Appendix B
Engineering Appendix

Table of Contents

1 General 4
2 Hydrology and Hydraulics (H&H) 4
3 Surveying, Mapping, and Other Geospatial Data Requirements 4
4 Geotechnical 4
4.1 General – 4
5 Environmental Engineering 5
5.1 Use of environmentally renewable materials. 5
5.2 Design of positive environmental attributes into the project. 5
5.3 Inclusion of environmentally beneficial operations and management for the project. 5
5.4 Beneficial uses of spoil or other project refuse during construction and operation 5
5.5 Energy savings features of the design. 5
5.6 Maintenance of the ecological continuity in the project with the surrounding area and within the region. 5
5.7 Consideration of indirect environmental costs and benefits. 5
5.8 Integration of environmental sensitivity into all aspects of the project. 6
5.9 Consideration of environmental problems on similar projects with respect to the Environmental Review Guide for Operations (ERGO). 6
5.10 Incorporation of environmental compliance measures into the project design. 6
6 Civil Design 6
6.1 Site selection and project development 6
6.2 Real Estate 7
6.3 Relocations. 7
6.4 Risk for Cost Overruns in Civil Design 8
6.4.1 Utilities 8
6.4.2 Unknown Site Conditions 8
6.5 Design Criteria and Standards. 8
7 Structural Requirements 8
7.1 General - 8
7.2 Design Criteria – 8
7.3 Structural Systems 9
7.4 Risk for Cost Overruns in the Structural Design 9

7.4.1 Railroad crossing 9
7.4.2 Structural modifications to existing bridges 9
7.4.3 Foundation Design 10
8 Electrical and Mechanical Requirements 10
9 Hazardous and Toxic Materials 10
10 Construction Procedures and Water Control Plan 10
11 Initial Reservoir Filling and Surveillance Plan - Not applicable 11
12 Flood Emergency Plans for Areas Downstream of Corps Dams – Not Applicable 11
13 Environmental Objective and Requirements 11
14 Reservoir Clearing - Not applicable 11
15 Operation and Maintenance 11
16 Access Roads 11
17 Corrosion Mitigation 12
18 Project Security 12
19 Cost Estimates 12
19.1 Description 12
19.2 Account Code 01 – Lands and Damages 12
19.3 Account Code 02 – Relocations 13
19.4 Account Code 09 – Channels and Canals 13
19.5 Account Code 30 – Engineering and Design 13
19.6 Account Code 31 – Construction Management 13
20 Schedule for Design and Construction 13
21 Special Studies – Not Applicable 13
22 Plates, Figures, and Drawings 13
23 Data Management 13
24 Use of Metric System Measurements 13

Attachments
Attachment A – H&H Report
Attachment B – Cost Analysis, Construction Schedule, and MCACES Cost Estimate
Attachment C – Cost and Schedule Risk Analysis
Attachment D – Cost Difference Summary
Attachment E – O&M Estimates

APPENDIX B- ENGINEERING APPENDIX

1 General

This appendix documents the engineering analysis and follows the format of Engineering Regulation 1110-2-1150. Included with this appendix are the following reports; the Hydrology and Hydraulics Report (Attachment A), the MCACES cost estimate and construction schedule (included in Attachment B), and the Cost and Schedule Risk Analysis (Attachment C).

2 Hydrology and Hydraulics (H&H)

A hydraulic and hydrologic study of Prairie Creek, and Engineer's Ditch was performed for this study; information obtained from the model was used in developing channel dimensions. The evaluation included water surface profiles for the 1/500, 1/100, 1/50, 1/25, 1/10, 1/5, and 1/1 Annual Chance Exceedence (ACE) storm events for without-project (existing) conditions, without-project (future) conditions, and for several respective with-project alternatives. ACE is defined as the chance of that particular flood happening during any given year, for example; a 1/100 ACE storm event has a 1-percent chance of occurring during any given year. Refer to the Hydrology and Hydraulics report (Appendix D) for in-depth analysis of existing conditions and details of each of the alternative plans.

3 Surveying, Mapping, and Other Geospatial Data Requirements

Terrain data used for this study was collected using Light Detection and Ranging (LiDAR). This data was collected in 2011 on 0.5 meter nominal post spacing (NPS) with a vertical accuracy of 9.25 centimeter and supplied by the City of Russellville. Vertical datum for LiDAR elevations is NAVD 88. This data was imported directly into Bentley InRoads as a series of points with elevation attributes. This information combined with aerial photography was utilized to layout, analyze, and compute quantities for the channel and associated work. There are no existing river gages on Prairie Creek or its tributaries.

A more recent and comprehensive topographic survey will be required in order to develop plans and specifications. Due to the abundance of commercial properties affected, it is recommended that an American Land Title Association (ALTA) Land Survey be performed prior to proceeding into PED. This survey will provide topographic features, boundary lines, easements, structures, utilities, streets and railways, etc.

4 Geotechnical

4.1 General – No existing geotechnical borings were available for this study. The design coordinator and hydraulic engineer reviewed soil maps and performed a visual inspection of the existing conditions of the channel bottom and side slope to assess the soil conditions in the project area. The primary soil in the area is a silty loam with a shallow depth to bedrock. This soil type is appropriate for the selected

alternative's project features. Additional geotechnical investigation in the areas where box culverts will be installed will be performed during design.

5 Environmental Engineering

5.1 Use of environmentally renewable materials.

There is little opportunity to incorporate renewable materials in this project. The majority of the work will consist of excavation for the channel. There may be an opportunity to reuse composted topsoil for the restoration of the channel slopes. One of the major construction materials will be concrete which will be used for channel walls and culverts. Concrete while not considered to be renewable, could be composed of recycled concrete.

5.2 Design of positive environmental attributes into the project.

The channel side slopes will be mostly vegetated utilizing a grass and wildflower seed mix. A low flow channel will be considered during the final design, in an attempt to aid habitat improvement and channel maintenance/sediment removal.

5.3 Inclusion of environmentally beneficial operations and management for the project.

The intent is to promote a more natural channel using a wildflower and grass seed mix. This will reduce the amount of mowing as is typical on a conventional grass swale. This approach should reduce emissions from mowing equipment and the use of oil and gas.

5.4 Beneficial uses of spoil or other project refuse during construction and operation.

All excavated material will be hauled off-site by the construction contractor. It is likely that the contractor could sell the spoil material to be reused as fill material on other projects within and around the city.

5.5 Energy savings features of the design.

Due to the scope and nature of this flood risk management project, there are no feasibly obtainable energy saving features available.

5.6 Maintenance of the ecological continuity in the project with the surrounding area and within the region.

The landscape of the project site will be altered by the excavation for the channel widening. However, the long term change in ecology of the area will be minimized as the areas will be returned to a vegetated condition to promote the habitat and minimize erosion.

5.7 Consideration of indirect environmental costs and benefits.

There are no significant indirect impacts anticipated.

5.8 Integration of environmental sensitivity into all aspects of the project.

Environmental sensitivity will be incorporated into the design and construction of the project to the maximum extent practicable.

5.9 Consideration of environmental problems on similar projects with respect to the Environmental Review Guide for Operations (ERGO).

The perusal of the Environmental Review Guide for Operations (ERGO) with respect to environmental problems that have become evident at similar existing projects and, through foresight during this design stage, have been mitigated/addressed in the project design. There are minimal environmental impacts, requiring no mitigation, from the proposed project.

5.10 Incorporation of environmental compliance measures into the project design.

A Storm-Water Pollution Prevention Plan (SWPPP) will be prepared by the construction contractor and implemented for the project. The Sponsor will be required by the partnering agreement to provide land free and clear of HTRW contamination. Acquisition of required state and Federal permits will be completed by the construction contractor prior to any construction activity.

6 Civil Design

6.1 Site selection and project development

In order to find a solution for flood risk management, various channel alignments and detention basins were evaluated to determine the available alternatives. The Project Delivery Team (PDT) conducted site visits, considered existing improvements via aerial photography, and prepared preliminary cost comparisons in order to help facilitate selection of the most feasible channel alignment.

The Federal interest limit of the proposed channel includes portions of Prairie Creek and Engineer's Ditch in Russelville, AR. The channel has varying depths and portions of the channel run through a significantly developed area of the city. The proposed channel was designed to stay within the existing channel geometry and have a trapezoidal cross-section and vegetated side slopes (typically 2.5H:1V). The channel was laid out in a manner that was hydraulically functional while minimizing the need to remove or relocate existing homes, businesses and other structures. Where it was not feasible to construct a trapezoidal channel due to real estate limitations, vertical concrete walls were incorporated. The city has multiple areas where they would like to utilize the excavated material.

The primary structural measures evaluated were channel modification, replacement of bridges with box culverts, boring culverts underneath a railroad embankment, and detention areas. As discussed in the main report and H&H appendix, numerous measures were analyzed and combined to form five alternatives. The selected plan is alternative 4 which included channel modifications and box culvert replacements on Prairie Creek and boring two culverts underneath the railroad embankment on Engineer's Ditch.

The channel quantities were computed by the Average End Area Method. Cross sections depicting existing geometry channel compared with the proposed geometry were analyzed with Bentley InRoads software. Cut and fill volumes were computed for each alternative by economic reach.

The site quantities (vegetation, stabilization, tree clearing, demolition, roads, railroads, walls, etc.) were determined by estimating quantities from InRoads cross sections and from aerial photography. The aerial photography data utilized was accessed through Google Earth and from imagery through previous Corps of Engineers aerial photography contracts in the area.

Utility quantities were calculated by analyzing data received from local utility companies and collected during site visits to identify potential utility conflicts. Aerial imagery was also utilized to identify utility conflicts. Quantities for utility relocation were estimated for areas where conflicts were suspected.

Union Pacific Railroad engineers have indicated that boring culverts through the railroad-owned embankment may be acceptable but would not confirm that without seeing a final design. We assumed that the proposed boring would be approved once submitted to the railroad.

We assumed utilities crossing the channel where channelization was occurring would require lowering or relocation, unless the channel was not being lowered at that location.

In general, a proposed right of way width of 20' beyond the top bank of the proposed channel was assumed. Staging/lay down areas were selected to be in close proximity to the reaches.

6.2 Real Estate

This project will require the acquisition of real estate in order to widen the channel, replace bridges with culverts, and obtain access for construction equipment. In general, the required right of way for the channel was determined by utilizing the proposed channel top-of-bank to top-of-bank dimension plus 20' feet on each side for construction, access, and maintenance. The right of way was increased in areas where culverts are scheduled to be installed . Also, real estate acquisition will be required for staging/lay down areas. No borrow or spoil areas will be acquired for this project. All excavated material will be hauled off-site by the construction contractor.

6.3 Relocations.

Utilities located in the vicinity of the project were identified by using files provided by local utility companies. For the selected plan sanitary sewer, potable water, natural gas, electricical, cable tv, and telephone lines will have to be removed and relocated in order to construct the channel and detention basins. In general, quantities reflect a "like for like" replacement, meaning that the same size and type of material would be utilized in the relocation of a utility to accommodate the proposed channel work.

There are no planned railroad relocations in the selected plan. Culverts are scheduled to be jacked underneath the railroad embankment in order to avoid halting railroad traffic or otherwise negatively impacting railroad activities. Regarding road relocations, Commerce Street and West Parkway Avenue

will be excavated to accommodate the new culverts that will be installed below those roads. After that work is completed, the roads will be replaced. Both roads may have to be raised slightly to accommodate the culvert heights.

6.4 Risk for Cost Overruns in Civil Design

6.4.1 Utilities

Utilities are always a challenge when constructing a project of this type. It is difficult to determine where underground utilities are located. Record files have been utilized in the design of this project, but it is quite common for utility lines to be present when not indicated on the drawings. This is especially true regarding abandoned utility lines. The depth of the utilities is also hard to predict, hence knowing whether or not a utility crossing the channel needs to be relocated is challenging. It is reasonable to believe that there are more utilities in the ground than what we have record of.

6.4.2 Unknown Site Conditions

Unknown site conditions are always a potential risk on a project. No HTRW or cultural resource sites were identified in the project area. Any new sites found during design could affect cost and schedule. Other possible unknown site conditions include utilities, rock formations, and artificial subsurface obstructions.

6.5 Design Criteria and Standards.

The following documents and standards, as a minimum, will be incorporated in the design of this flood risk management project.

- "Manual on Uniform Traffic Control Devices (MUTCD)", Federal Highway Administration
- "Americans with Disabilities Act and the Architectural Barriers Act Guidelines" (ADAAG)
- "International Building Code"
- Architectural and Engineering Instruction Manual (AEIM), Southwestern Division
- Unified Facilities Criteria (UFC)
- ASTM International Standards
- SpecsIntact will be utilized to develop the project specifications

7 Structural Requirements

7.1 General - This section provides the criteria, design planning and analysis for which the design decisions were made and the structural requirements that are presented and assumed in the cost estimate.

7.2 Design Criteria – The current edition of the following documents will be used in the structural design of this flood control project.

- AASHTO LRFD Bridge Design Specifications; Design Load shall be based on the HL-93 Design Loading

- Arkansas Standard Specifications for Highway Construction
- Manual For Railway Engineering (AREMA)
- American Concrete Institute Standards (ACI)
- American Institute of Steel Construction (AISC – Manual of Steel Construction)

7.3 Structural Systems

Railroad Bridge

There is an existing railroad bridge crossing over Engineer's Ditch. The opening is insufficient to allow water passage without the headwater rising above flood levels. Lengthening this bridge to 90 feet proved to be prohibitively expensive. Circular reinforced concrete pipe culverts will be jacked through the embankment approximately 100 feet to the West.

Foundation Modifications

Little or no information is known about many of the existing structural foundation systems. Modifications that lower the channel bottom elevation will require a check of existing structural foundations that will remain in place.

Bridge Replacement

The maximum elevation at road crossings is set by existing infrastructure. Since the governing upper elevation of the opening is the bottom of the bridge girder, it is possible to create a larger opening with box culverts. Therefore, bridges with an inadequate opening will be replaced with box culverts.

Vertical Concrete Walls in the Channel

In isolated areas, it may be necessary to include vertical concrete walls to provide sufficient flow area within the available channel area which was restricted due to real estate limitations. These walls were designed and estimated as cast in place concrete walls. During design, differing wall options will be considered during further analysis to determine the most cost effective and suitable wall system once we have the soil conditions and final geometry of the channel.

7.4 Risk for Cost Overruns in the Structural Design

7.4.1 Railroad crossing

Coordination with the railroad has some inherent unknowns based on who owns the line, who operates on the line, and the individual entities that are involved with the design approval and coordination. Every effort was made to coordinate with the railroads involved, in order to use a typical design system that would alleviate as many problems as possible.

7.4.2 Structural modifications to existing bridges

Very little information is known about the existing structures and what could be done to modify the existing structure to pass the water flow or channel volume required. When a channel and a plan has been chosen, additional work will be required to find the existing construction information and detailed site inspections will be required to provide a more detailed design for these modifications.

7.4.3 Foundation Design

Rock pinnacles and soft areas are always potential risks that are associated with any feasibility design.

8 Electrical and Mechanical Requirements

The feasibility study includes functional design requirements, technical design criteria and quantity takeoff for relocation of all electric and telecom utilities above ground and underground within the project boundary that will interfere with the new channel system. Quantities were obtained using Google Earth and Bing Map satellite images as well as paper copies of electrical utilities maps provided by Entergy. Telecommunications maps have been requested but have not been received. Only utility equipment visible from satellite images were inspected, and from these images and maps the electrical equipment quantities were estimated. No underground utilities have been identified.

Technical design criteria for relocating the electric and telecom utilities and for providing under bridge lighting at bridge structures shall, at a minimum comply, with the requirements of the following criteria:

- **NFPA 70: National Electrical Code**
- **ANSI C2: National Electrical Safety Codes**

9 Hazardous and Toxic Materials

Little Rock District environmental personnel contacted the Arkansas Department of Environmental Quality (ADEQ) and received a listing of all known HTRW sites in Russelville, AR. The sites identified by ADEQ are outside of the boundaries of this project. Little Rock District engineering representatives also made multiple site visits to evaluate the project area and identify any potential HTRW sites. No HTRW sites were found and no other known or potential hazardous and toxic material sites have been identified in the project area. If HTRW sites are identified during the design phase, the study team will coordinate with all local, state, and federal authorities to determine if or where additional action is needed.

10 Construction Procedures and Water Control Plan

The construction of the culverts and bridges will be sequenced in order to minimize the impact on the local traffic patterns. Some streets will be required to be temporarily closed during construction, specifically Commerce Street and West Parkway Avenue. Where possible, the work will be installed in sections allowing traffic to be detoured around construction. Otherwise, sequencing the installation of the structures will be necessary to allow vehicular traffic to be rerouted around the local collector streets during construction.

Barriers will be installed near the edge of the excavated channel at locations where the channel intersects an existing road.

It is anticipated that the culverts will be constructed by using the adjacent in-place soil as a natural cofferdam. Groundwater and rainwater will have to be considered during construction of these features. A combination of ditches, well points, sumps or pumps will need to be used for removal of water from the excavations for satisfactory completion of the work.

Erosion control measures will also be put in place to minimize the erosion on the excavated slopes and all adjacent land that may have been stripped of vegetation.

11 Initial Reservoir Filling and Surveillance Plan - Not applicable

12 Flood Emergency Plans for Areas Downstream of Corps Dams – Not Applicable

13 Environmental Objective and Requirements

This information is provided in the main body of the report.

14 Reservoir Clearing - Not applicable

15 Operation and Maintenance

The sponsor will be responsible for annually traversing the entire length of the channel and looking at the condition of the channel bottom and side slopes and concrete structures. The sponsor will ensure that the earthen side slopes are mowed where appropriate; and that undesirable weeds and woody growth will be removed by herbicides or cutting. The concrete structures will also need to be inspected annually for damage and deterioration and repaired immediately to prevent further damage to the structure. The sponsor will be responsible for repair to any damaged sections of the riprap as well as removal of plant growth within the riprap. These activities are already being performed by the sponsor throughout the full length of Prairie Creek, therefore the additional O&M activities will primarily be at the culverts installed on Engineer's Ditch. The without-project total 50 year O&M cost is estimated at $973,520. The with-project total 50 year O&M cost estimate is $1,106,110 for a total 50 year cost difference of $132,590. These costs can be seen in attachment E.

16 Access Roads

This project is located within the city of Russelville and in most cases it will be feasible to use the existing public city streets for transportation miscellaneous construction equipment and hauling of excavated material, debris and construction materials. One construction access road will be constructed to access the area adjacent to the north side of the railroad bridge on Engineer's Ditch. The project site will have

construction easements along the top banks of the excavated channel. The easements will provide sufficient right of way for the sponsor to go back in the future and perform maintenance as required.

17 Corrosion Mitigation

Coatings and/or cathodic protection will be included in the design as required for materials which are installed in the soil.

18 Project Security

This project, consisting only of channelization and detention ponds, is not anticipated to require a security plan.

19 Cost Estimates

19.1 Description

The MII is developed using October 2014 Price Levels and the latest labor rates for Little Rock District areas. The feasibility estimate is based upon one (1) contract being issued. The contract is organized in accordance with a work breakdown structure. Midpoint dates for the construction contract are developed in conjunction with the project manager for developing the fully-funded costs. The estimate is prepared in accordance with ER 1110-2-1302 Civil Works Cost Engineering, dated 15 Sep 08. The costs are escalated in accordance with the above Engineering Regulation and EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS), dated 31 Mar 2014. All data is input into the Total Project Cost Summary (TPCS) spreadsheet.

