are nearly vertical (Figure 5.42) while the banks along the two short reaches are much flatter (Figure 5.43). The riparian vegetation along the majority of the reach includes heavily wooded upper banks and terraces with almost no bank vegetation. There are occasional trees growing on the banks of the stream but the lack of any other vegetation is resulting in continued bank erosion, undercutting, and occasional mass wasting. Even where trees are present on the slopes, the bank material is being mined from beneath and between the roots. Due to the high sediment load from bank erosion and incision the depositional patterns within Sandy Creek include frequent side bars, point bars, and occasional transverse or mid-channel bars. The wooded terrace provides dense shade along most of Sandy Creek but due to the sediment load and near vertical banks there is little to no habitat potential within the channel.

The rapid geomorphic classification for Bullard Creek is presented as Figure 5.44. In terms of the rapid assessment classification, most of Sandy Creek appears to be Type III in the evolution process with two reaches that are Type IV. The continued widening of this creek indicates it is not in equilibrium. The classification for the majority of this stream is poor, with approximately 83% of the reach given a" poor" rating and the remainder rating "fair."



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SCALE AS SHOWN
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LOWER BOIS D'ARC CREEK PROPOSED RESERVOIR PROJECT

FLUVIAL GEOMORPHOLOGY

SANDY CREEK

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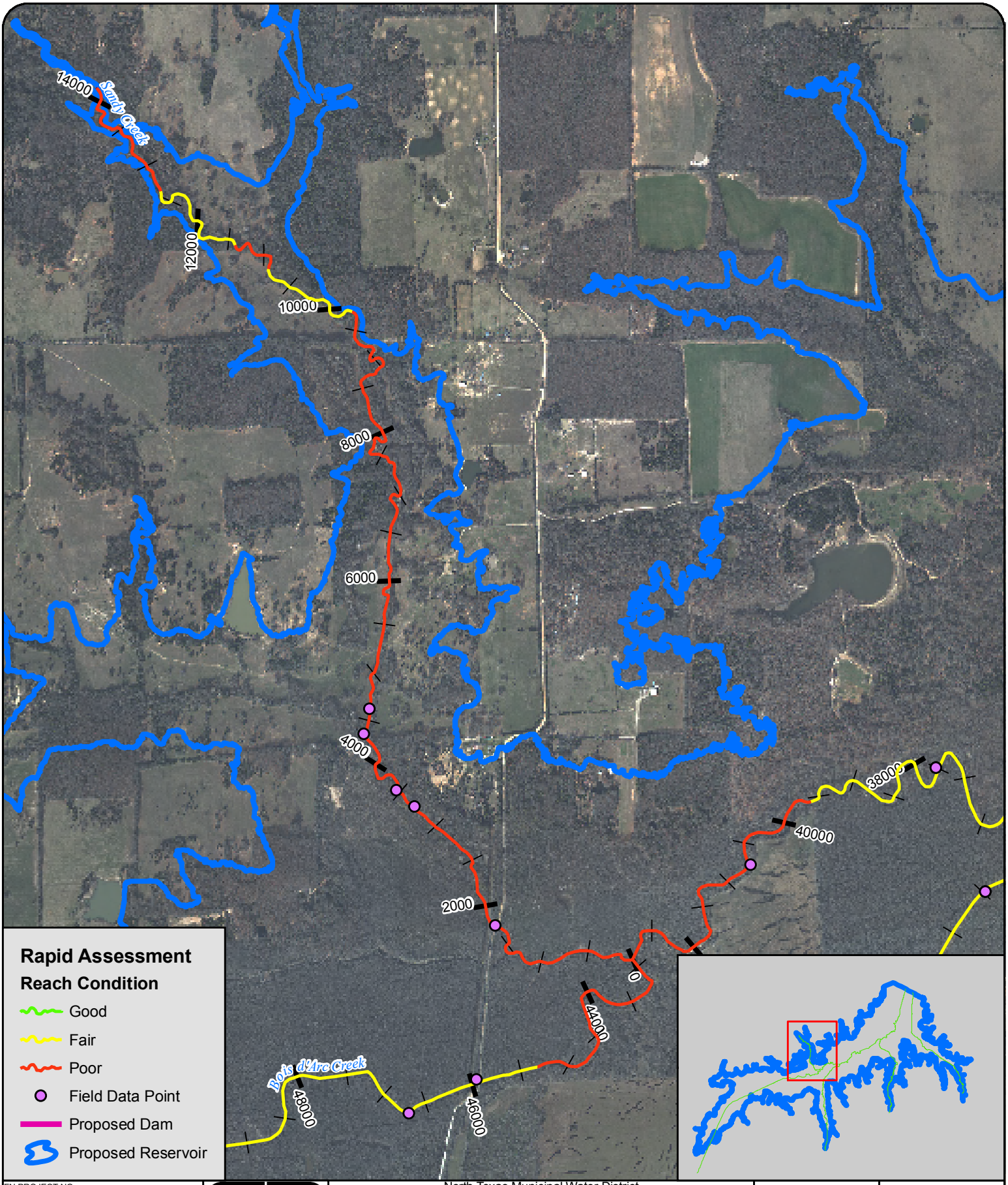
5.41

FIGURE

Figure 5.42: Typical View of Sandy Creek with vertical side slopes.