Direct costs include a small business set-aside contract mechanism productivity of 85% and sales tax at 9.5%. The sales tax was determined from dfa.arkansas.gov (State Sales and Use Tax of 6.5%; Russellville Tax of 1.5%; and Pope County Tax of 1. 5%). There are no Hazardous, Toxic, and Radioactive Wastes anticipated. The Operation and Maintenance estimate is dated October 2014, with an effective pricing date of October 2014.

An Abbreviated Cost Risk Analyses (ACRA) was performed by the PDT on 28 Aug 14, in coordination with Cost Engineering Directory of Expertise (DX) of the Walla Walla District (October 2014). The risks are quantified and a cost risk model developed to determine a contingency at 80% Confidence Level. An ATR Certification of Cost Estimate is provided by Walla Walla District.

Estimated project costs increased significantly between October 2013 and October 2014. A cost difference summary showing the differences in the project and its estimated costs can be found in Attachment D.

19.2 Account Code 01 – Lands and Damages

This contract cost is outlined in the Real Estate Plan.

19.3 Account Code 02 – Relocations

This contract is based on communication, electric, gas, sewer, and water lines and equipments identified via visual inspections of Google Earth and Bing Map satellite images and site visits as provided by SWL-EC-DG. The quantities are approximate and based on visual observations only. No investigation for underground utilities was conducted. Relocations also include a 4000-SF commercial building. Risks are noted in the ACRA.

19.4 Account Code 09 – Channels and Canals

This contract is based on Engineers Ditch (Reach 01), Prairie Creek (Reach 03), and Prairie Creek (Reach 04-05). Reach 01 work is pipe jacking under an active railroad and channel diversion. Reach 03 work is demolition of West Parkway Street Bridge, Commerce Street Bridge, building, asphalt and concrete parking lots, and concrete channel walls; channel improvements and reinforcement; and installation of reinforced concrete culvert bridges at West Parkway Street and Commerce Street Bridge. Reach 04-05 work is channel improvements and riprap stockpiles and reuses (and supplements). Risks are noted in the ACRA.

19.5 Account Code 30 – Engineering and Design

The cost for this account was developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager. Risks are noted in the ACRA.

19.6 Account Code 31 – Construction Management

The cost for this account was developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager. Risks are noted in the ACRA.

20 Schedule for Design and Construction

The schedule for the tentatively selected plan, Alternative 4, is located within Attachment B.

21 Special Studies – Not Applicable

22 Plates, Figures, and Drawings

There are no plates attached to the main engineering appendix. Maps and drawings can be found in the Feasibility Report and within the H&H appendix.

23 Data Management

During the feasibility study, electronic data was compiled and maintained in project folders for each discipline involved on the server. This data is backed up regularly by USACE's data manager (ACE-IT). The project information will be available for the next phase of the project.

24 Use of Metric System Measurements

The Sponsor specifically requested that the project be designed in English units. They have stated that the English system is consistent with their current standards, specifications and bidding practices. With

English units being the locally familiar system in this area, the material testing, utility, and surveying companies would likely be forced to work with unfamiliar units. The data used to produce the H&H models and quantity calculations were all provided in English units. Converting this survey data from English to Metric would have created additional work effort for the design team resulting in slips in the schedule and additional costs.

Attachment A

Prairie Creek and Tributaries

Feasibility Study

H&H Report

US Army Corps
of Engineers
Little Rock District

PRAIRIE CREEK AND TRIBUTARIES

RUSSELLVILLE, ARKANSAS

SECTION 205 FEASIBILITY STUDY

HYDROLOGIC AND HYDRAULIC ANALYSIS

FEBRUARY 2015

CESWL-EC-H

PRAIRIE CREEK AND TRIBUTARIES
RUSSELLVILLE, ARKANSAS
SECTION 205 FEASIBILITY STUDY
FEBRUARY 2015

TABLE OF CONTENTS

1. Introduction

2. General

2.1	Scope of Work	1
2.2	Watershed Descriptions	1
2.3	Summary of Available Data	1

3. Hydrologic Analysis

3.1	General	2
3.2	Hypothetical Design Storms	2
3.3	Watershed and Subwatershed Delineation	3
3.4	Infiltration Loss Rates	3
3.5	Basin Lag Times	6
3.6	Storage Areas	6
3.7	Channel Routing	6
3.8	Design Discharges	8
3.9	Uncertainty Analysis	9

4. Existing (W/O Project) Condition Hydraulic Analysis

4.1	General	10
4.2	Existing Conveyance System	10
4.3	Cross-Sections	12
4.4	Hydraulic Structures	12
4.5	Flow Optimizations	12

5. Alternative Development

5.1	Engineers Ditch Measures	13
5.2	Prairie Creek Measures	16
5.2.1	Storage Areas	16
5.2.2	Prairie Creek Reach 3 Measures	19
5.2.3	Prairie Creek Reach 4 and Reach 5 Measures	21
5.3	Combined Measures	23

6. Selected Alternatives

LIST OF TABLES

Table 1	Precipitation Depth for Frequency Event	3
Table 2	Land Cover Reclassification	4
Table 3	Subwatershed Infiltration Rates	5
Table 4	Basin Lag times	7
Table 5	Existing Conditions Design Discharges	8
Table 6	Future Conditions Design Discharges	9
Table 7	Uncertainty Analysis	9
Table 8	Manning's "n" Values	10
Table 9	Storage Area 4% Flows	19

LIST OF FIGURES

Figure 1	Prairie Creek Stream Network	11
Figure 2	Engineers Ditch Subreach Map	14
Figure 3	Detention Basin Location	17
Figure 4	Prairie Creek Reach 3 Subreach Map	20
Figure 5	Prairie Creek Reach 4 and 5 Subreach Map	22
Figure 6	Prairie Creek – Alt 4 99% ACE Water Surface Profiles	27
Figure 7	Prairie Creek – Alt 4 50% ACE Water Surface Profiles	28
Figure 8	Prairie Creek – Alt 4 20% ACE Water Surface Profiles	29
Figure 9	Prairie Creek – Alt 4 10% ACE Water Surface Profiles	30
Figure 10	Prairie Creek – Alt 4 4% ACE Water Surface Profiles	31
Figure 11	Prairie Creek – Alt 4 2% ACE Water Surface Profiles	32
Figure 12	Prairie Creek – Alt 4 1% ACE Water Surface Profiles	33
Figure 13	Prairie Creek – Alt 4 0.2% ACE Water Surface Profiles	34
Figure 14	Engineers Ditch – Alt 4 99% ACE Water Surface Profiles	35
Figure 15	Engineers Ditch – Alt 4 50% ACE Water Surface Profiles	36
Figure 16	Engineers Ditch – Alt 4 20% ACE Water Surface Profiles	37
Figure 17	Engineers Ditch – Alt 4 10% ACE Water Surface Profiles	38
Figure 18	Engineers Ditch – Alt 4 4% ACE Water Surface Profiles	39
Figure 19	Engineers Ditch – Alt 4 2% ACE Water Surface Profiles	40
Figure 20	Engineers Ditch – Alt 4 1% ACE Water Surface Profiles	41
Figure 21	Engineers Ditch – Alt 4 0.2% ACE Water Surface Profiles	42

1. Introduction

The City of Russellville, Arkansas (population 27,920 by 2010 estimate) is located approximately 80 miles West of Little Rock in the southwest corner of Pope County. This report presents a description of the analytical approach, analyses performed, and the results obtained for a detailed hydrologic and hydraulic study of an approximately six mile reach of Prairie Creek that passes through the city as well as 4.5 miles of tributaries. This work was done in support of a flood risk management feasibility study under Section 205 authority. Results of this study include water surface profiles for the 99%, 50%, 20%, 10%, 4%, 2%, 1%, and 0.2% annual exceedance probability (ACE) rainfall events for without-project conditions (existing conditions) and for the selected with-project alternative conditions. This study was prepared by the U.S. Army Corps of Engineer District, Little Rock, Hydrology and Hydraulics Section (CESWL-EC-H).

2. General

2.1 Scope of Work

For each respective flow event analyzed, the study required development of an existing condition hydrologic model, future condition hydrologic model, an existing and future condition (w/o project) hydraulic model, and an existing and future hydraulic model for each respective with-project alternative condition analyzed.

2.2 Watershed Description

Prairie Creek is located in Russellville, Arkansas, approximately 80 miles West of Little Rock. The main channel of Prairie Creek begins approximately 3.3 miles North West of the City of Russellville. The stream collects from several tributaries and converges into a sump area located behind Russellville Dike, located at the Northwest corner of the City. Russellville Dike and the Prairie Creek Pump Station provide flood protection for the City of Russellville from the Arkansas River and Illinois Bayou. The project design was in conjunction with the development and construction of the Dardanelle Lock and Dam on the Arkansas River as documented in the Dardanelle Lock and Dam, Design Memorandum No. 15, Protection of Russellville, December 1961. The pump station transfers storage within the sump area to the Illinois Bayou (backwater from the Arkansas River) on the other side of the Russellville Dike. Engineers Ditch is a major tributary that also causes flooding and is included in the study.
The Prairie Creek watershed is primarily urban. The watershed is relatively small covering a total area of 12.6 mi^2. The largest tributary is Engineers Ditch with a total watershed area of 2.5 mi^2. The upper portions of the basins are steep and contain the majority of the undeveloped land found within the watershed. The watershed slope becomes more mild leading to the middle portions of the Creek, in which the City of Russellville is located. The lower portion of the watershed is a designated sump area behind the Russellville Dike.

2.3.1 Summary of Available Data

No historical stream flow data was available for the reaches addressed in this study. The following is a list of data that was available for use and considered pertinent to the evaluation of the watershed.

- LiDAR Terrain Data (2011)
- USACE Reconnaissance Study (2001)
- Culvert and Hydraulic Structure Inventory, City of Russellville (1998)

- GIS Data (USGS Quad Maps, Aerial Imagery, Street Maps)
- Flood Pain Study (1990)
- Pump Station Pertinent Data
- Sump Area Pertinent Data

3. Hydrologic Analysis

3.1. General

The Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) version 3.5 was used to model the rainfall-runoff process and compute discharge hydrographs at index location along several reaches within the Prairie Creek Watershed. Multiple HEC-HMS models were developed to estimate the excess rainfall amounts for the existing conditions, future conditions, and each alternative that had a significant impact on the hydrology of the watershed. The methods used to compute the watershed runoff parameters are outlined in the United States Department of Agriculture Soil Conservation Service Technical Release 55, Urban Hydrology for Small Watersheds (TR-55, 1986). Hypothetical design storms having a triangular, or "balanced", distribution were developed internally by HEC-HMS based on depth-duration-frequency data from the National Weather Service (NWS) publications HYDRO-35 and TP-40. Rainfall losses due to infiltration were accounted for with the SCS Runoff Curve Number methodology developed by the U.S. Department of Agriculture - Soil Conservation Service (USDA-SCS). The basin lag method was used to transform the rainfall excess into surface runoff and generate discharge hydrographs. The methods used to determine the basin lag time are detailed in the United States Department of Agriculture Soil Conservation Service Technical Release 55, Urban Hydrology for Small Watersheds (TR-55, 1986). Since little precipitation data and no stream flow data exists for the stream reaches and associated watershed analyzed in this study, computed flood flows were assumed to have the same frequency of occurrence as the hypothetical design storm events from which they were generated.

3.2 Hypothetical Design Storms

Hypothetical design storms having an Annual Chance Exceedance (ACE) of 99%, 50%, 20%, 10%, 4%, 2%, 1%, and 0.2% were required for this study. The most recent rainfall depth-duration data from the maps, supplied by NWS publications Hydro-35 and TP-40, provided the basis for the balanced storm distributions developed within the HEC-HMS models. Point rainfall depth values for storms having durations of five minutes through 24 hours were interpolated from the maps for each frequency event of 99%, 50%, 20%, 10%, 4%, 2% and 1%. Point rainfall depths for the various durations having a frequency of 0.2% are extrapolated estimates based on a graphical best fit curve for the interpolated data. Table 1 summarizes the precipitation data utilized as input for the HEC-HMS models. Values shown are annual series values.

Table 1 Precipitation Depth (in) for Frequency Event									
Storm Duration	99%	50%	20%	10%	4%	2%	1%	0.20%	Source
5 min	0.40	0.47	0.52	0.60	0.70	0.78	0.84	0.97	HYDRO-35
15 min	0.90	0.99	1.20	1.35	1.49	1.64	1.79	2.09	
60 min	1.55	1.79	2.29	2.68	3.06	3.44	3.75	4.38	
2 hr	1.88	2.28	2.80	3.25	3.80	4.20	4.65	5.50	TP-40
3 hr	2.10	2.48	3.20	3.60	4.15	4.65	5.18	6.20	
6 hr	2.50	2.98	3.80	4.42	5.05	5.65	6.20	7.28	
12 hr	2.99	3.60	4.60	5.25	6.11	6.82	7.50	8.82	
24 hr	3.50	4.12	5.28	6.10	7.05	7.90	8.75	10.35	

3.3 Watershed and Subwatershed Delineation

The terrain data used for the delineation of the watersheds and subwatersheds was collected through Light Detection and Ranging (LiDAR). This data was collected in 2011 on 0.5 meter nominal post spacing (NPS) with a vertical accuracy of 9.25 centimeter and supplied by the City of Russellville. The recently collected terrain data was used for the delineation of the watershed and subwatersheds. The HEC-GeoHMS program was used for preprocessing of the terrain data. The preprocessing includes smoothing of the existing terrain and creating flow direction and flow accumulation grids. The smoothing process fills in all sinks allowing excess rainfall to flow to a single outlet location. The flow direction and accumulation grids are used to create the initial drainage network. The drainage network was then used to delineate the watershed and subwatersheds without regard for the storm sewer system. The watersheds and subwatersheds delineated by the HEC-GeoHMS program were edited based on the natural terrain in concert with any apparent storm sewer lines that cross subbasin boundaries. These edited watershed and subwatersheds were then divided and/or merged depending on the characteristic of the drainage network. Each watershed and subwatershed was manipulated until a hydrologically correct system was achieved.

3.4 Infiltration Loss Rates

The SCS Runoff Curve Number (CN) methodology as described in the USDA-SCS National Engineering Handbook (NEH) (1985), Section 4:Hydrology, was implemented in the HEC-HMS models to account for infiltration loss rates. The CN for each subwatershed was developed using the GIS software ArcMap. The most recent land cover data (NLDC 2006) available was obtained from the National Land Cover Database (NLDC) through the Multi-Resolution Land Characteristics Consortium (MRLC). NLCD classes were consolidated from the original 15 classes to six classes. Table 2 displays the consolidation process.

Table 2 Land Cover Reclassification

Original NLCD Classification		Revised Classification	
Number	Description	Number	Description
11	Open Water	1	Water
90	Woody Wetlands		
95	Emergent Herbaceous Wetlands		
24	Developed, High Intensity	2	Commercial/Industrial/High Density Residential
23	Developed, Medium Intensity	3	Medium Density Residential
21	Developed, Open Space	4	Low Density Residential
22	Developed, Low Intensity		
31	Barren Land	5	Cleared Land
52	Shrub,Scub		
71	Grassland/Herbaceous		
81	Pasture/Hay		
82	Cultivated Crops		
41	Deciduous Forest	6	Forest
42	Evergreen Forest		
43	Mixed Forest		

Once the original 15 NLDC classes were reclassified into six, more manageable classes, the results were checked for accuracy and edited against 2012 aerial imagery supplied by the City of Russellville. While checking for accuracy, it was determined that an additional class was needed to further improve on the accuracy of the CN. The High Density Residential class was added and populated based on the 2012 aerial imagery.

The most recent soil survey data was downloaded from the NRCS soil data mart in the Soil Survey Geographic Database (SSURGO) format. The SSURGO soil data was used in the ArcMap program and combined with the reclassified land use shapefile based on the land use type and hydrologic soil group, creating a land/soil polygon shapefile. A lookup table was created to assign individual CN values, based on AMC II conditions, to the land/soil polygon based on their attributes. The HEC-GeoHMS program was then use to calculate the subwatersheds composite CN based on the land/soil polygon CN values and the subwatershed polygon.

The future condition infiltration analysis was performed using the same process as the existing conditions analysis, but the land cover shapefile was edited to coincide with the City of Russellville's zoning map assuming fully developed conditions. Table 3 displays the infiltration loss rates used in the HEC-HMS models for each of the study subwatersheds.

Table 3 Subwatershed Infiltration Rates

Subwatershed Name	Subwatershed Area (sqmi)	Existing CN	Future CN	Percent Increase
ED1	0.306	76.2	88.9	17%
ED2	0.109	82.1	87.6	7%
ED3	0.394	78.8	82.0	4%
ED4	0.348	77.6	79.1	2%
ED5	0.336	75.0	75.1	0%
ED6	0.208	78.0	78.4	1%
ED7	0.156	73.4	73.6	0%
ED8	0.119	75.4	75.5	0%
ED9	0.525	74.9	78.6	5%
PC1	0.177	71.3	77.6	9%
PC2	0.423	70.8	79.0	12%
PC3	1.046	76.5	82.3	8%
PC4	0.545	79.3	81.6	3%
PC5	0.421	73.8	77.5	5%
PC6	0.099	78.9	81.0	3%
PC7	0.230	79.0	87.3	11%
PC8	0.196	82.4	89.3	8%
PC10	0.285	79.3	82.2	4%
PC11	0.841	71.6	78.3	9%
PC12	0.118	68.1	77.0	13%
PC13	0.322	83.0	85.5	3%
PC14	0.425	84.9	89.5	5%
PC15	0.005	80.6	93.0	15%
PC16	0.056	86.7	90.5	4%
PC18	0.562	80.3	82.9	3%
PC19	0.181	79.0	91.0	15%
PC20	0.183	77.7	79.6	2%
PC21	0.763	73.2	80.5	10%
PC22	0.081	80.3	91.1	13%
PC23	0.244	82.0	86.4	5%
PC24	0.287	83.5	89.9	8%
PC25	0.422	87.0	92.0	6%
PC26	0.091	74.5	86.8	17%
PC27	0.204	72.8	88.4	21%
PC28	0.616	74.9	77.4	3%
PC29	1.245	75.1	78.6	5%

3.5 Basin Lag Times

The basin lag time is defined as the length of time between the centroid of precipitation to the peak of the runoff hydrograph. This amount was estimated using two thirds of the total time of concentration for each individual subwatershed. The time of concentration is defined as being the time it takes for rainfall runoff to travel from the most hydrologically distant point to the location of interest within the watershed, in this case the outlet of each subwatershed. The methods used to determine the time of concentration are detailed in the United States Department of Agriculture Soil Conservation Service Technical Release 55, Urban Hydrology for Small Watersheds (TR-55, 1986), and summarized herein. The time of concentration for each subwatershed was developed by splitting the runoff into three travel segments: sheet, shallow concentrated, and channel flow.
The HEC-GeoHMS program was used to determine and digitize the longest flow path for each subwatershed. The rainfall runoff was considered to be sheet flow for the first 300 feet of the longest flow path, or when a discernible channel is visible in the terrain data, whichever comes first. The travel time for the shallow concentration flow was determined using the length and average velocity of the watercourse. The average channel velocity was selected from a graph relating the average velocity to the channel slope and channel type (TR55, 1986). The flow was considered to be shallow concentrated until a discernible channel was visible through either the aerial imagery or the gridded terrain data. The channel flow segment travel time was determined using the Hydrologic Engineering Center – River Analysis System (HEC-RAS) program. An initial HEC-RAS model was built based on the methods described in the Hydraulics section of the report. From the initial HEC-RAS model, average channel reach velocities were extracted and used to calculate the channel flow times for each subwatershed. The travel times, time of concentration and lag time for each subwatershed are summarized in Table 4. Based on the current development and zoning maps of the City of Russellville, it was determined that the possible change in basin lag times through future development is negligible due to the limited room for development that is available throughout the watershed.