Figures 5.43: Typical view of Sandy Creek with flatter side slopes.



FN PROJECT NO.	NTD06128
DATE	September 2008
DATUM & COORDINATE SYSTEM	NAD83 State Plane
FILE	Fig5o44_Sandy.mxd
PREPARED BY	JM

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North Texas Municipal Water District

Proposed Lower Bois d'Arc Reservoir Project

Sandy Creek

0 0.125 0.25 0.5 Miles

N

FIGURE 5.44

Date: Tuesday, September 02, 2008 1:25 PM Prepared By: jm File: H:\STORMWATER\FINAL_EXHIBITS\Fig5o44_Sandy.mxd

5.6 Summary of Stream Classification

As outlined in Section 3.0, channelized streams in the southwest can take more than 100 years to complete the channel evolution cycle. Given the time-scales it is possible that some of the reaches within the Bois d'Arc Creek system that were altered in the early 20th Century have completed the channel evolution cycle and have re-established or are approaching dynamic equilibrium. No evidence of complete recovery was observed within the study area, likely due to the continued channel and vegetative modifications through the 1970's. Although there are reaches within the system that show signs that they are in the process of recovery, it is clear that there are a number of reaches that show signs of continued disequilibrium. Those reaches appear to be actively widening and show no signs of permanent benches or terraces forming within the channel at this time.

The following table summarizes the results of the Rapid Geomorphic Stability Assessment.

Table 5.2 – Channel Classification

Name	Classification	Reach Length (ft)	Percentage
Bois d'Arc Creek Reach 1	**Total Reach**	**7,000**	**100%**
	Good	-	0%
	Fair	3,587	51%
	Poor	3,413	49%
Bois d'Arc Creek Reach 2	**Total Reach**	**12,000**	**100%**
	Good	-	0%
	Fair	5,419	45%
	Poor	6,581	55%
Bois d'Arc Creek Reach 3	**Total Reach**	**5,000**	**100%**
	Good	-	0%
	Fair	50	1%
	Poor	4,950	99%
Bois d'Arc Creek Reach 4	**Total Reach**	**24,500**	**100%**
	Good	-	0%
	Fair	17,084	70%
	Poor	7,416	30%
Bois d'Arc Creek Reach 5	**Total Reach**	**40,800**	**100%**
	Good	-	0%
	Fair	15,200	37%
	Poor	25,600	63%
Bois d'Arc Creek Total	**Total Reach**	**89,300**	**100%**
	Good	-	0%
	Fair	41,340	46%
	Poor	47,960	54%
Honey Grove Creek	**Total**	**35,700**	**100%**
	Good	2,700	8%
	Fair	30,700	86%
	Poor	2,300	6%
Ward Creek	**Total**	**27,900**	**100%**
	Good	-	0%
	Fair	23,500	84%
	Poor	4,400	16%
Bullard Creek	**Total**	**25,900**	**100%**
	Good	-	0%
	Fair	4,600	18%
	Poor	21,300	82%
Sandy Creek	**Total**	**14,150**	**100%**
	Good	-	0%
	Fair	2,400	17%
	Poor	11,750	83%

Appendix A

Rapid Assessment Classification Forms

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD36, 37	1290	
BD35	3414	

Extrapolated Stations		
To	From	Reasoning
0	1290	Same straightened reach; similar W, D, & S
1290	3414	Same land owner; identical aerial representation; similar channel W, D, & S; all straightened

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	4	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		10		4

Description: Sediment deposition along side of channel trying to create low flow. Limited vegetation on banks. No shrubs, lacking a good root zone. Undercut low banks. Deep pools, overhanging vegetation, and logs/brush present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	14

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD33	6660	
BD34		

Extrapolated Stations		
To	From	Reasoning
3414	6660	Similar W, D & S; same straightened reach; abandoned channel now serves as oxbows on left bank
6660	8500	Similar W, D & S; similar aerial representation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V	8	1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		14		13		0

Description: Laid back slopes. Vegetated banks mixed with grasses and trees. Steeper undercut banks on outside bends of meanders. Minimal stream cover. Shallows, oxbows, deep pools, overhanging vegetation and logs/brush present. Class IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	27

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD32	11350	11688

Extrapolated Stations		
To	From	Reasoning
8500	11350	Same meandering channel in aerial; same W, D & S; outside banks widening due to farm practices & lack of vegetation
23950	28370	Same tight meandering channel as downstream eroding outside bends by aerial with potential for widening

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	7	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.	6	Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		13		13		2

Description: More vegetation downstream of this area on banks. Appears to be stable, because not a lot of sediment in stream, but poor habitat potential. No vegetation on banks. Going from F→ C. Undercut banks and little overhanging vegetation. Sediment accumulation and vegetation along channel toe indication of Class III (approaches IV) in channel evolution