3.6 Storage Areas

There are two areas within the Prairie Creek Watershed that have the potential to store a considerable amount of rainfall excess. Each of these areas, Prairie Creek Sump Area and Waco Storage Pond, were modeled using the HEC-HMS program. The Prairie Creek Sump Area was designed to store the interior runoff from the Prairie Creek Watershed while the detained volume is pumped through the Russellville Dike into the Arkansas River. The volume stored within the sump area is evacuated into the Arkansas River by way of three 54,000 GPM pumps. The Waco Storage Pond is a planned inline, wet pond located in the Engineers Ditch watershed. The Waco Pond is designed to protect a subdivision that is subjected to flooding from low frequency rainfall events. The Waco Storage Pond will release storage by way of a single 48 inch RCP and a 34 foot riprap auxiliary spillway. The elevation-storage relationship for the sump area was developed from the LiDAR data provided by the city. Pertinent data regarding the Waco Storage Pond was also supplied by the city.

3.7 Channel Routing

The lag method was selected for the channel routing through subwatersheds. This method is conservative, appropriate for small basins, and essentially delays or lags the flow hydrograph as it is routed through a subwatershed. The channel velocities used in the routing lag computations were developed by averaging the channel velocities from the HEC-RAS model for each routing reach. The length of each routing reach was divided by the average channel velocity of the respective reach to determine the reaches lag time. Table 4 displays the basin lag times for each subwatershed.

Table 4 Basin Lag Times

Subwatershed Name	Sheet Flow Travel Time (min)	Shallow Concentrated Travel Time (min)	Channel Flow Time (min)	Time of Concentration (min)	Basin Lag (min) (SCS 1972)
ED1	5	33	16	54	32
ED2	6	23	2	30	18
ED3	4	13	16	34	20
ED4	5	20	10	35	21
ED5	5	45	9	58	35
ED6	3	34	13	49	30
ED7	4	29	0	33	20
ED8	7	22	0	29	18
ED9	4	15	8	27	16
PC1	10	60	11	81	49
PC2	4	24	21	49	29
PC3	7	29	25	61	37
PC4	6	47	22	75	45
PC5	8	60	13	81	49
PC6	5	56	1	62	37
PC7	3	22	20	44	27
PC8	8	46	4	58	35
PC10	4	33	7	43	26
PC11	4	61	9	75	45
PC12	4	102	1	107	64
PC13	3	81	0	85	51
PC14	10	41	22	74	44
PC15	8	1	1	10	6
PC16	3	17	6	26	16
PC18	4	13	18	35	21
PC19	10	35	4	49	29
PC20	5	57	0	62	37
PC21	5	59	17	82	49
PC22	4	17	6	27	16
PC23	8	39	6	53	32
PC24	5	56	4	66	40
PC25	3	17	18	37	22
PC26	8	10	8	26	16
PC27	7	37	15	60	36
PC28	5	24	9	38	23
PC29	4	28	44	76	46

3.8 Design Discharges

Design discharges at designated index points along the study reach were obtained from the results of the HEC-HMS model. Tables 5 and 6 lists, in downstream order, the design discharges for the current and future scenarios, used in the hydraulic model for computation of the water surface profiles. Each discharge was applied in the hydraulic model from its starting stream station downstream to the starting stream station for the next discharge.

Table 5 Existing Conditions Design Discharges

Stream Name	Starting Stream Station (ft)	Design Discharge (cfs) for Frequency Event							
		99%	50%	20%	10%	4%	2%	1%	0.20%
Engineers Ditch	65+86	410	537	992	1196	1457	1691	1906	2307
	49+28	479	624	1063	1376	1672	1938	2181	2658
	46+18	807	1070	1689	2425	2978	3504	4036	5165
Engineers Trib 1	5+97	377	507	890	1169	1509	1900	2293	3113
PC Trib 1	44+10	291	408	768	1038	1308	1548	1773	2200
	9+83	457	625	1124	1495	1865	2190	2494	3081
PC Trib 2	36+62	239	337	624	842	1062	1255	1437	1790
PC Trib 3	7+48	343	441	736	945	1141	1318	1479	1780
PC Trib 4	25+10	348	424	650	807	950	1080	1196	1418
PC Trib 5	54+12	259	341	636	845	1050	1234	1405	1741
Prairie Creek	314+70	344	479	874	1170	1469	1730	1975	2451
	263+12	640	886	1635	2192	2740	3228	3681	4541
	239+61	816	1116	1987	2636	3283	3844	4374	5405
	201+49	1017	1375	2403	3167	3929	4586	5206	6421
	185+61	1155	1571	2691.4	3529	4390	5101	5798	7192
	181+82	1439	1969	3416.2	4504	5612	6546	7447	9143
	121+61	2327	3106	5325	6984	8751	10328	11848	14839
	106+47	2749	3700	6398	8400	10504	12359	14170	17735

Table 6 Future Conditions Design Discharges

Stream Name	Starting Stream Station (ft)	Design Discharge (cfs) for Frequency Event							
		99%	50%	20%	10%	4%	2%	1%	0.20%
Engineers Ditch	65+86	469	600	994	1273	1533	1768	1982	2381
	49+28	557	706	1155	1472	1768	2034	2275	2750
	46+18	859	1124	1915	2484	3059	3623	4181	5364
Engineers Trib 1	5+97	362	489	866	1168	1594	2013	2412	3258
PC Trib 1	44+10	413	547	942	1229	1510	1758	1985	2424
	9+83	643	831	1369	1758	2138	2469	2775	3374
PC Trib 2	36+62	349	460	778	1010	1237	1435	1618	1974
PC Trib 3	7+48	393	494	795	1006	1202	1379	1538	1838
PC Trib 4	25+10	425	500	724	878	1017	1143	1258	1478
PC Trib 5	54+12	302	399	695	911	1118	1304	1475	1798
Prairie Creek	314+70	415	573	990	1297	1601	1866	2112	2592
	263+12	842	1110	1905	2479	3037	3531	3984	4852
	239+61	1062	1386	2302	2968	3624	4191	4719	5755
	201+49	1320	1707	2782	3564	4335	4995	5613	6835
	185+61	1491	1931	3105	3963	4829	5549	6241	7633
	181+82	1918	2487	4021	5141	6266	7208	8107	9909
	121+61	2931	3763	6069	7813	9650	11256	12781	15782
	106+47	3522	4550	7368	9460	11644	13541	15367	18952

3.9 Uncertainty Analysis

To determine the uncertainty in the stage of the developed hydraulic models, methods outlined in EM 1110-2-1619, “Risk-Based Analysis for Flood Damage Reduction Studies” 1996, were applied. The total uncertainty was developed by taking the standard deviation of the natural uncertainty and the model uncertainty. The model uncertainty was developed by taking the higher values from two methods. One method included using values from Table 5-2 in EM 1110-2-1619, while the other consisted of performing an uncertainty analysis on a representative reach within the existing conditions hydraulic model. The higher of the two values was adopted to compute the total uncertainty. The higher value of 1.3 was used for the model uncertainty. The natural uncertainty was developed using Equation 5-6 from EM1110-2-1619. Table 7 displays the results from the uncertainty analysis.

Table 7 Uncertainty Analysis

Sample Reach	Natural Uncertainty					Model Uncertainty (m)	Total Uncertainty (m)
	Bed Identifier	Basin Area (sqKM)	Max Range in Stage (m)	Q100 (m^3/s)	From Equation 5-5	Table 5-2	Equation 5-6
Engineers Ditch	2.5	5.6	3.8	114.0	0.1	0.34	0.34
Prairie Creek Upper	2.5	7.3	2.2	147.0	0.1	0.34	0.34
Prairie Creek Lower	2.5	12.8	2.5	311.0	0.1	0.34	0.34

4. Existing (W/O Project) Condition Hydraulic Analysis

4.1 General

Peak flows from the computed discharge hydrographs, along with surveyed, estimated, and interpolated cross-section geometry, were input into the HEC-RAS program version 4.1.0. A one-dimension steady-state backwater model was created for computation of the water surface profiles. Existing (w/o project) condition water surface profiles were developed for the 99%, 50%, 20%, 10%, 4%, 2%, 1% and 0.2% frequency events. Figure 1 displays the stream network included in the hydraulic model. Note that PC Trib 4 is not included in the limit of federal interest, but is modeled to include the effects of lateral flow to and from Prairie Creek Reach 6.

4.2 Existing Conveyance System

The study area was visited in February 2013 for purposes of characterizing the existing conveyance system and verifying and measuring hydraulic structures. The predominant conveyance characteristics of the channel and the overbanks were noted, and estimates of Manning's "n" values made. Aerial photography, dated 2012, provided information regarding the extent of the various cover types identified during the site visit. Channel bed slope is generally steep in the areas experiencing significant damages, ranging from about 0.003 ft/ft in the lower end to about 0.007 ft/ft in the upper end. Channel bed material ranged from gravels on silty sand to small cobbles to concrete lined channels. Specific values of Manning's n were developed using engineering judgment to select values within the ranges presented by Ven Te Chow, "Open-Channel Hydraulics," 1956. For instance, a concrete lined channel with cracks and some sandy deposits, a value of 0.016 – 0.02 was used depending on the amount of deposition and condition of the concrete.
Overbank cover consisted of a wide range of cover types including well maintained pasture and forest with medium to thick undergrowth in the lower and upper reaches, and residential areas and commercial areas in the middle reaches. Manning's n values were adjusted to values ranging from 0.1 to 0.15 for reaches with developed overbanks. These values will incorporate the effects that structures located in the overbanks have on loss of conveyance. The range of Manning's roughness coefficients used in the hydraulic model is shown in Table 8.

Table 8 Manning's "n" Values

	Channel		Overbanks	
Stream - Reach	Min.	Max	Min	Max
Engineers Ditch - 1	0.015	0.035	0.06	0.15
Engineers Ditch - 2&3	0.015	0.02	0.015	0.15
Engineers Trib 1	0.015	0.015	0.05	0.06
PC Trib 1	0.033	0.034	0.05	0.06
PC Trib 2	0.016	0.016	0.15	0.15
PC Trib 3	0.033	0.038	0.06	0.075
PC Trib 4	0.03	0.032	0.03	0.1
PC Trib 5	0.033	0.035	0.05	0.1
Prairie Creek - 1	0.032	0.035	0.075	0.075
Prairie Creek - 2	0.03	0.03	0.05	0.05
Prairie Creek - 3	0.02	0.034	0.06	0.15
Prairie Creek - 4	0.022	0.033	0.05	0.15
Prairie Creek - 5	0.02	0.034	0.05	0.15
Prairie Creek - 6	0.032	0.04	0.05	0.1
Prairie Creek - 7	0.03	0.036	0.05	0.1

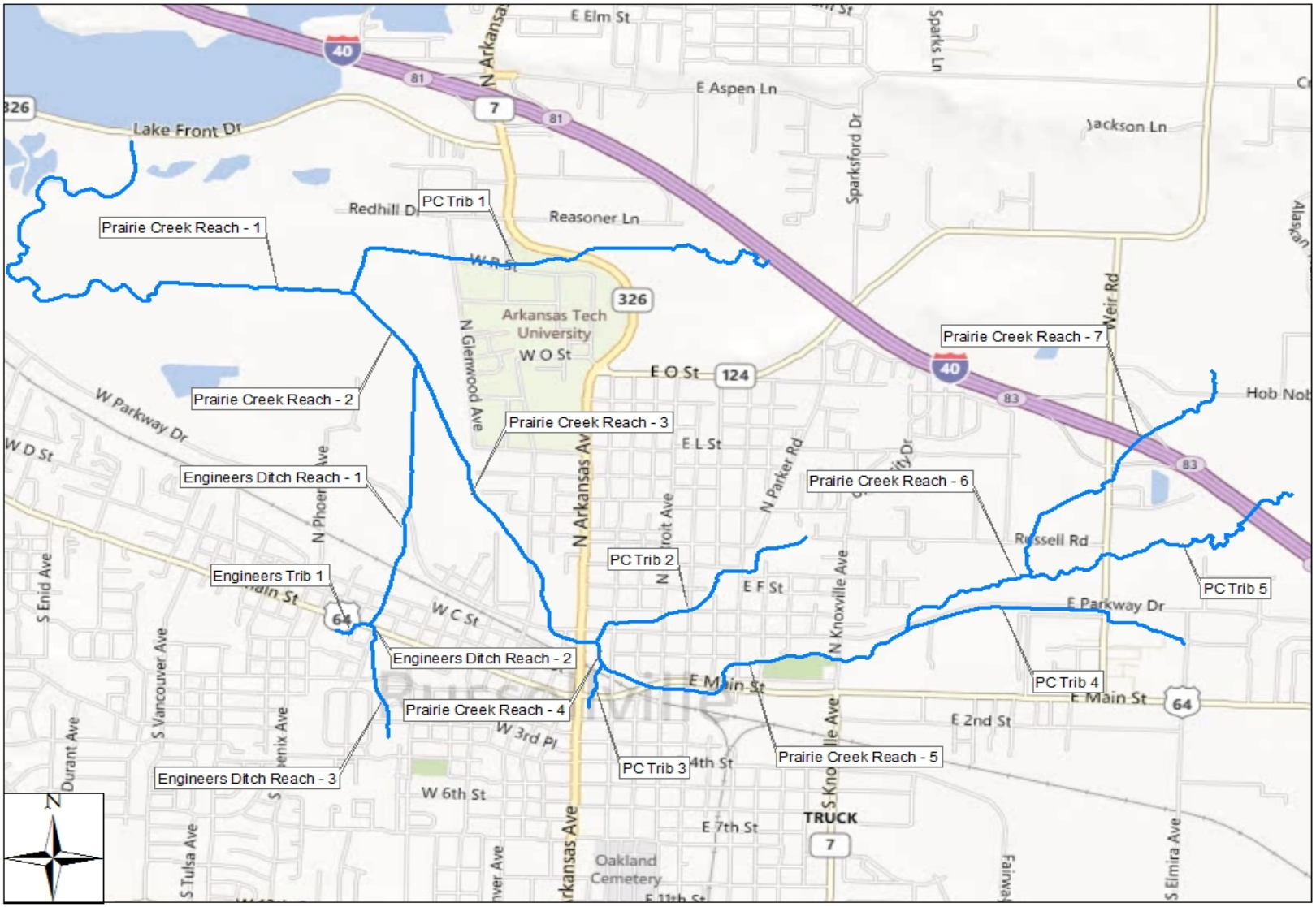

Figure 1 Prairie Creek Stream Network

4.3 Cross-Sections

The cross-sections were digitized using the ArcMap program to extract elevation data from the LiDAR data supplied by the City of Russellville. Cross-section locations were selected based on various factors. Initially the cross-sections were digitized based on distance between upstream and downstream cross-sections, location of hydraulic structures or flow obstructions, and changes in channel slope, channel shape and stream and overbank roughness. More cross-sections were then added using the same terrain data to achieve a more accurate representation of the existing geometry of the channel and overbanks, and to allow for more effective mapping.

4.4 Hydraulic Structures

The physical characteristics of the hydraulic structures within the modeled reaches were collected during the field reconnaissance. The type, material, dimensions, inlet conditions, cover, and other physical attributes were collected during these visits. The field measurements were taken by hand with a 100 foot open reel fiberglass surveyors tape. The invert elevations of the culverts were taken by measuring down from the high ground crest (usually road crest). This distance was then subtracted from the LiDAR data to obtain invert elevations. The accuracy of the invert elevations was deemed acceptable after conducting a sensitivity analysis in HEC-RAS and noting no major changes in water surface elevations. The results from the field reconnaissance were compared to the drainage structure inventory that was completed by the City of Russellville in 1998 to check for compliance. The inlet coefficients for each culvert were selected from the HEC-RAS user manual Table 6-3, Entrance Loss Coefficient for Pipe Culverts and Table 6-4, Entrance Loss Coefficient for Reinforced Concrete Box Culverts. The default value of 1 was used as the exit loss coefficient. A sensitivity analysis was also conducted on these coefficients in HEC-RAS and no significant difference in water surface elevation was observed.

4.5 Flow Optimizations

In some cases where stream flow is conveyed through culverts of significant length, the normal culvert calculations were not sufficient to accurately calculate the culvert and overland flow elevations. In these cases it was necessary to split the flow into two reaches. One reach is culvert flow while the other is overland flow. This is modeled by creating lidded cross-sections. The lidded cross-sections will not allow water to flow in the lidded section, containing the flow within the specified area, or culvert area. The other reach represents the overland flow. This reach is created by cutting cross-sections on the natural ground, where flow is expected pass over top of the culvert. To determine how much flow passes through the culvert and overland, the flow optimization feature is used. In this case, the flow optimization is an iterative process that HEC-RAS uses to balance flow between the overland and lidded reaches. Other special situations occur when there is interaction between two or more reaches. This case is handled in HEC-RAS by creating a lateral weir between the reaches. The lateral weir allows flow to be exchanged between reaches over the natural ground. This feature also requires the use of the flow optimization tool to properly account for the flow exchanged between the reaches. The flow optimization feature was used at every split flow junction and lateral weir location.

5. Alternative Development

Individual measures were developed to reduce flood stages in the most significant locations. Areas where major damage occurs from low to high frequency events were considered key locations to reduce flood stages and reduce damages. While each type of flood reduction measure was considered, only feasible

measures were preserved to the list of possible alternatives. For example, flood walls or levees were discarded during the initial screening process because of the likely effects they would have on the community. Diversions were discussed and roughly modeled, but were deemed unacceptable due to the flood risk associated with their locations and the cost of the lands, easements, relocations, and construction. Other, nonstructural measures were considered on a case by case basis and will not be discussed in this section. Two types of structural flood reduction measures were selected to move on to the design/modeling phase of the alternative development; channel modification and rainfall runoff detention. Due to the separate nature of Engineers Ditch and Prairie Creek, each stream was analyzed separate and will be reported in the same manner.

5.1 Engineers Ditch Measures

Engineers Ditch experiences significant flooding from the confluence with Prairie Creek to upstream of the Main Street culverts. The lower reach of Engineers Ditch is incapable of conveying flows resulting from an approximate 50% ACE flood. Backwater from the lower portion of the ditch creates flood water evacuation problems for the commercial and residential areas upstream of Main Street. The floodwaters of Engineers Ditch are routed through a double barrel 6 foot X 10 foot reinforced concrete box (RCB) and a triple barrel 6 foot X 6 foot RCB culvert that convey flow under Main Street to Engineers Ditch Reach 1. During large rainfall events, backwater from Reach 1 limits the capacity of the Main Street culverts resulting in the overtopping of Main Street.