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	28

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD30, BD31	11688	12229
BD27	12730	13159
BD26	13159	13259
BD24	13506	13706

Extrapolated Stations		
To	From	Reasoning

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	0
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	2
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	4	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	4	Extensive amount of manmade channel alteration.	
Total		0		0		8		6

Description: Lots of potential for erodible sediment, deposition bars everywhere, limited vegetation on slopes, poor habitat potential, overhanging vegetation, Class IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	14

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD28, BD29	12229	12730
BD25	13259	13506

Extrapolated Stations		
To	From	Reasoning

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	4	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	5	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	5	Extensive amount of manmade channel alteration.	
Total		0		0		22		1

Description: Really steep banks with minimal cover→ mostly grasses. Overhanging vegetation. Mid-channel bars. Class IV approaching Class V

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	23

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD22	13706	14961
BD23		

Extrapolated Stations		
To	From	Reasoning

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	3	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material	6	Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	6	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	0
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		12		6		0

Description: Influence from bridge crossing. Deep pools, hanging vegetation, emergent/submergent vegetation, and logs/brush present. Class II or III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	18

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD21	16946	

Extrapolated Stations		
To	From	Reasoning
14961	19582	Identical aerial representation; same top width, bank slopes, & channel slope

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	1
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	1
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	3	Extensive amount of manmade channel alteration.	
Total		0		0		9		4

Description: Sediment deposition in mid-channel. No stream cover. Sloughing and undercut banks. Trees from uppe banks falling into creek and onto slope. Shallows, deep pools, overhanging vegetation and logs/brush present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	13

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
	19618	19865

Extrapolated Stations		
To	From	Reasoning

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	0
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	0
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	1
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		0		2

Description: High, steep banks → undercut, little to no vegetation, exposed sediment. Deep pools, overhanging vegetation and logs/brush present. Class III/IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	8

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD20	19865	20309

Extrapolated Stations		
To	From	Reasoning

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	0
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	5	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		18		0

Description: F → C Reach has been straightened, but it's trying to stabilize itself by depositing sediment and forming bars. Class III → IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	18

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD18	23109	
BD19		

Extrapolated Stations		
To	From	Reasoning
20309	23950	Similar W,D & S; same aerial representation and straightened reach

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	0
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	4	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		4		4

Description: 2-3 times wider than point at confluence with Bullard. Lots of bank sloughing, limited stream cover. Exposed sediment. Straightened segment with little to no vegetation on left overbank. Undercut banks, overhanging vegetation and logs/brush present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	14

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD17	29602	

Extrapolated Stations		
To	From	Reasoning
28370	30000	Straightened portion of reach; similar topography, aerial; original creek is now oxbows
30000	33500	Similar channel width, depth, slope & pattern; same vegetation by aerial

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	3	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	6	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	5	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	8	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		14		11		0

Description: High flood event during visit. Hard to see banks and creek bottom. A lot of vegetation on top of banks, but little on slopes itself. Undercut and steep banks with some roots. Oxbows, deep pools, overhanging vegetation, and logs/brush present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	25

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD16	34443	

Extrapolated Stations		
To	From	Reasoning
33500	35200	Reach through meander where S, W & D are similar

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	0
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	0
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	1
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	3	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.	10	Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		10		0		6		1

Description: Evidence of high bank sloughing. Exposed roots and barren slopes outside of trees. Deposition in mid-channel and on side. Undercut banks. Shallows, deep pools, overhanging vegetation and logs/brush present

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	17

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD14	35661	37500
BD15		

Extrapolated Stations		
To	From	Reasoning
35200	35661	Same channel width, depth, slope and pattern; same aerial representation
37500	39608	Same channel width, depth, and slope; tighter meanders; evidence of sloughing and similar vegetation in aerial

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	3	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	4	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.	10	Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		10		6		10		2

Description: Good cover over creek. Little to no vegetation on banks. Trees on top of banks. Undercut banks. Shallows, deep pools, overhanging vegetation and logs/brush present

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	28

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD13	40728	

Extrapolated Stations		
To	From	Reasoning
39608	42115	Same aerial & topographic conditions
42215	45323	Similar channel pattern; same channel properties (width, depth, slope); more vegetation on right bank

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	1
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	6	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	3	1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	5	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		6		8		5

Description: No substantial vegetation on right bank causing bank sloughing. Back eddies occurring due to sedimen deposition. Undercut banks with mass wasting. No stream cover. Shallows, deep pools, overhanging vegetation and logs/brush present. Class IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	19

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD11	46696	
BD12	45951	

Extrapolated Stations		
To	From	Reasoning
45323	46696	Straightened reach from bridge crossing

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	7	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.	9	Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	5	Extensive amount of manmade channel alteration.	
Total		9		7		15		2

Description: This is beginning of straightened reach due to road crossing. Good stream cover and mix of vegetated species. Steep, undercut banks. Milky water. Deposition in creek. Deep pools, overhanging vegetation and logs/brush present