To improve the conveyance of the lower reach of Engineers Ditch, an increase in effective cross-sectional area of the reach is proposed. To effectively increase the cross-sectional area of the reach and improve the conveyance, the structures located within the improved reach are to be sized accordingly to reduce the amount of blockage within the channel and maintain the proposed cross-sectional area of the channel. With improved conveyance in the lower reach of Engineers Ditch, the Main Street culverts are more efficient at evacuating the floodwaters of Engineers Ditch and Tributaries, and reduce the frequency of overtopping of Main Street.

The most flow hindering location along Engineers Ditch is the Railroad that crosses in Reach 1. This embankment is approximately 20 feet tall, and has an inadequate bridge span of 25 feet. The bridge opening causes flooding for most frequent rainfall events while causing backwater problems upstream. Multiple measures to alleviate the impounding water behind the railroad embankment were discussed, but only one feasible measure emerged. Floodwaters will be transported through the embankment by way of relief culverts. The culverts will be bored through the embankment and an ‘overflow/diversion’ section will be created upstream and downstream of the embankment for flow to leave and reenter the channel. Multiple variations and combinations of culvert sizes were tested and optimized to the selected size.

The modifications to Engineers Ditch are designed to increase conveyance and capacity of the lower reach just downstream of Main Street. The original channel consists of a trapezoidal natural channel with an approximate 10 foot-15 foot bottom width and 1V:1.5H to vertical side slopes. The existing channel has minor under cutting at various locations within the channel and significant erosion at road crossings. The modified channel measures were designed to increase channel capacity and reduce the potential for slope damages and/or failure. The modified channel consists of widening the channel bottom and stabilizing the bank with a lesser side slope and riprap where needed. The initial 13 different measures created include varying the bottom width of the modified channel, extent/length of modifications made, removal, widening, or replacing of the West B and West C St bridges and type of modification to the railroad embankment. These original measures were screened and reduced to five measures. The measures were reduced based on construction cost and reduction in stage.

Work proposed on Engineers Ditch is limited to Reach 1 only. This reach was further divided into subreaches of similar features. Subreach 1 extends from the Union Pacific Railroad crossing to West Main Street. Subreach 2 extends from West Parkway Drive to the Union Pacific Railroad crossing. Subreach 3 extends from the Engineers Ditch – Prairie Creek confluence to West Parkway Drive. Figure 2 displays the locations of the subreaches of Engineers Ditch.

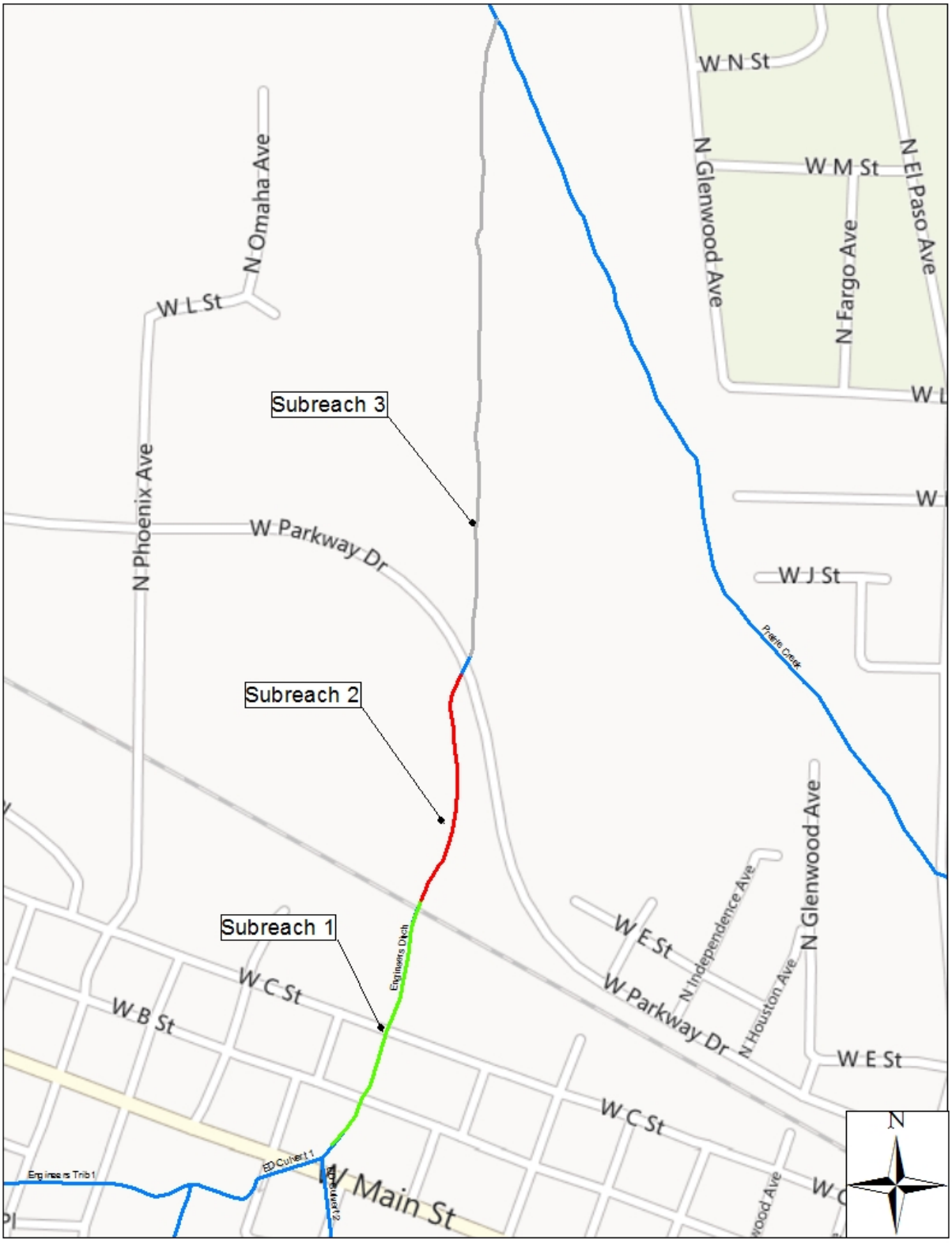

Figure 2 Engineers Ditch Subreach Map

ED Measure 9

- Subreach 1: Nothing.
- Subreach 2: Widen channel to 20 foot bottom with 1V:2.5H side slopes.
- Subreach 3: Widen channel to 25 foot bottom with 1V:2.5H side slopes.
- Subreach 4: Nothing.
- West B Street Bridge: Widen to 50 feet.
- West C Street Bridge: Widen to 50 feet.
- Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

ED Measure 10

- Subreach 1: Nothing.
- Subreach 2: Widen channel to 20 foot bottom with 1V:2.5H side slopes.
- Subreach 3: Widen channel to 25 foot bottom with 1V:2.5H side slopes.
- Subreach 4: Nothing.
- West B Street Bridge: Replace with 4 – 10 foot X 9 foot RCB.
- West C Street Bridge: Replace with 4 – 10 foot X 10 foot RCB.
- Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

ED Measure11

- Subreach 1: Nothing.
- Subreach 2: Widen channel to 20 foot bottom with 1V:2.5H side slopes.
- Subreach 3: Widen channel to 25 foot bottom with 1V:2.5H side slopes.
- Subreach 4: Nothing.
- West B Street Bridge: Replace with 40 foot X 9 foot Three Sided RCB (on strip footings).
- West C Street Bridge: Replace with 40 foot X 10 foot Three Sided RCB (on strip footings).
- Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

ED Measure 12

- Subreach 1: Nothing.
- Subreach 2: Nothing.
- Subreach 3: Nothing.
- Subreach 4: Nothing.
- West B Street Bridge: Remove.
- West C Street Bridge: Remove
- Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

ED Measure 13

- Subreach 1: Nothing.
- Subreach 2: Nothing.
- Subreach 3: Nothing.
- Subreach 4: Nothing.
- West B Street Bridge: Nothing.
- West C Street Bridge: Nothing.
- Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

With the above channel modifications implemented, the Main Street culverts are capable of evacuating more flow, although the extra flow does not significantly impact the stage upstream of Main Street. One measure that could reduce the stage upstream of Main Street is to increase the size or amount of the Main

Street culverts. Other measures discussed included replacing the Main Street Culverts with a bridge, and creating a diversion channel to reduce flow through the culverts. This measure was eliminated due to the high construction cost and the relatively low amount of total damages occurring upstream of Main Street.

5.2 Prairie Creek Measures

The main cause of flood damage along Prairie Creek is due to capacity deficiency in the channel and constrictions within the channel. The primary locations along Prairie Creek that experience flood damages are Reaches 3-5. To successfully reduce the amount of flood damages, the channel capacity must be increased, or the inflow must be significantly reduced. The first set of measures deal with reducing the flow by way of upstream detention basins.

5.2.1 Storage Areas

Two detention basins were developed to reduce the flow within reaches 3 – 5. The locations of the detention basins were selected primarily on the availability of real estate. Another factor in the location of the detention ponds was their ability to reduce flows within the damage reaches. Figure 3 displays the location of the two proposed detention basins. Table 9 displays the 4% flow data associated with SA1 and SA2.

Figure 3 Detention Basin Location

Storage Area 1 (SA1)

- Embankment
    - Embankment Crest Elevation: 371 feet, NAVD88.
    - Embankment Side Slope: 1V:5H Maximum.
    - Bottom Elevation: 357 feet, NAVD88.
    - Storage to embankment crest: 182 Acre-Feet.
- Inlet Works
    - Type: Lateral broad-crested weir.
    - Length: 100 feet.
    - Crest Elevation: 368.25 feet, NAVD88.
    - Location: DS of Prairie Creek 7 and PC Trib 5 Confluence.
- Outlet Works – Low Flow
    - Type: Low Flow Drain – Reinforced Concrete Pipe.
    - Size: Approximately 24 inches – 48 inches.
    - Inlet Elevation: 357 feet, NAVD88.
    - Outlet Elevation: 356.5 feet, NAVD88.
    - Length: Approximately 200 feet.
- Outlet Works – Spillway
    - Type: Broad-crested weir.
    - Length: 150 feet.
    - Crest Elevation: 369 feet, NAVD88.
    - Maximum DS Slope of 1V:10H.

Storage Area 2 (SA2)

- Embankment
    - Embankment Crest Elevation: 364 feet, NAVD88.
    - Embankment Side Slope: 1V:5H Maximum.
    - Bottom Elevation: 353 feet, NAVD88.
    - Storage to embankment crest: 110 Acre-Feet.
- Inlet Works
    - Type: Lateral broad-crested weir.
    - Length: 100 feet.
    - Crest Elevation: 360 feet, NAVD88.
    - Location: DS of Prairie Creek 6 and PC Trib 4 Confluence
- Outlet Works – Low Flow
    - Type: Low Flow Drain – Reinforced Concrete Pipe.
    - Size: Approximately 24 inches – 48 inches.
    - Inlet Elevation: 353 feet, NAVD88.
    - Outlet Elevation: 352 feet, NAVD88.
    - Length: Approximately 150 feet.
- Outlet Works – Spillway
    - Type: Broad-crested weir.
    - Length: 150 feet.
    - Crest Elevation: 361.25 feet, NAVD88.
    - Maximum DS Slope of 1V:10H

Table 9 Storage Area 4% Flows						
Prairie Creek Reach	Prairie Creek Station	Existing	SA1		SA2	
		Flow (CFS)	Flow (CFS)	% Reduction	Flow (CFS)	% Reduction
6	263+12	2740	1344	51%	2740	0%
5	239+61	3283	1990	39%	2437	26%
5	201+49	3929	2778	29%	3084	22%
4	185+61	4390	3610	18%	3575	19%
3	181+82	5612	4767	15%	4814	14%
2	121+61	8751	8515	3%	8387	4%
1	106+47	10504	10331	2%	10238	3%

5.2.2 Prairie Creek Reach 3 Measures

Another measure designed to reduce damages along Prairie Creek include channel modifications to the existing channel. Two segments of Prairie Creek, where significant damages occur, were selected for channel modifications. The first segment consists of Prairie Creek Reach 3. Reach 3's channel geometry includes rectangular and trapezoidal channel sections with varying channel bottom width and side slope. The primary cause for flood damages along Reach 3 includes insufficient channel capacity and constrictions in the channel due to inadequate bridge openings. Flooding along Reach 3 begins from a rainfall event that produces flows of approximately a 67% ACE flood event.

The modified channel measures were designed to increase channel capacity and reduce the potential for slope damages and/or failure. The modified channel consists of widening the channel bottom and stabilizing the bank with a lesser side slope and/or riprap and concrete where needed. The initial 11 alternative measures for Reach 3 include varying the bottom width of the modified channel, extent/length of modifications made and removal, widening, or replacing of the North Commerce Ave Bridge and West Parkway Bridge. Of the 11 initial measures, four were screened out due to the high construction cost and failure to make flood stage reductions comparable to the other measures. Another four measures were removed due to the removal of the North Commerce Ave Bridge. These measures were determined to have adverse effects on the flow of traffic.

The modifications to Prairie Creek Reach 3 have been segmented into four subreaches where modifications differ from one another. Subreach 1 extends from Highway 7 to the Prairie Creek – PC Trib 2 confluence. Subreach 2 extends from West Parkway Drive to Highway 7. Subreach 3 extends from North El Paso Avenue to West Parkway Drive. Subreach 4 extends from the Prairie Creek – Engineers Ditch confluence to North El Paso Avenue. Figure 4 displays the locations of the subreaches of Prairie Creek Reach 3.

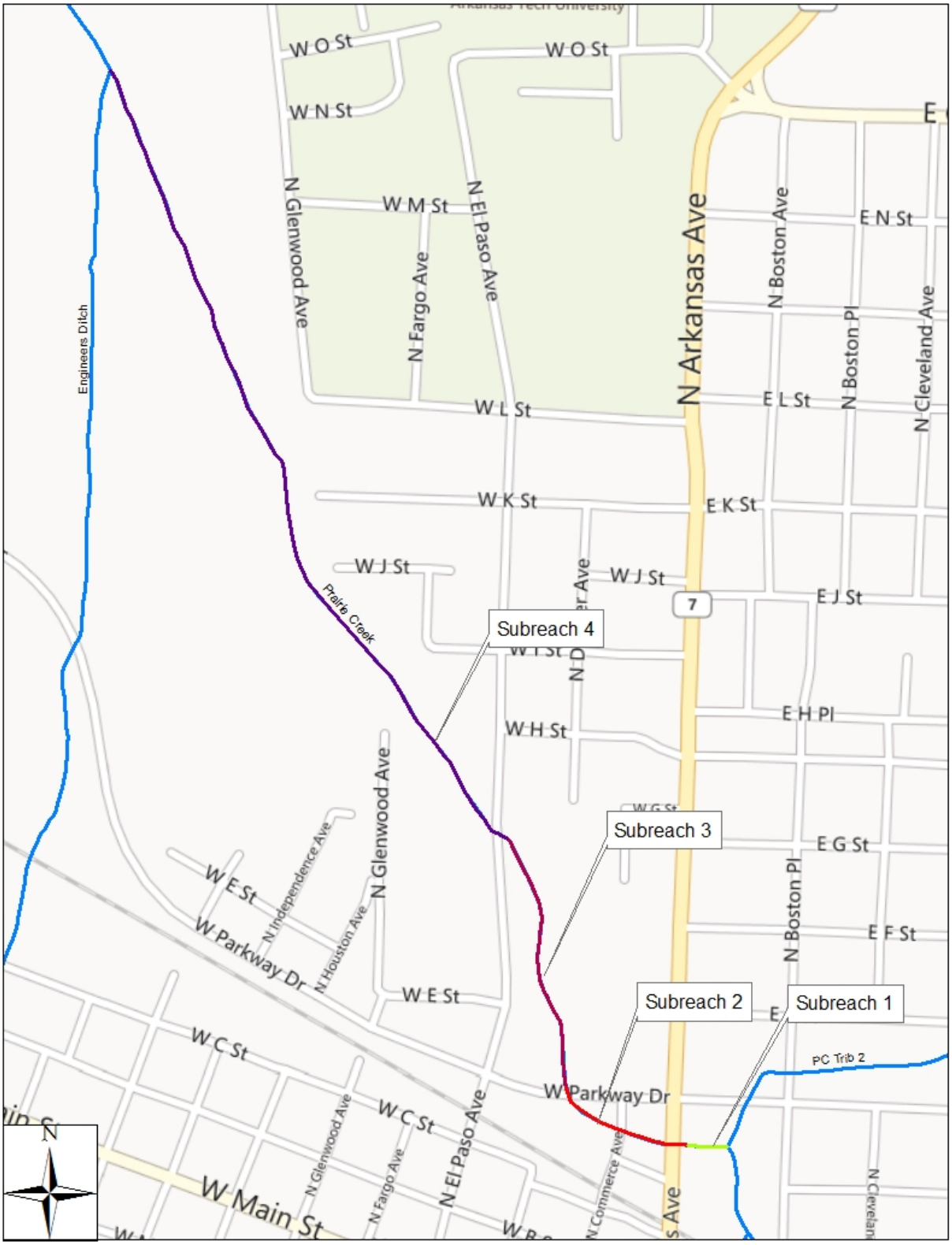

Figure 4 Prairie Creek Reach 3 Subreach Map

PC3 - Measure 6

- Subreach 1: Widen to 45 feet rectangular concrete channel.
- Subreach 2: Widen to 50 feet with RT bank 1V:1.5H SS, LT bank vertical concrete channel.
- Subreach 3: Widen to 45 feet with 1V:2H SS.
- Subreach 4: widen to 50 feet with 1V:2.5H SS.
- HWY 7 Bridge: Nothing.
- North Commerce Bridge: 7 – 8 foot x 8 foot RCB culverts.
- West Parkway Bridge: 7 – 8 foot x 8 foot RCB culverts.
- North El Paso Culverts: Clean.

PC3 – Measure 7

- Subreach 1: Widen to 40 feet rectangular concrete channel.
- Subreach 2: Widen to 50 feet with RT bank 1V:1.5H SS, LT bank vertical concrete channel.
- Subreach 3: Widen to 45 feet with 1V:2H SS.
- Subreach 4: widen to 50 feet with 1V:2.5H SS.
- HWY 7 Bridge: Nothing.
- North Commerce Bridge: 5 – 10 foot x 8 foot RCB culverts.
- West Parkway Bridge: 5 – 10 foot x 8 foot RCB culverts.
- North El Paso Culverts: Clean.

PC3 - Measure 8

- Subreach 1: Widen to 45 feet rectangular concrete channel.
- Subreach 2: Widen to 50 feet with RT bank 1:1.5 SS, LT bank vertical concrete channel.
- Subreach 3: Widen to 45 feet with 1V:2H SS.
- Subreach 4: widen to 50 feet with 1V:2.5H SS.
- HWY 7 Bridge: Nothing.
- North Commerce Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
- West Parkway Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
- North El Paso Culverts: Clean.

5.2.3 Prairie Creek Reach 4 and Reach 5 Measures

The second segment of channel modifications of Prairie Creek includes Reach 4 and Reach 5. This segment has similar channel capacity issues as the previously described segment, but does not have the grossly insufficient bridge openings like Prairie Creek Reach 3. The set of measures identified in this segment consists of modifications to the channel only. These measures include varying the channel bottom widths. All the structures and crossings located along Reach 4 and Reach 5 will remain in their current conditions.

Prairie Creek Reach 4&5 was further subdivided into three subreaches of similar features. Subreach 1 extends from East Main Street to East Parkway Drive. Subreach 2 extends from the Prairie Creek – PC Trib 3 confluence to East Main Street. Subreach 3 extends from the Prairie Creek – PC Trib 2 confluence to the Prairie Creek – PC Trib 3 confluence. Figure 5 displays the subreaches located in Prairie Creek Reach 4 and Reach 5.

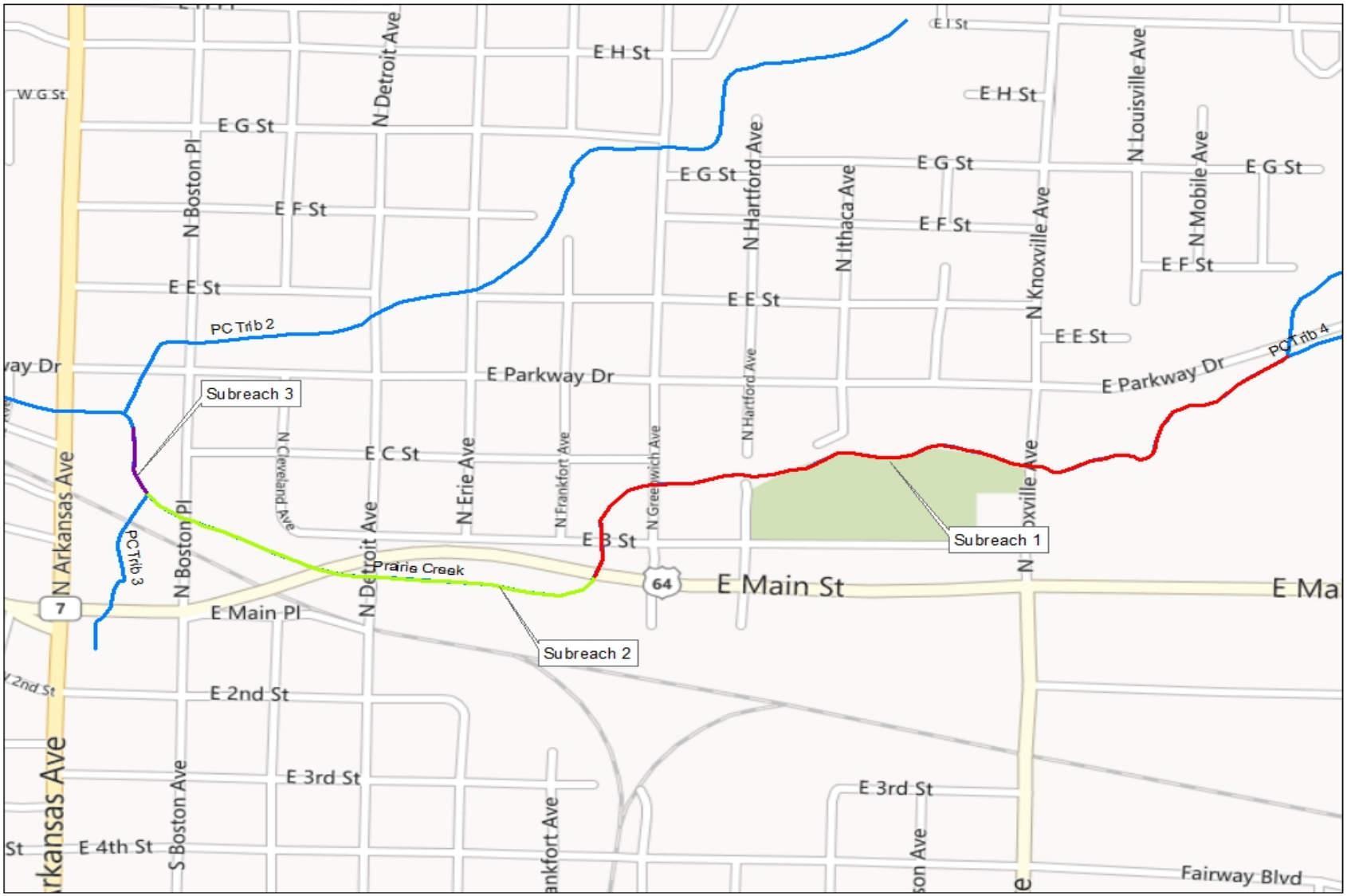

Figure 5 Prairie Creek Reach – 4 and Reach 5 Subreach Map

PC 4&5 - Measure 12:

- Subreach 1: Widen to 20 feet with 1V:2.5H SS.
- Subreach 2: Widen to 25 feet with 1V:2.5H SS.
- Subreach 3: Widen to 25 feet with 1V:2.5H SS.

PC 4&5 - Measure 13:

- Subreach 1: Widen to 20 feet with 1V:2.5H SS.
- Subreach 2: Widen to 20 feet with 1V:2.5H SS.
- Subreach 3: Widen to 20 feet with 1V:2.5H SS.

PC 4&5 – Measure 15:

- Subreach 1: Widen to 25 feet with 1V:2.5H SS.
- Subreach 2: Widen to 30 feet with 1V:2.5H SS.
- Subreach 3: Widen to 30 feet with 1V:2.5H SS.

5.3 Combined Measures

Alternatives were developed by combining measures based on the net benefits of each individual measures. Five separate alternatives were developed. Alternative 1 is capable of providing a higher level of protection from more frequent rainfall events. Alternative 2 is compiled of measures that provide the highest level of protection for all frequency events. Alternative 3 is also capable of providing a higher level of protection from less frequent rainfall events. Alternatives 4 and 5 provide the same benefits along Prairie Creek as Alternative 1 varying only in the measures implemented along Engineers Ditch. The following is a description of the final alternatives. The alternatives are broken down by subreaches.

Alternative 1

- Engineers Ditch (ED - Measure 10)
    - Subreach 1: Nothing.
    - Subreach 2: Widen channel to 20 foot bottom with 1V:2.5H side slopes.
    - Subreach 3: Widen channel to 25 foot bottom with 1V:2.5H side slopes.
    - Subreach 4: Nothing.
    - West B Street Bridge: Replace with 4 – 10 foot X 9 foot RCB.
    - West C Street Bridge: Replace with 4 – 10 foot X 10 foot RCB.
    - Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

- Prairie Creek Reach 4 and Reach 5 (PC 4&5 - Measure 13)
    - Subreach 1: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 2: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 3: Widen to 20 feet with 1V:2.5H SS.

- Prairie Creek Reach 3 (PC 3 – Measure 8)
    - Subreach 1: Widen to 45 feet rectangular concrete channel.
    - Subreach 2: Widen to 50 feet with RT bank 1:1.5 SS, LT bank vertical concrete channel.
    - Subreach 3: Widen to 45 feet with 1V:2H SS.

    - Subreach 4: Widen to 50 feet with 1V:2.5H SS.
    - HWY 7 Bridge: Nothing.
    - Commerce Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - W Parkway Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - N El Paso Culverts: Clean.

Alternative 2

- Engineers Ditch (ED – Measure 10)
    - Subreach 1: Nothing.
    - Subreach 2: Widen channel to 20 foot bottom with 1V:2.5H side slopes.
    - Subreach 3: Widen channel to 25 foot bottom with 1V:2.5H side slopes.
    - Subreach 4: Nothing.
    - West B Street Bridge: Replace with 4 – 10 foot X 9 foot RCB.
    - West C Street Bridge: Replace with 4 – 10 foot X 10 foot RCB.
    - Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

- Prairie Creek Reach 4 and Reach 5 (PC 4&5 - Measure 13)
    - Subreach 1: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 2: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 3: Widen to 20 feet with 1V:2.5H SS.

- Prairie Creek Reach 3 (PC 3 – Measure 8)
    - Subreach 1: Widen to 45 feet rectangular concrete channel.
    - Subreach 2: Widen to 50 feet with RT bank 1:1.5 SS, LT bank vertical concrete channel.
    - Subreach 3: Widen to 45 feet with 1V:2H SS.
    - Subreach 4: Widen to 50 feet with 1V:2.5H SS.
    - HWY 7 Bridge: Nothing.
    - Commerce Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - W Parkway Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - N El Paso Culverts: Clean.

- Storage Area
    - SA1

Alternative 3

- Engineers Ditch (ED – Measure 10)
    - Subreach 1: Nothing.
    - Subreach 2: Widen channel to 20 foot bottom with 1V:2.5H side slopes.
    - Subreach 3: Widen channel to 25 foot bottom with 1V:2.5H side slopes.
    - Subreach 4: Nothing.
    - West B Street Bridge: Replace with 4 – 10 foot X 9 foot RCB.

    - West C Street Bridge: Replace with 4 – 10 foot X 10 foot RCB.
    - Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

- Prairie Creek Reach 3 (PC 3 – Measure 8)
    - Subreach 1: Widen to 45 feet rectangular concrete channel.
    - Subreach 2: Widen to 50 feet with RT bank 1:1.5 SS, LT bank vertical concrete channel.
    - Subreach 3: Widen to 45 feet with 1V:2H SS.
    - Subreach 4: Widen to 50 feet with 1V:2.5H SS.
    - HWY 7 Bridge: Nothing.
    - Commerce Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - W Parkway Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - N El Paso Culverts: Clean.

- Storage Area
    - SA1

Alternative 4

- Engineers Ditch (ED - Measure 13)
    - Subreach 1: Nothing.
    - Subreach 2: Nothing.
    - Subreach 3: Nothing.
    - Subreach 4: Nothing.
    - West B Street Bridge: Nothing.
    - West C Street Bridge: Nothing.
    - Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

- Prairie Creek Reach 4 and Reach 5 (PC 4&5 - Measure 13)
    - Subreach 1: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 2: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 3: Widen to 20 feet with 1V:2.5H SS.

- Prairie Creek Reach 3 (PC 3 – Measure 8)
    - Subreach 1: Widen to 45 feet rectangular concrete channel.
    - Subreach 2: Widen to 50 feet with RT bank 1:1.5 SS, LT bank vertical concrete channel.
    - Subreach 3: Widen to 45 feet with 1V:2H SS.
    - Subreach 4: Widen to 50 feet with 1V:2.5H SS.
    - HWY 7 Bridge: Nothing.
    - Commerce Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - W Parkway Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - N El Paso Culverts: Clean.

Alternative 5

- Engineers Ditch (ED - Measure 12)
    - Subreach 1: Nothing.
    - Subreach 2: Nothing.
    - Subreach 3: Nothing.
    - Subreach 4: Nothing.
    - West B Street Bridge: Remove.
    - West C Street Bridge: Remove.
    - Union Pacific Railroad: Add diversion and 2 – 8 foot Reinforced Concrete Pipe Culverts.

- Prairie Creek Reach 4 and Reach 5 (PC 4&5 - Measure 13)
    - Subreach 1: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 2: Widen to 20 feet with 1V:2.5H SS.
    - Subreach 3: Widen to 20 feet with 1V:2.5H SS.

- Prairie Creek Reach 3 (PC 3 – Measure 8)
    - Subreach 1: Widen to 45 feet rectangular concrete channel.
    - Subreach 2: Widen to 50 feet with RT bank 1:1.5 SS, LT bank vertical concrete channel.
    - Subreach 3: Widen to 45 feet with 1V:2H SS.
    - Subreach 4: Widen to 50 feet with 1V:2.5H SS.
    - HWY 7 Bridge: Nothing.
    - Commerce Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - W Parkway Bridge: 4 – 10 foot x 8 foot RCB (Inside), 2 – 8 foot x 8 foot RCB (Outside).
    - N El Paso Culverts: Clean.

6. Selected Alternative

The NED alternative chosen for the Prairie Creek Section 205 Flood Risk Management project is Alternative 4. Alternative 4 provides the same benefits along Prairie Creek as Alternatives 1 and 5. The channel modifications along Prairie Creek provide a significant reduction in flood damages from the 99% - 1% ACE rainfall events. Figures 6 – 13 display the existing conditions and the Alternative 4 current conditions water surface profiles for the 99% - 0.2% ACE rainfall events along the effected reaches of Prairie Creek.

This Alternative provides good benefits on Engineers Ditch by increasing conveyance through the railroad embankment. The railroad embankment is considered to be the most flow hindering obstruction along Engineers Ditch. While this will not prevent flooding along Engineers Ditch, it significantly reduces the flood damages along Engineers Ditch Reach 1 for all ACE events, and significant reductions along Reach 2 for the 2% - 0.2% ACE flood events. Figures 14 – 21 display the existing conditions and the Alternative 4 current conditions water surface profiles for the 99% - 0.2% ACE rainfall events along Engineers Ditch.