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	33

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD09	57000	

Extrapolated Stations		
To	From	Reasoning
51500	60298	Similar stream characteristics → steep banks, incised, straightened

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	3	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	1
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	0
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		3		4

Description: High, vertical banks with limited cover. Tree root mass cover 1/2 bank height. Undercut low banks and high banks. Good stream cover in spring/summer. Milky water. Shallows, overhanging vegetation and logs/brush present. Class II

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	7

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD05	65738	
BD06	62145	
BD07	60420	
BD08	60298	
BD10	50672	

Extrapolated Stations		
To	From	Reasoning
60298	65738	Several data points between representing same conditions; identical aerial
46696	51500	Good likeness to historical aerial; laid back slopes; similar aerial representation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)	9	Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V	8	1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		9		14		10		0

Description: Good variety of vegetation- trees, shrubs, grass. Decent stream cover along banks of creek. High flows, hard to note deposition, but very milky water→ high sediment load. Study bank = bankfull, so low stress banks and use of floodplain. Undercut banks. Deep pools, overhanging vegetation and logs/brush

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	33

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD04	69536	

Extrapolated Stations		
To	From	Reasoning
69171	69635	Within same utility easement; matching aerial and topography

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)	8	Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)	9	Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	0
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		9		8		5		2

Description: Utility easement. Farm fields right up to limits of creek taking out all vegetation except grasses. One bank looking upstream has trees on top of bank, but slope is undercut with no vegetation. Steep slopes. No stream cover. Shallows, deep pools, overhanging vegetation and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	24

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD03	75775	

Extrapolated Stations		
To	From	Reasoning
69635	76973	Identical aerial; one landowner; similar topography
65738	69171	Identical aerial; straightened; same channel dimensions

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	6	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	2
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		8		4

Description: Good stream cover, good habitat potential, steep but short banks with limited cover. Tree debris and mid-channel vegetated bars formed some undercut banks with exposed roots. Straightened reach. Deep pools, overhanging vegetation, emergent/submergent vegetation and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	18

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
BD02	78742	

Extrapolated Stations		
To	From	Reasoning
76973	82975	Same aerial representation; same stream S, W & D

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	1
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	1
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	2
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	0
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		0		5

Description: Right bank has thick root masses sprawling cut into the creek. Vertical banks. Left bank has some dense roots, but mostly barren slopes. No grass or shrub coverage besides tree roots. Good habitat potential and stream cover. Undercut banks. Deep pools, overhanging vegetation and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	5

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bois D' Arc

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
BD01	83137	

Extrapolated Stations		
To	From	Reasoning
82975	END	Similar W, D & S; thick vegetation by aerial

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)	9	Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material	8	Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)	9	Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	3	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	5	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		18		8		8		0

Description: Good variety of vegetation on stream banks- shrubs, trees. Not a lot of stream cover. Steep banks. Sediment deposition in mid-channel downstream of bridge. Shallows and overhanging vegetation present

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	34

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Honey Grove

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
HG08	1268	

Extrapolated Stations		
To	From	Reasoning
0	1268	Similar to data point, steep banks, deep channel, high BEHI, tribs headcutting = channel incision
1268	2300	Similar deep/steep banks, evidence of recent sloughing

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	0
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		6		4

Description: A lot of mid-bar sedimentation. Sloughing from upper banks. Exposed slopes. Overhanging trees over main channel. Undercut banks, shallows, deep pools and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	10

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Honey Grove

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
HG07	4106	

Extrapolated Stations		
To	From	Reasoning
2300	4106	Similar to data, steep/deep channel but appears banks better cover, no evidence of mass wasting
4106	5500	Similar width, depth banks, aerial; no evidence of sloughing/mass wasting

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)	6	Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	4	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	6	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	3	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	4	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		12		11		0

Description: Banks have coverage, but no deep root zones. A lot of deposition, with side bars going into mid channe bars. Undercut banks, shallows, overhanging vegetation and logs/brush present

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	23

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Honey Grove

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
HG06	7570	

Extrapolated Stations		
To	From	Reasoning
5500	11820	Similar top width, banks, and channel slopes; identical aerial representation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material	6	Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	8	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V	6	1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		26		5		0

Description: Building a bankful bench. Good bank cover→ more rooted species. Milky water due to suspended solids. Undercut banks, shallows, deep pools, overhanging vegetation and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	31

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Honey Grove

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
HG04	18058	
HG05		

Extrapolated Stations		
To	From	Reasoning
11820	18058	Similar stream characteristics by field photo; same top width, stream slope and side slopes
18058	19500	Similar width/depth bank shape, stream slope - aerial shows minor bank sloughing 1 location
27000	29500	Similar channel pattern/shape - slightly steeper slope; good aerial similarity

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	3	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	2
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	5	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	5	Extensive amount of manmade channel alteration.	
Total		0		6		16		2

Description: Milky water due to suspended solids. Skinny trees on top of banks, with some falling in creek. Undercut banks. Limited vegetation on left bank. Shallows, deep pools and overhanging vegetation also present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	24