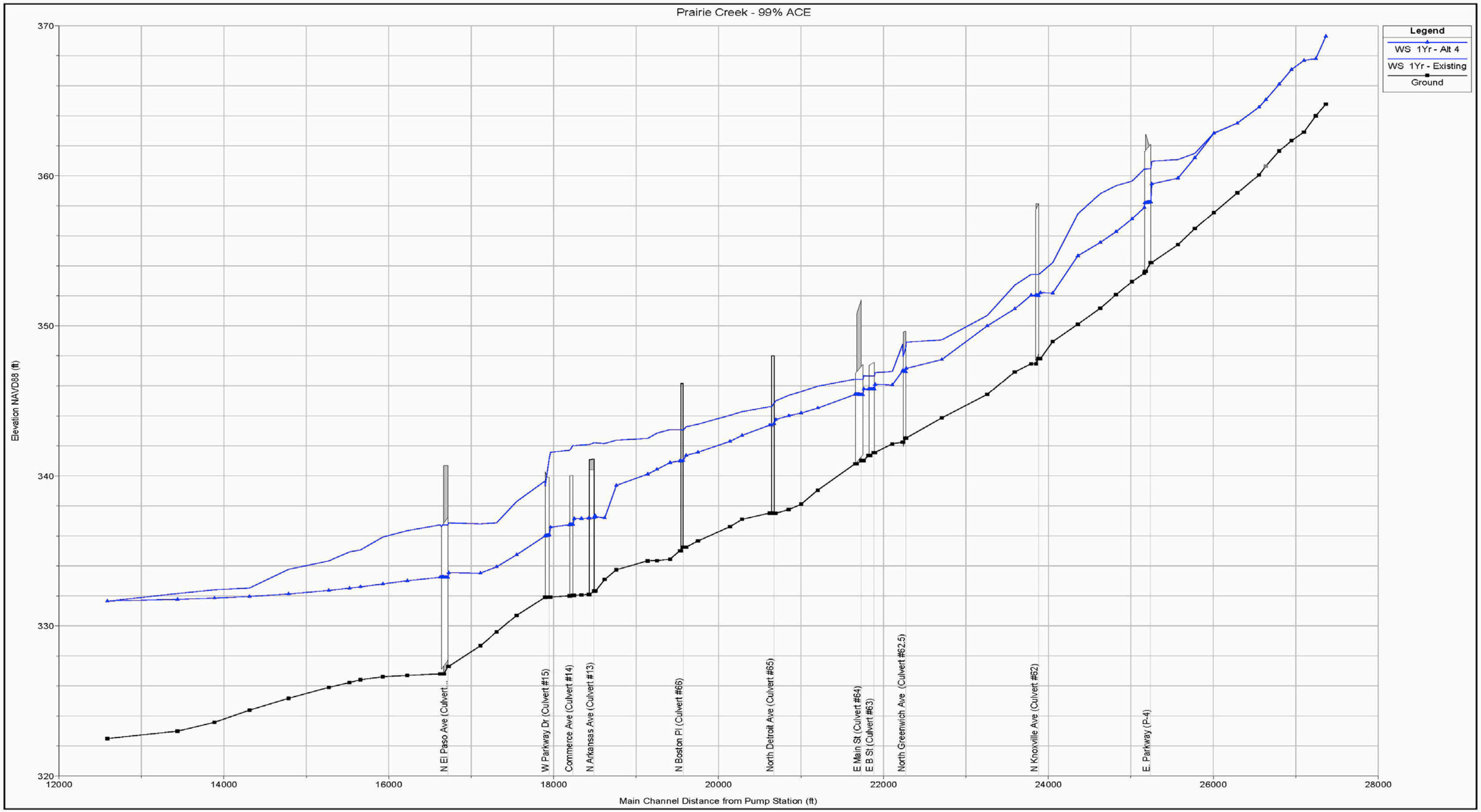

Figure 6. Prairie Creek - Alternative 4 99% ACE Water Surface Profile

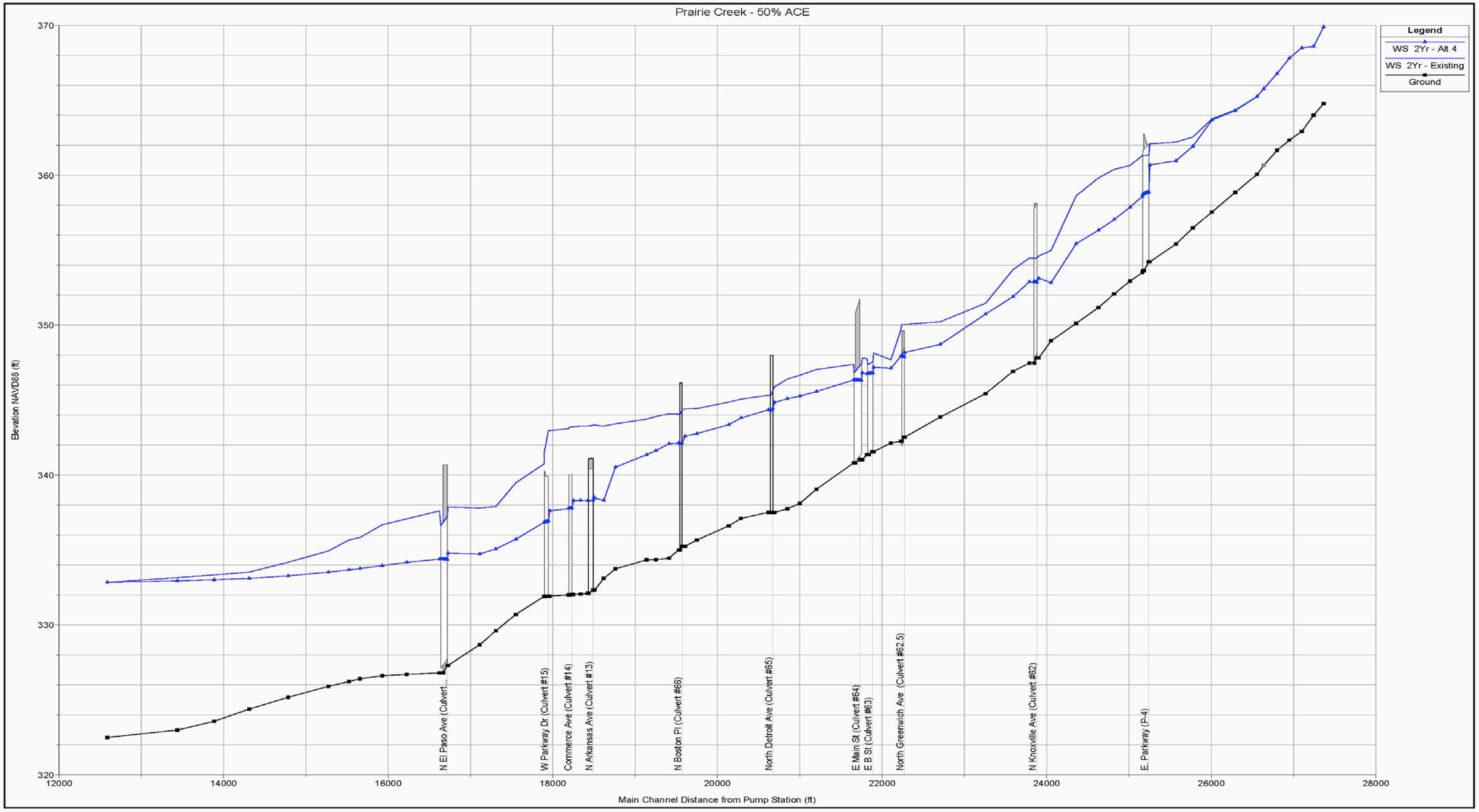

Figure 7. Prairie Creek - Alternative 4 50% ACE Water Surface Profile

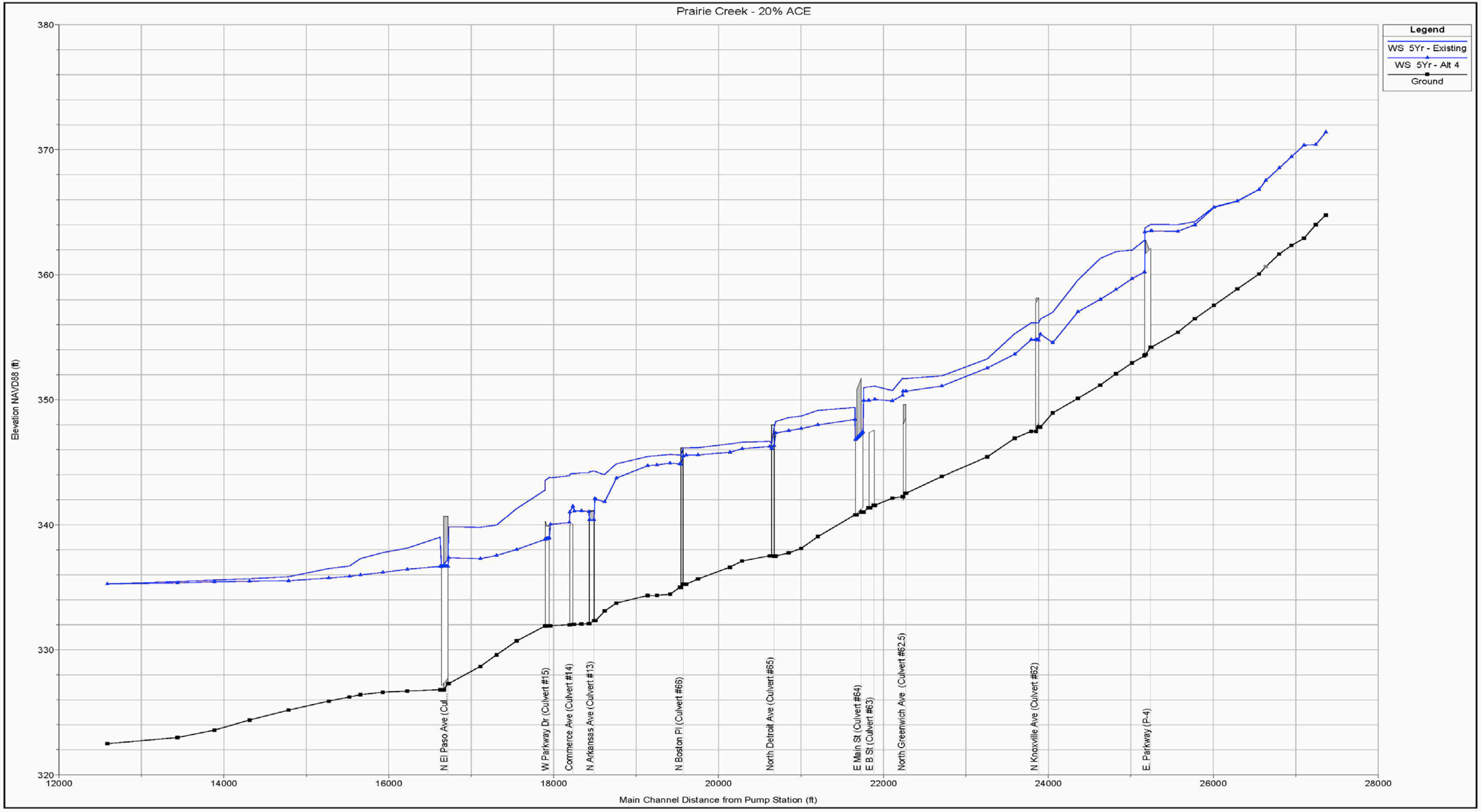

Figure 8. Prairie Creek - Alternative 4 20% ACE Water Surface Profile

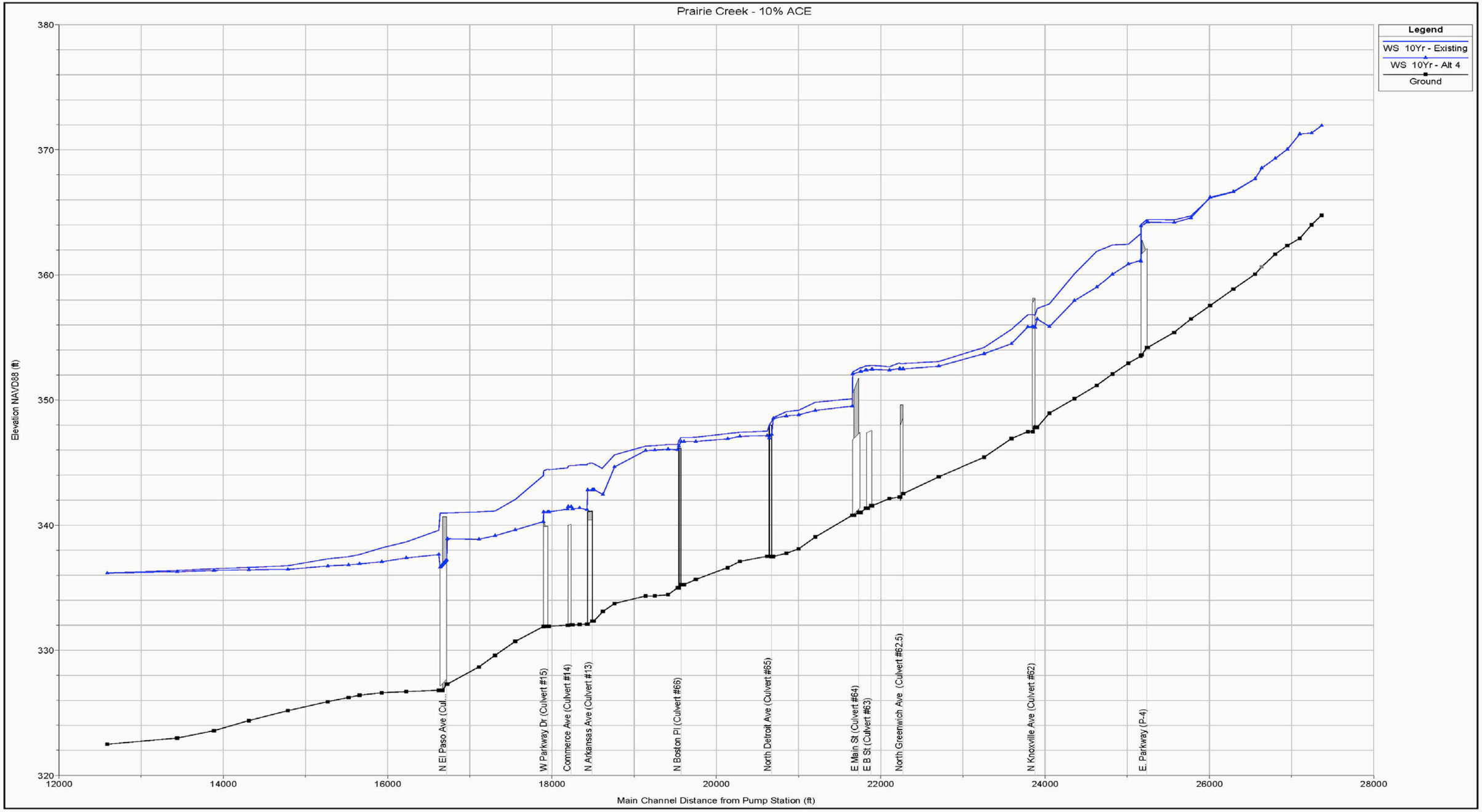

Figure 9. Prairie Creek - Alternative 4 10% ACE Water Surface Profile

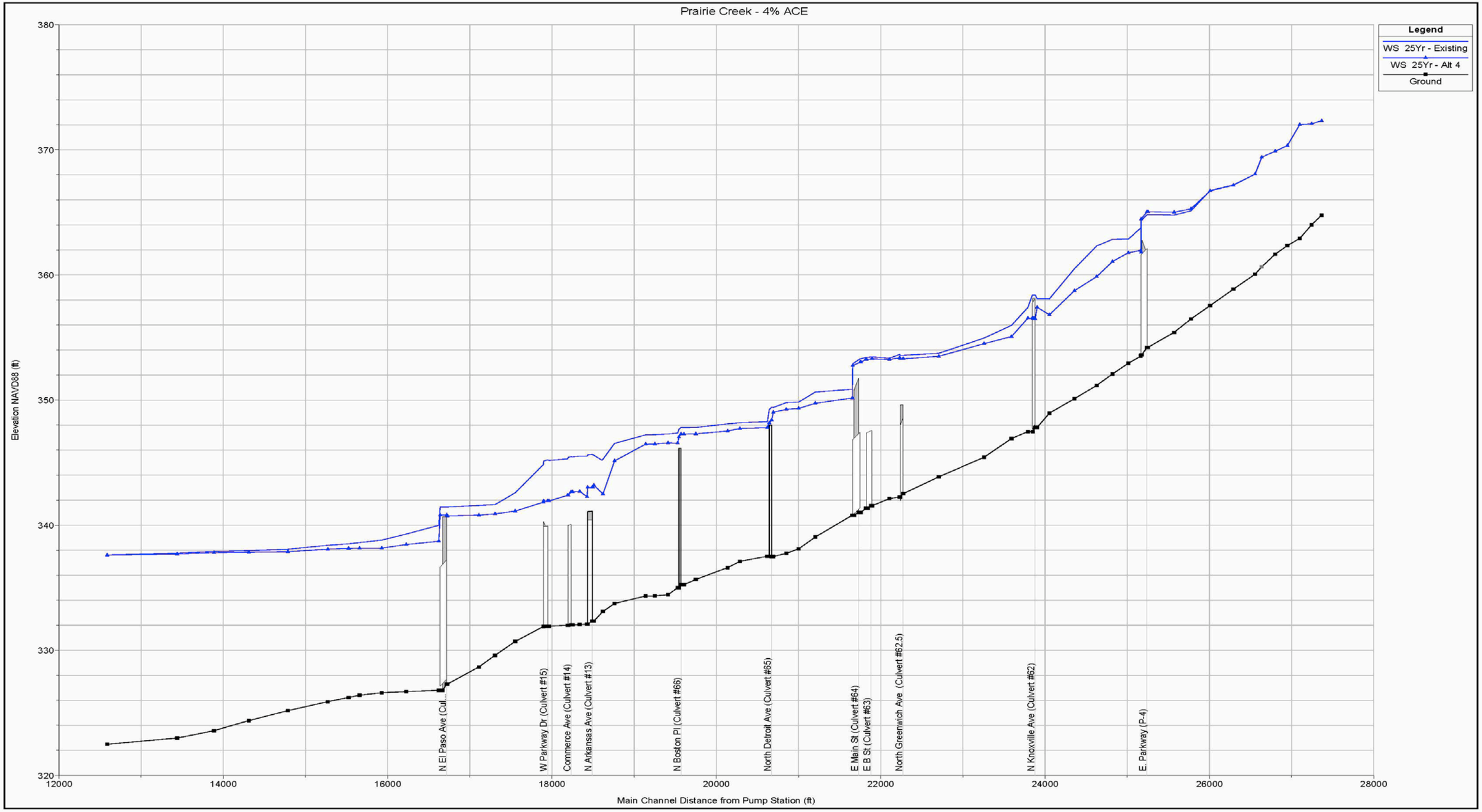

Figure 10. Prairie Creek - Alternative 4 4% ACE Water Surface Profile

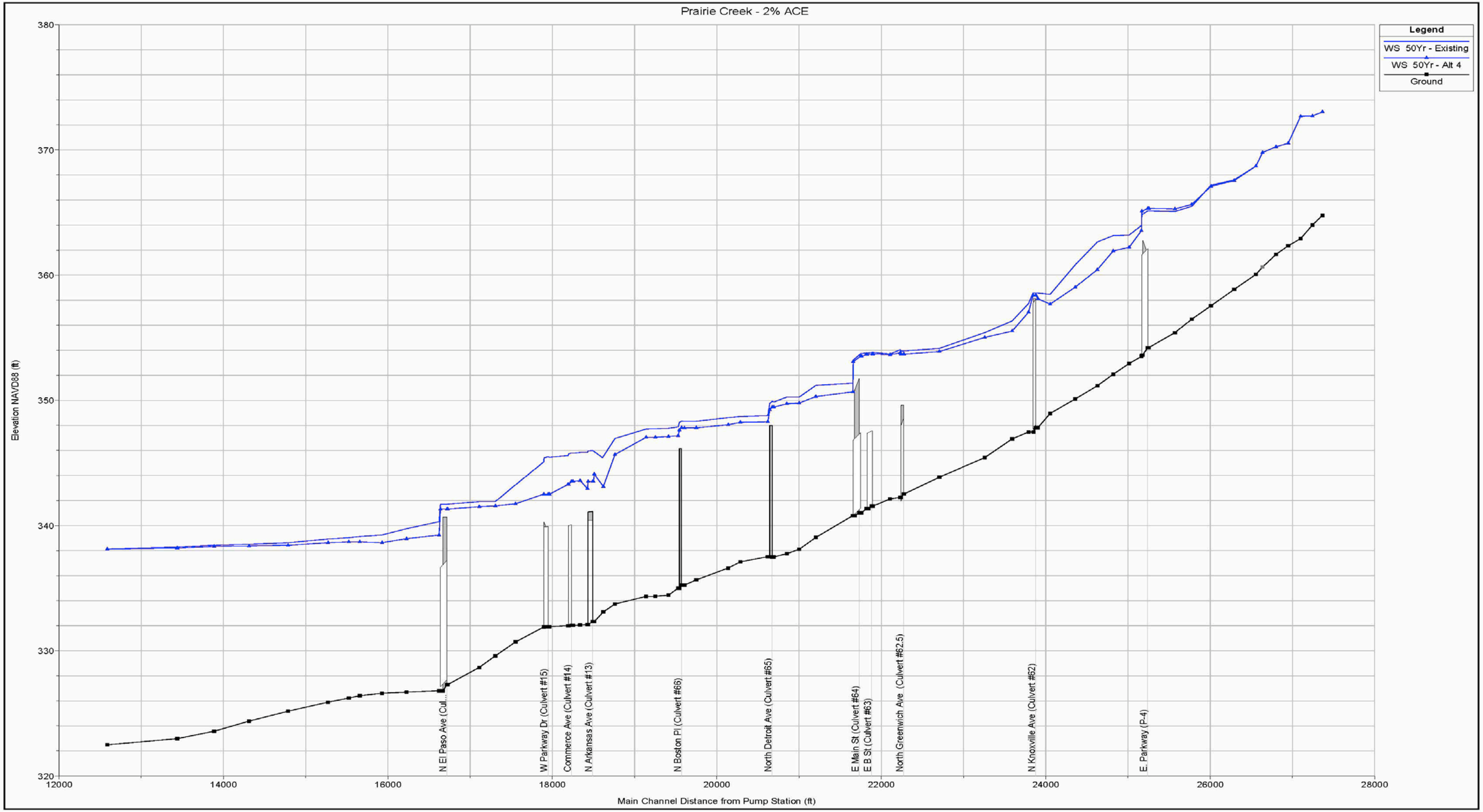

Figure 11. Prairie Creek - Alternative 4 2% ACE Water Surface Profile

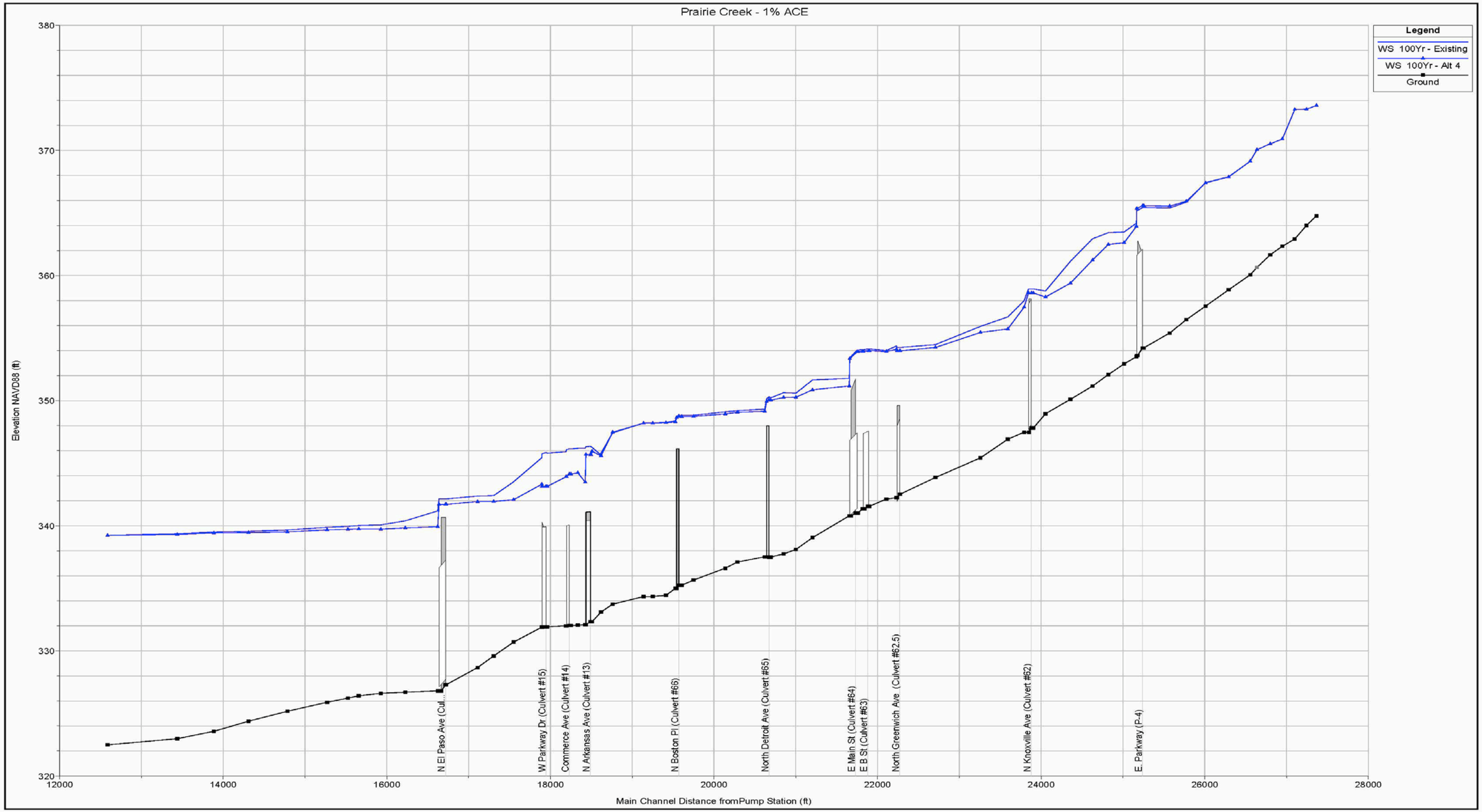

Figure 12. Prairie Creek - Alternative 4 1% ACE Water Surface Profile

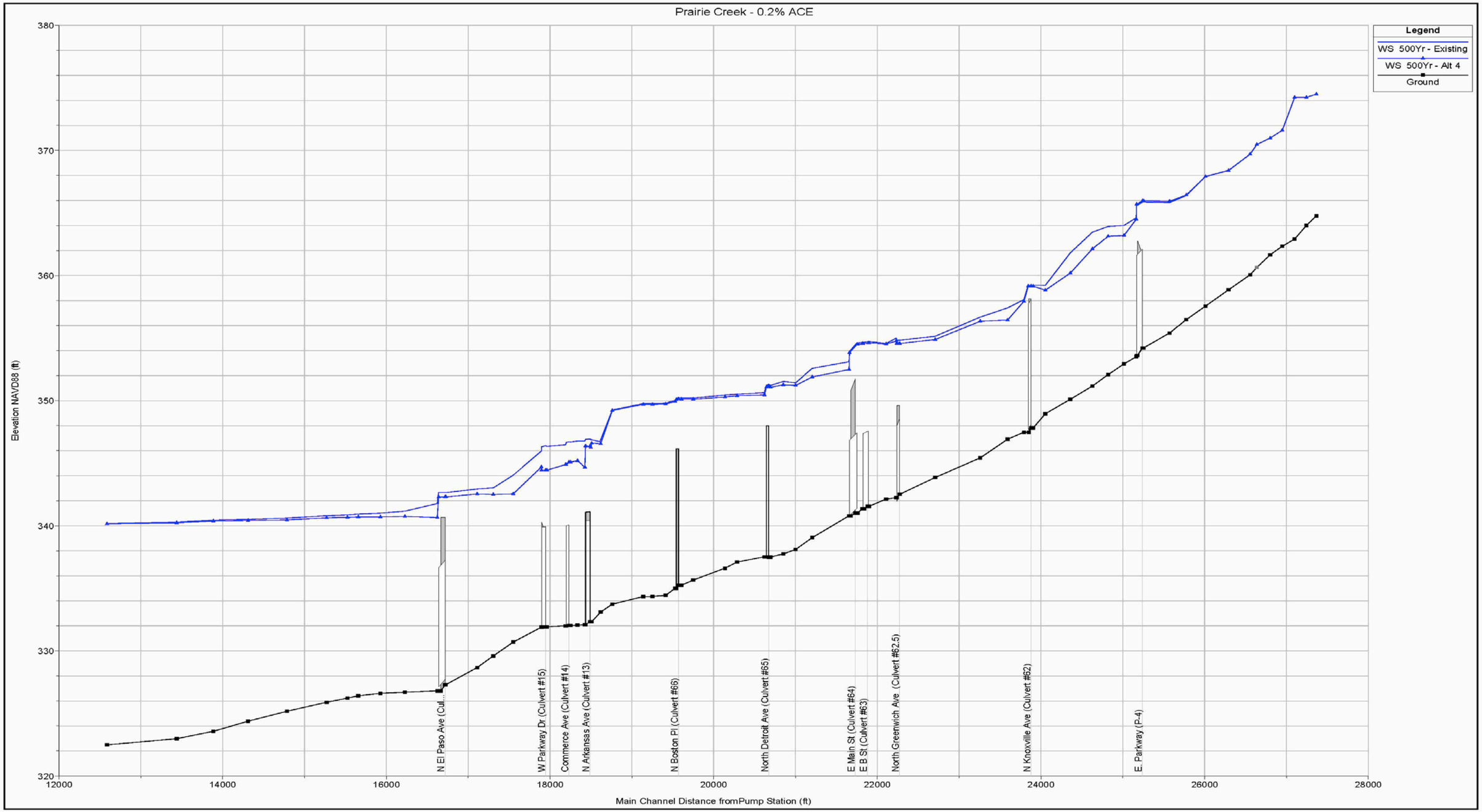

Figure 13. Prairie Creek - Alternative 4 0.2% ACE Water Surface Profile

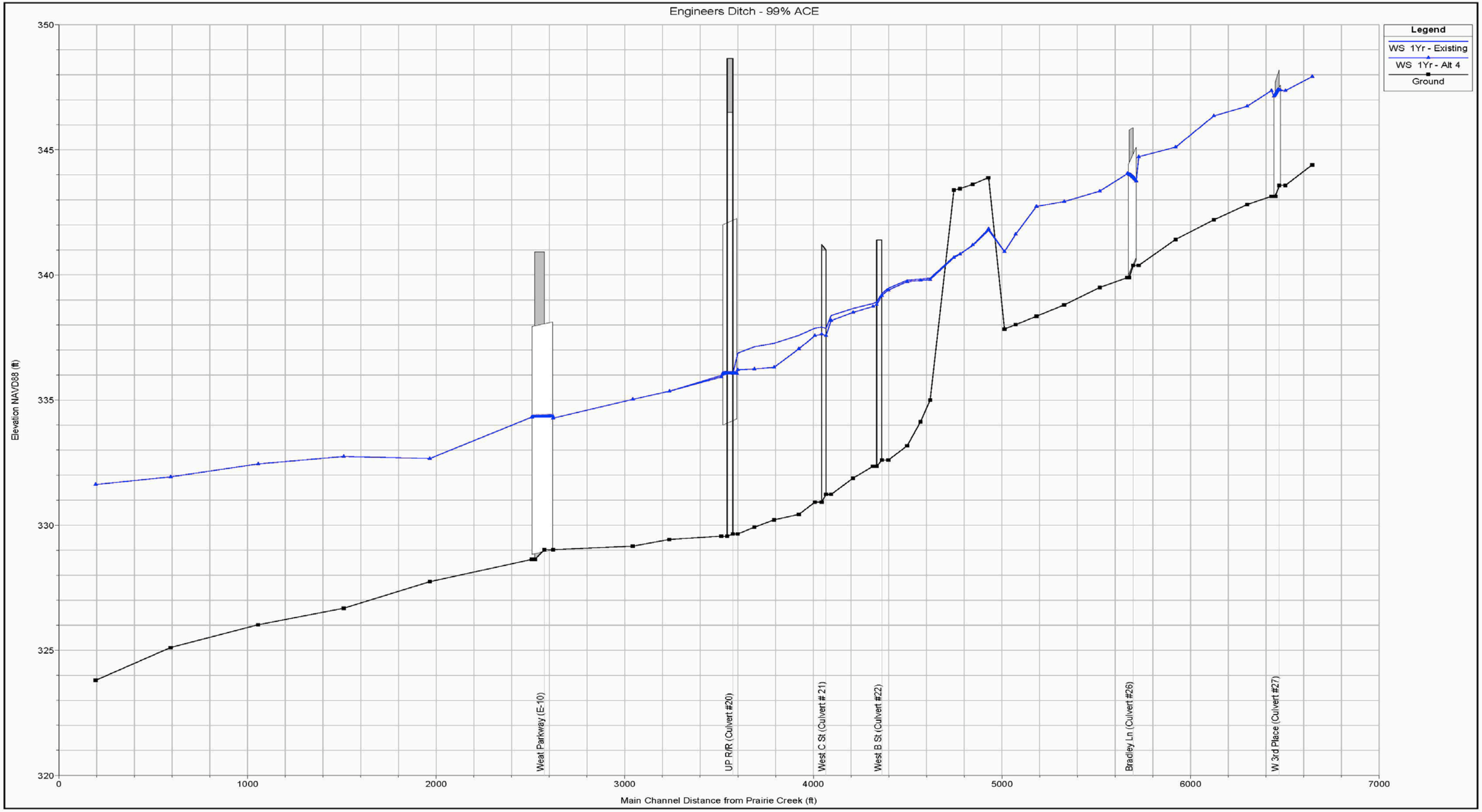

Figure 14. Engineers Ditch - Alternative 4 99% ACE Water Surface Profile

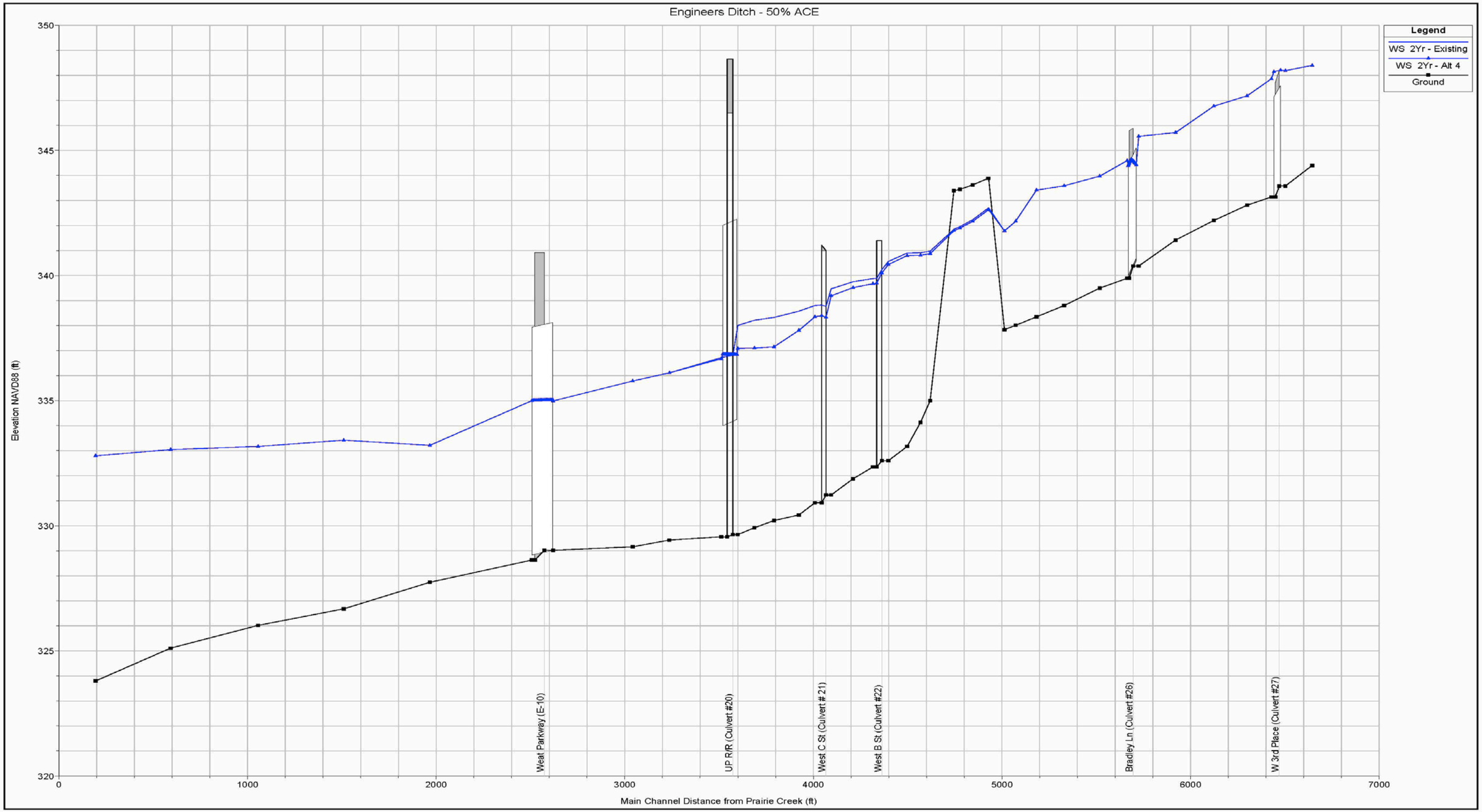

Figure 15. Engineers Ditch - Alternative 4 50% ACE Water Surface Profile

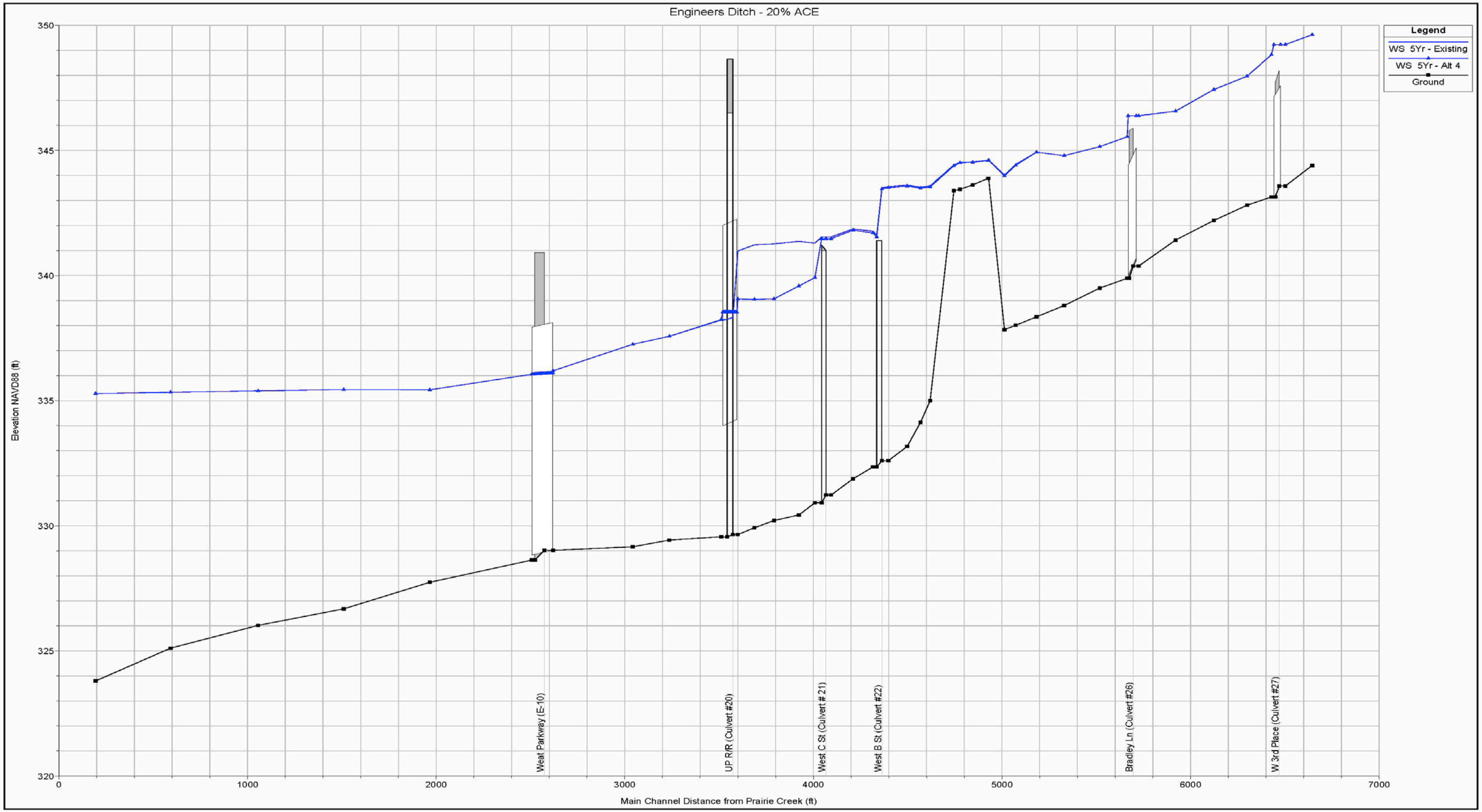

Figure 16. Engineers Ditch - Alternative 4 20% ACE Water Surface Profile

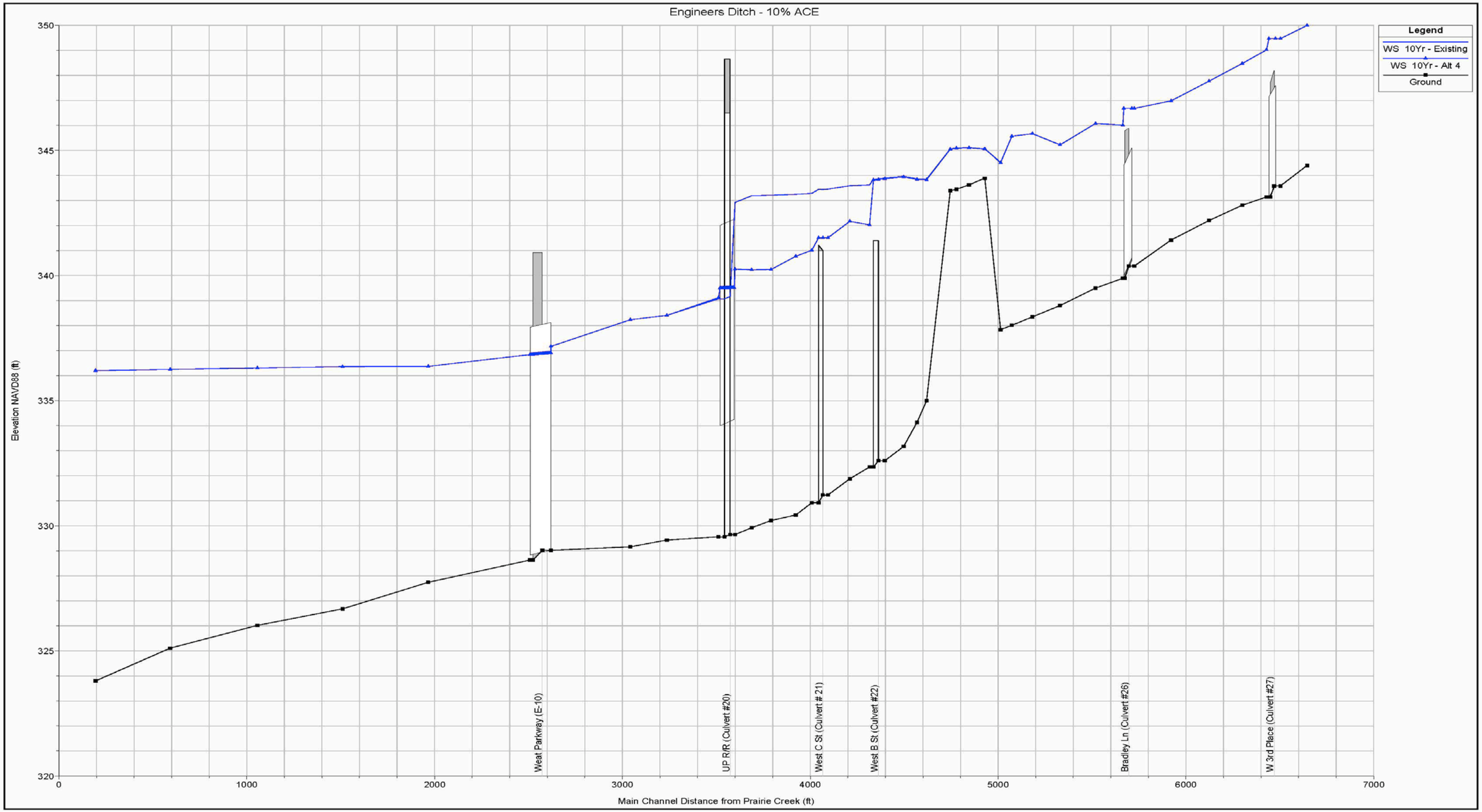

Figure 17. Engineers Ditch – Alternative 4 10% ACE Water Surface Profile

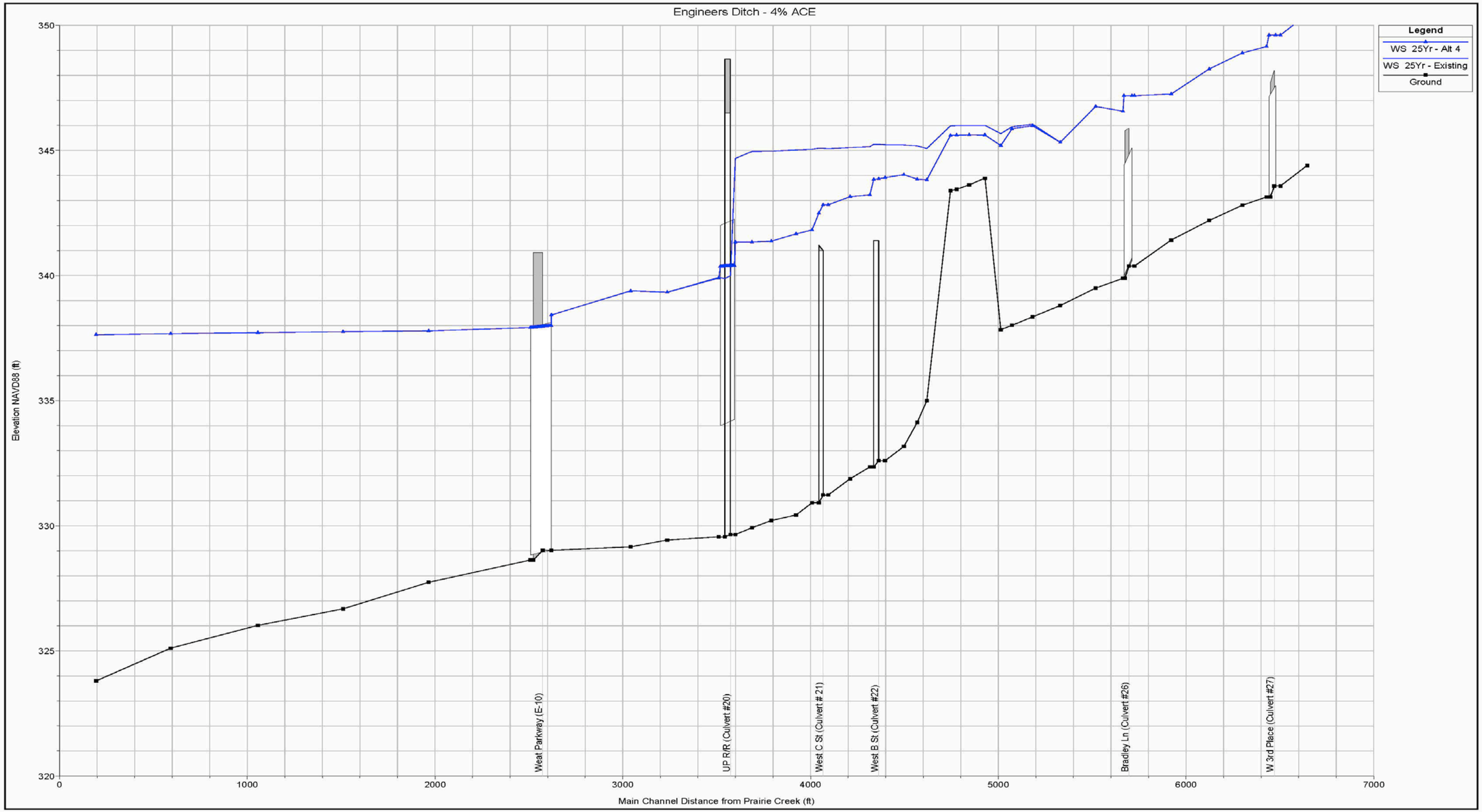

Figure 18. Engineers Ditch - Alternative 4 4% ACE Water Surface Profile

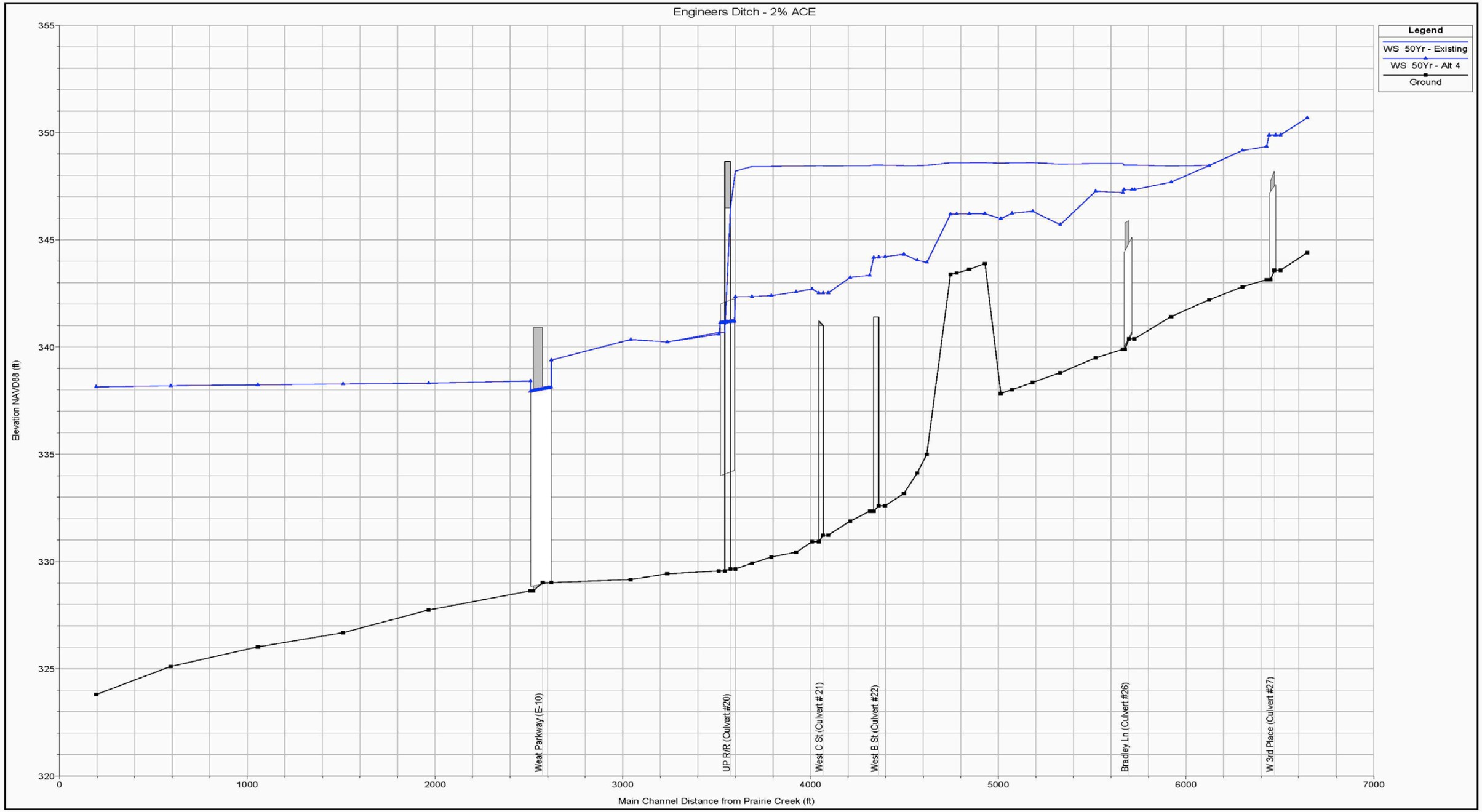

Figure 19. Engineers Ditch - Alternative 4 2% ACE Water Surface Profile

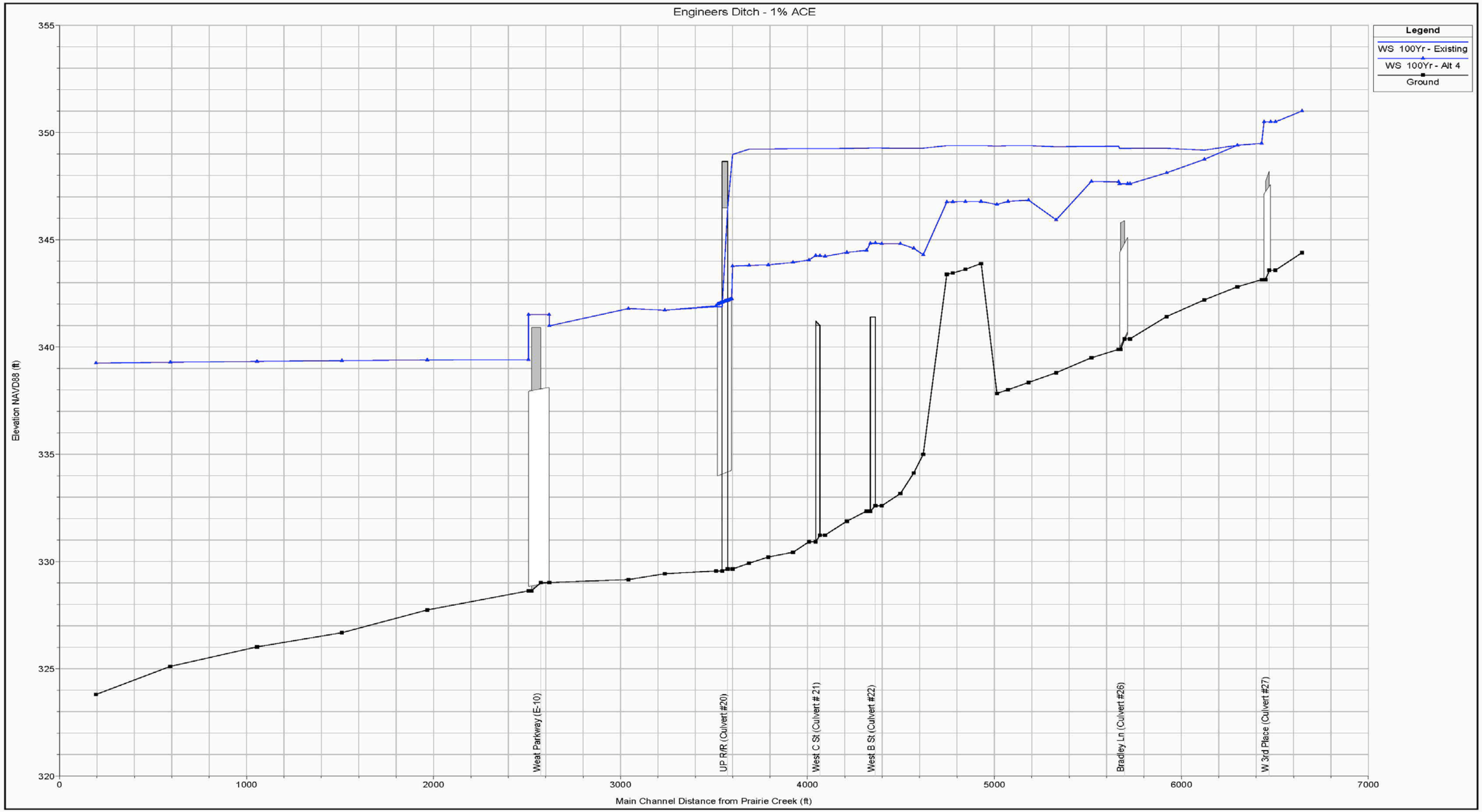

Figure 20. Engineers Ditch - Alternative 4 1% ACE Water Surface Profile

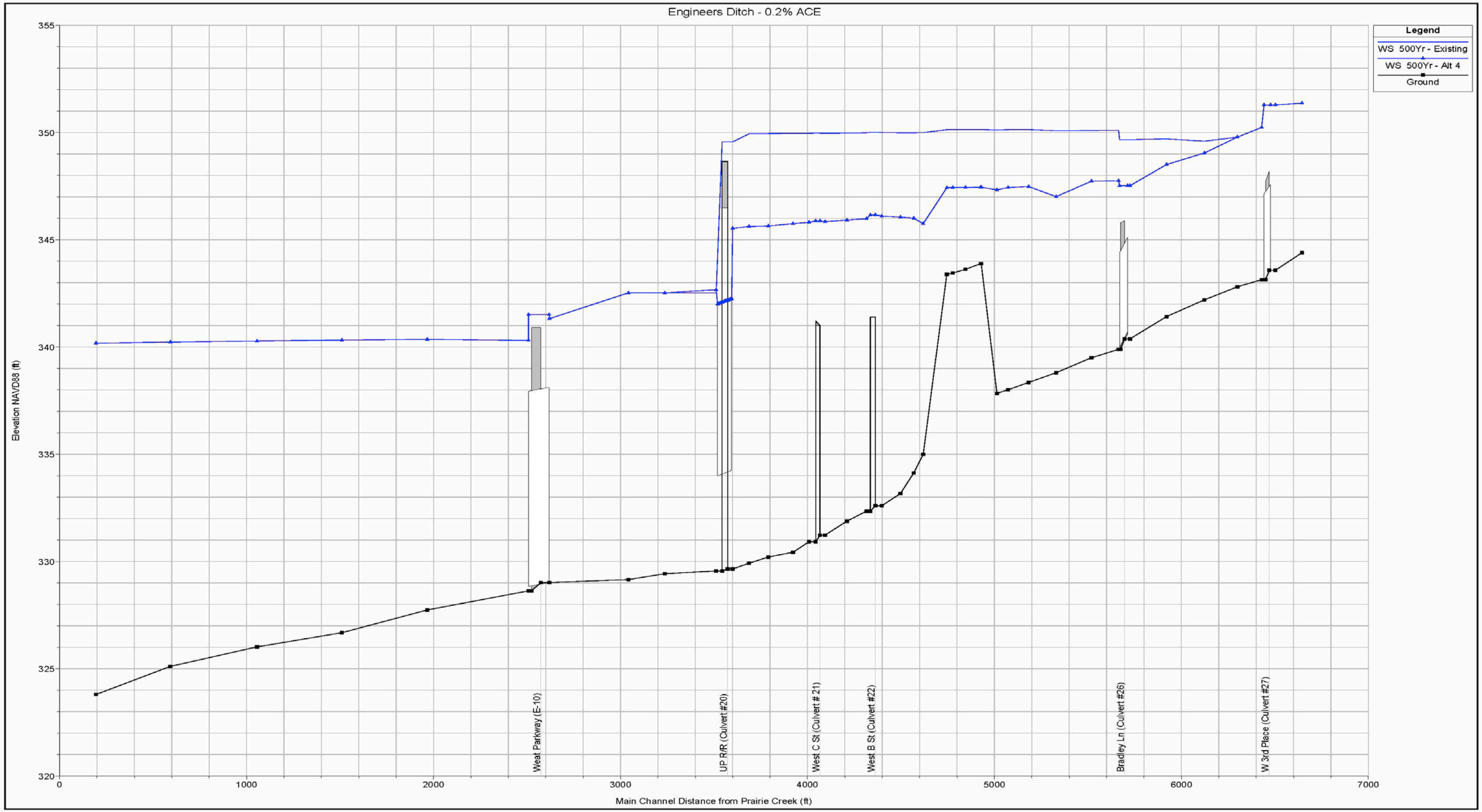

Figure 21. Engineers Ditch - Alternative 4 0.2% ACE Water Surface Profile

Attachment B

Cost Analysis,

Construction Schedule,

& MCACES Cost Estimate

Estimated by	CESWL-EC-DG
Designed by	CESWL-EC-DG
Prepared by	CESWL-EC-DG
Preparation Date	10/1/2014
Effective Date of Pricing	10/1/2014
Estimated Construction Time	730 Days

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Library Properties i

Project Notes ii

Markup Properties iii

Project Cost Summary Report 1

01 ENGINEERS DITCH - REACH 01 1

01 LANDS AND DAMAGES 1

09 CHANNELS AND CANALS 1

02 PRAIRIE CREEK - REACH 03 1

01 LANDS AND DAMAGES 1

02 RELOCATIONS 1

09 CHANNELS AND CANALS 1

03 PRAIRIE CREEK - REACH 04-05 1

01 LANDS AND DAMAGES 1

02 RELOCATIONS 1