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Honey Grove

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
HG03	23410	
HG02	24040	

Extrapolated Stations		
To	From	Reasoning
23410	25000	Sites very similar except one is in summer and the other in winter; similar top width and channel slope
19500	23410	Channel width, depth, bank similar, stream slope same - local disturbance at US end due to bridge
25000	27000	Site has similar width, depth, bank/slope - few local sloughs but good vegetation
29500	31000	Similar pattern, channel width, depth
31000	33000	More sinuous but similar slope, channel width, depth, vegetation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)	10	Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material	8	Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)	10	Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	0
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		20		14		0		0

Description: In good condition, but localized destabilization due to road crossing. Section has been straightened. Built inner berm with lots of potential for habitat - good stream cover. Barren vegetation in some areas. Undercut banks, shallows, deep pools, overhanging vegetation and logs/brush present. Class V

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	34

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Honey Grove

Rapid Assessment Stream Stability Rating			
○ Excellent	◉ Good	○ Fair	○ Poor

Field Data Point	Station	
	To	From
HG01	35621	

Extrapolated Stations		
To	From	Reasoning
33000	END	No aerial, but same top width and side slopes

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)	8	Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material	8	Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V	6	1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.	9	Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	5	Extensive amount of manmade channel alteration.	
Total		9		22		10		0

Description: Isolated degraded area downstream of bridge to cattle crossing, but not unstable due to laid back slopes and established everywhere else. Good stream cover. Great access to floodplain for large storm events. Shallows and overhanging vegetation present. Class V

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	41

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Ward

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
	2000	

Extrapolated Stations		
To	From	Reasoning
0	4000	Similar to Bois d'Arc 17000 - effect of downcut affecting Ward

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	1
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	1
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	3	Extensive amount of manmade channel alteration.	
Total		0		0		9		4

Description: Midstream bars, sloughing and bank failures from aerial. Resembles Bois d'Arc at station 17000. Shallows, deep pools and overhanging vegetation present

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	13

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Ward

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
W01	9735	12901
W02		
W03		

Extrapolated Stations		
To	From	Reasoning
4000	23300	Similar to data reach pattern, width, depth, slope; good riparian vegetation
23700	25500	
26800	END	

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	2
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)	9	Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	0
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.	6	Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		9		12		5		2

Description: Wide, deep channel, side bars/point bars, lower banks and channel bottom recovery - good bank vegetation. Major undercut banks and overhanging vegetation present. Class IV / V

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	28

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Ward

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
	23500	

Extrapolated Stations		
To	From	Reasoning
23300	23700	

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	0
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	0
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	0
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	5	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.	8	Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	
Total		0		8		8		0

Description: Overhead electric easements - cleared of all trees and brush. Active mass wasting and widening. Undercut banks.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	16

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Ward

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
	26000	

Extrapolated Stations		
To	From	Reasoning
25500	26800	

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)	6	Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V	7	1H:1V - 2H:1V		1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.	5	Extensive amount of manmade channel alteration.	
Total		0		19		15		0

Description: Similar to Ward station 12000 except much steeper gradient and narrower riparian corridor. Over steepened section just below a knick point.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	34

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
B10	977	
B09	3362	

Extrapolated Stations		
To	From	Reasoning
0	3362	Similar top width and slopes; at station 3362, looks just like station 977 by field visit and aerial

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	4	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	5	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		19		0

Description: Depositional area along sides of creek. Vegetation made up of trees and grasses. Sloughing from uppe banks. Forming vegetated inner berms. Steep banks outside of berms, 50% cover on banks. Undercut banks, shallows, overhanging vegetation and logs/brush present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	25

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
B08	7286	

Extrapolated Stations		
To	From	Reasoning
3362	8261	One landowner; minimal vegetation on floodplain by aerial, same width, depth, slope; straightened reach
20330	22943	Similar farming practices, straightened reach; similar slope, but smaller width, depth due to less drainage area

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	5	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	4	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		17		2

Description: Vertical left bank made up of tree roots and grasses. Laid back right slope. Deposition in creek forming vegetated inner berms. Lots of stream cover. Undermining at toe of slope. Overhanging vegetation. Developing into a good 'C' channel. Class IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	19

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
B07	10394	

Extrapolated Stations		
To	From	Reasoning
8261	14932	Similar width, depth, slope; same aerial representation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	3	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	2
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	2
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		6		5

Description: Evident from aerial that outside banks at meanders are widening and have no vegetation to stabilize. Vertical banks on both sides with inner berm forming due to mass wasting from upper banks. Little to no vegetation on slopes. Landowners farming right up to left stream bank. Deeply incised channel. Undercut banks, shallows and overhanging vegetation present. Class III

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	11

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
B06	15911	

Extrapolated Stations		
To	From	Reasoning
14932	16060	Field inspection; creek confined by road on left and farmed right up to bank on left

Classification Basis								
Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	1
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	0
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	3	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		3		3

Description: Hard armored with concrete on right bank and confined by road. Vegetated up to left bank with only grass as vegetation. Degradation due to road crossing. Class I

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	12

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
B04	16993	
B05	16118	

Extrapolated Stations		
To	From	Reasoning
16060	16200	Similar topography and identical aerial imagery
16200	16993	Similar topography and identical aerial imagery

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	2
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	2
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		11		4

Description: Steep banks, loose sand, downed trees, little vegetation on banks. Undercut banks, deep pools, overhanging vegetation and logs/brush present. Class III / IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	15

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
B03	18188	

Extrapolated Stations		
To	From	Reasoning
16993	18188	Similar site characteristics; straightened section of creek

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	2
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	4	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		7		5

Description: Really steep banks, exposed roots, lots of debris, little vegetation on banks. Undercut banks, overhanging vegetation and logs/brush present. Class IV

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	12

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
B02	18821	

Extrapolated Stations		
To	From	Reasoning
18188	19346	Same landowner; aerial matches; similar topography with matching side slopes, top width, and slope
19346	20330	Same channel properties (width, depth, slope), but less vegetation according to aerial; same channel pattern
24000	END	Same channel properties and pattern; limited vegetation on right overbank

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	2
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	2
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	2
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.	6	Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		0		7

Description: Channelized section with no bars forming or potential for instream habitat. Vertical banks with decent root zone. Vegetation sparse. Undercut banks and overhanging vegetation present. Class II

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	13

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Bullard

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
B01	22943	23700

Extrapolated Stations		
To	From	Reasoning
23700	24000	Similar aerial representation by straightening and vegetation; same channel properties

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)	8	Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material	8	Banks comprised of highly erodible tree/plant/soil material and material is compromised.		Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)	9	Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	3	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	5	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		9		16		8		0

Description: Bridge crossing @ US 82. Good overhanging vegetation along banks and overbanks. Good stream cover. Straightened for (2) bridge crossings. Minor sedimentation downstream of crossings. Class V / VI

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	33

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Sandy

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
S05	1825	

Extrapolated Stations		
To	From	Reasoning
1600	2200	Short reach upstream and downstream of the road crossing appear stable; flat slopes; good vegetation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)		Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)	4	High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	4	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	3	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	2
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		0		16		2

Description: Very sandy → deposition in creek, lots of instream cover. Bank vegetation includes grass and small woody material. Bank angle is flatter than incised reaches. Road is acting as a hard point. Shallows, overhanging vegetation, emergent/submergent vegetation and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	18

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Sandy

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	○ Fair	◉ Poor

Field Data Point	Station	
	To	From
S01	3291	4615
S02		
S03		
S04		

Extrapolated Stations		
To	From	Reasoning
0	1600	Similar to data reach W, D and bank angle; channel downcut below rooting zone, little in channel vegetation
2200	9700	Similar to data reach W, D and bank angle; channel downcut below rooting zone, little in channel vegetation
10800	11400	Similar to data reach W, D and bank angle; channel downcut below rooting zone, little in channel vegetation
12700	END	Similar to data reach W, D and bank angle; channel downcut below rooting zone, little in channel vegetation

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)	6	Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	3	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)		Little to no cover (<10%)	1
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V		1H:1V or steeper	1
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.		Stream branching with mid-channel bars and islands or no depositional features.	2
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		3		4

Description: Very sandy → deposition in creek, lots of instream cover but no bank covers except tree roots. Undercut banks, overhanging vegetation and logs/brush present.

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	13

Bois d'Arc Creek and its Tributaries
Channel Stability Rating System

Reach: Sandy

Rapid Assessment Stream Stability Rating			
○ Excellent	○ Good	◉ Fair	○ Poor

Field Data Point	Station	
	To	From
	9700	

Extrapolated Stations		
To	From	Reasoning
9700	10800	Short reach upstream and downstream of the road crossing appear stable; flat slopes; good vegetation
11400	12700	

Classification Basis

Evaluation Category	Excellent (9 - 10)		Good (6 - 8)		Fair (3 - 5)		Poor (0 - 2)	
Evidence of Bank Erosion	Little to no evidence of bank sloughing, slumping, or failure. (< 10%)		Infrequent evidence of bank sloughing, slumping, or failure. Mostly healed over. (10-29.9%)	6	Recent evidence of bank sloughing, slumping, or failure. High potential during flood events. (30-50%)		High evidence of bank sloughing, slumping, or failure. (>50%)	
Bank Root Zone	Banks comprised of highly resistant tree/plant/soil material.		Banks comprised of moderately resistant tree/plant/soil material		Banks comprised of highly erodible tree/plant/soil material and material is compromised.	5	Banks comprised of highly erodible tree/plant/soil material and material is severely compromised.	
Vegetative Bank Cover	Abundant cover (>70%)		Moderate cover (40-69.9%)		Infrequent cover (10-39.9%)	5	Little to no cover (<10%)	
Bank Angle	3H:1V or flatter		2H:1V - 3H:1V		1H:1V - 2H:1V	5	1H:1V or steeper	
Sediment Transport	Point bars small and stable, well vegetated and/or armored with little or no fresh sand.		Mix of point bars and few side bars.		Moderate amount of mid-channel bars and side bars.	3	Stream branching with mid-channel bars and islands or no depositional features.	
Channel Alteration	No manmade channel alteration.		Infrequent amount of manmade channel alteration.		Moderate amount of manmade channel alteration.		Extensive amount of manmade channel alteration.	0
Total		0		6		18		0

Description: Very sandy → deposition in creek, lots of instream cover. Bank angle is flatter than incised reaches. Riparian vegetation and land use changes along this reach occurred sooner than along remainder of the reach. Overhanging vegetation

Score	Rapid Assessment Stream Stability Rating
51 - 60	Excellent Condition
37 - 50	Good Condition
20 - 36	Fair Condition
< 20	Poor Condition

Total Score	24

Appendix B

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Appendix C
Glossary of Terms

Glossary of Terms

Adapted from:
ERDC TN-EMRRP-SR-01 1
Glossary of Stream Restoration Terms
by Craig Fischenich.. February 2000
USACE Research and Development Center, Environmental Laboratory,
3909 Halls Ferry Rd., Vicksburg, MS 39180

Aggradation, aggrade - A progressive buildup or raising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that stream discharge and/or bed-load characteristics are changing. Opposite of degradation.

Alluvial - Deposited by running water.

Alluvium - A general term for detrital deposits made by streams on riverbeds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during time of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas or lakes.

Anthropogenic – Of, relating to, or resulting from the influence of human beings on nature.

Armoring - A natural process where an erosion-resistant layer of relatively large particles is established on the surface of the streambed through removal of finer particles by stream flow. A properly armored streambed generally resists movement of bed material at discharges up to approximately 3/4 bank-full depth.

Bank stability - The ability of a streambank to counteract erosion or gravity forces.

Bar - An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the center of an over-widened channel.

Biodiversity – Biological diversity in an environment as indicated by numbers of different species of plants and animals.

Canopy - A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand. Leaves, branches and vegetation that are above ground and/or water that provides shade and cover for fish and wildlife.

Channel - An area that contains continuously or periodically flowing water that is confined by banks and a streambed.

Channelization - The process of changing (usually straightening) the natural path of a waterway.

Confluence – Junction of two or more streams.

Cover – Any structure that provides refuge for fish, reptiles or amphibians. These animals seek cover to hide from predators, to avoid warm water temperatures, and to rest, by avoiding higher velocity water. These animals come in all sizes, so even cobbles on the stream bottom that are not sedimented in with fine sands and silt can serve as cover for small fish and salamanders. Larger fish and reptiles often use large boulders, undercut banks, submerged logs, and snags for cover.

Cretaceous – Of, relating to, or being the last period of the Mesozoic Era categorized by continued dominance of reptiles, emergent dominance of angiosperms, diversification of mammals, and the extinction of many types of organisms at the close of the period;

Degradation - A progressive lowering of the channel bed due to scour. Degradation is an indicator that the stream's discharge and/or sediment load is changing. The opposite of aggradation.

Downcut – Process by which a stream adjusts vertically by scouring the channel profile.

Erosion factor, K – Susceptibility of a soil to sheet and rill erosion by water. The estimates are based on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 – 0.64; the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Ferruginous – (1) Of, relating to, or containing iron; (2) Resembling iron rust in color.

Floodplain - Land built of sediment that is regularly covered with water as a result of the flooding of a nearby stream.

Floodplain (100-year) - The area adjacent to a stream that has a one percent probability of flooding in any given year.

Fluvial – (1) Of, relating to, or living in a stream or river; (2) Produced by the action of a stream.

Geomorphology - A branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place due to erosion of the primary elements and the buildup of erosional debris.

Glauconite – A mineral consisting of a dull green earthy iron potassium silicate occurring in greensand.

Headcut – (1) Exposed subsoil in section, forming small tunnels that may attain lengths of many feet. (2) Collapse of tunnel roofs initiates lateral gullying and lengthens existing cuts headward. (3) Commonly associated with piping, because headcuts frequently expose the subsoil. (4) An abrupt step in the channel profile, some several feet high.

Incised river - A river that erodes its channel by the process of degradation to a lower base level than existed previously or is consistent with the current hydrology.

Incision ratio - The low bank height divided by the bankfull maximum depth.

Inner berm – The mean high water mark; scour line or small bench halfway between the low flow water surface and bankfull stage

Instream cover - The layers of vegetation, like trees, shrubs, and overhanging vegetation, that are in the stream or immediately adjacent to the wetted channel.

Instream flows - (1) Portion of a flood flow that is contained by the channel. (2) A minimum flow requirement to maintain ecological health in a stream.

Inundation – To cover with a flood.

Lithology – (1) The study of rocks; (2) The character of a rock formation; a rock formation having a particular set of characteristics.

Marl – A loose or crumbling deposit (as of sand, silt, or clay) that contains a substantial amount of calcium carbonate.

Mass wasting - Bulk movements of soil and rock debris down slopes in response to the pull of gravity, or the rapid or gradual sinking of the Earth's ground surface in a predominantly vertical direction.

Meander - The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.

Mid-channel Bars – bars located in the channel away from the banks, generally found in areas where the channel runs straight. Mid-channel bars caused by recent channel instability are unvegetated.

Point bar - The convex side of a meander bend that is built up due to sediment deposition.

Pool - A reach of stream that is characterized by deep, low-velocity water and a smooth surface.

Reach - A section of stream having relatively uniform physical attributes, such as valley confinement, valley slope, sinuosity, dominant bed material, and bed form, as determined in the Phase 1 assessment.

Riffle - A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riparian area - An area of land and vegetation adjacent to a stream that has a direct effect on the stream. This includes woodlands, vegetation, and floodplains.

Riparian buffer - the width of naturally vegetated land adjacent to the stream between the top of the bank (or top of slope, depending on site characteristics) and the edge of other land uses. A buffer is largely undisturbed and consists of the trees, shrubs, groundcover plants, duff layer, and naturally uneven ground surface. The buffer serves to protect the water body from the impacts of adjacent land uses.

Riparian corridor - lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile, and sediment regime. For instance, in stable pool-riffle streams, riparian corridors may be as wide as 10-12 times the channel's bankfull width. In addition the riparian corridor typically corresponds to the land area surrounding and including the stream that supports (or could support if unimpacted) a distinct

ecosystem, generally with abundant and diverse plant and animal communities (as compared with upland communities).

Riparian habitat - The aquatic and terrestrial habitat adjacent to streams, lakes, estuaries, or other waterways.

Riparian - Located on the banks of a stream or other body of water.

Riparian vegetation - The plants that grow adjacent to a wetland area such as a river, stream, reservoir, pond, spring, marsh, bog, meadow, etc., and that rely upon the hydrology of the associated water body.

River channels - Large natural or artificial open streams that continuously or periodically contain moving water, or which form a connection between two bodies of water.

River reach - Any defined length of a river.

Riverine - Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc.

Riverine habitat - The aquatic habitat within streams and rivers.

Sand - Small substrate particles, generally from 0.06 to 2 mm in diameter. Sand is larger than silt and smaller than gravel.

Scour - The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material and can be classed as general, contraction, or local scour.

Sediment - Soil or mineral material transported by water or wind and deposited in streams or other bodies of water.

Sedimentation - (1) The combined processes of soil erosion, entrainment, transport, deposition, and consolidation. (2) Deposition of sediment.

Sinuosity - The ratio of channel length to direct down-valley distance. Also may be expressed as the ratio of down-valley slope to channel slope.

Sinuous – Of a serpentine or wavy planform.

Slope - The ratio of the change in elevation over distance.

Slope stability - The resistance of a natural or artificial slope or other inclined surface to failure by mass movement.

Stable channel - A stream channel with the right balance of slope, planform, and cross section to transport both the water and sediment load without net long-term bed or bank sediment deposition or erosion throughout the stream segment.

Straightening - the removal of meander bends, often done in towns and along roadways, railroads, and agricultural fields.

Stream - A general term for a body of water flowing by gravity; natural watercourse containing water at least part of the year. In hydrology, the term is generally applied to the water flowing in a natural narrow channel as distinct from a canal.

Stream banks - features that define the channel sides and contain stream flow within the channel; this is the portion of the channel bank that is between the toe of the bank slope and the bankfull elevation. The banks are distinct from the streambed, which is normally wetted and provides a substrate that supports aquatic organisms. The top of bank is the point where an abrupt change in slope is evident, and where the stream is generally able to overflow the banks and enter the adjacent floodplain during flows at or exceeding the average annual high water.

Stream channel - A long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.

Stream morphology - The form and structure of streams.

Stream order - A hydrologic system of stream classification. Each small unbranched tributary is a first-order stream. Two first-order streams join to make a second-order stream. A third order stream has only first-and second-order tributaries, and so forth.

Stream reach - An individual segment of stream that has beginning and ending points defined by identifiable features such as where a tributary confluence changes the channel character or order.

Streambank erosion - The removal of soil from streambanks by flowing water.

Streambank stabilization - The lining of streambanks with riprap, matting, etc., or other measures intended to control erosion.

Streambed - (1) The unvegetated portion of a channel boundary below the baseflow level. (2) The channel through which a natural stream of water runs or used to run, as a dry streambed.

Substrate material – A layer beneath the surface soil.

Thalweg - (1) The lowest thread along the axial part of a valley or stream channel. (2) A subsurface, groundwater stream percolating beneath and in the general direction of a surface stream course or valley. (3) The middle, chief, or deepest part of a navigable channel or waterway.

Tributary - A stream that flows into another stream, river, or lake.

Udic moisture regime - Common to soils of humid climates which have well-distributed rainfall, or which have enough rain in summer so that the amount of stored moisture plus rainfall is approximately equal to, or exceeds, the amount of evapotranspiration.

Undercut – To cut away material from the underside of, so as to leave an overhanging portion in relief.

Vertisols - Soils that have a high content of expending clay and that have at some time of the year have deep wide cracks. They shrink when drying and swell when they become wetter.