09 CHANNELS AND CANALS 1

Library Properties
Designed by
CESWL-EC-DG
Estimated by
CESWL-EC-DG
Prepared by
CESWL-EC-DG

Design Document	CAP
Document Date	10/1/2014
District	SWL
Contact	MARTIN REGNER, 501.324.6483
Budget Year	2015
UOM System	Original

Direct Costs
LaborCost
EQCost
MatlCost
SubBidCost
Railroad
RSMeans
REP
QUOTE

Timeline/Currency

Preparation Date	10/1/2014
Escalation Date	10/1/2014
Eff. Pricing Date	10/1/2014
Estimated Duration	730 Day(s)
Currency	US dollars
Exchange Rate	1.000000

Costbook CB12EB-b: MII English Cost Book 2012-b

Labor AR 3 13: Labor Arkansas 2014 (Area 3) - Pope County
Note: RSMeans 2013 (January 2013) and WageDeterminationsOnLine.gov for Pope County (January 2014).

Labor Rates
LaborCost1
LaborCost2
LaborCost3
LaborCost4

Equipment EP11R03: MII Equipment 2011 Region 03

03 SOUTHEAST

Sales Tax	8.35
Working Hours per Year	1,530
Labor Adjustment Factor	0.86
Cost of Money	1.75
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Fuel

Electricity	0.103
Gas	3.400
Diesel Off-Road	3.290
Diesel On-Road	3.750

Shipping Rates

Over 0 CWT	15.58
Over 240 CWT	14.19
Over 300 CWT	12.14
Over 400 CWT	10.20
Over 500 CWT	6.13
Over 700 CWT	6.13
Over 800 CWT	9.25

Date	Author	Note

Project Notes
6/17/2015 12:34:05 PM REGNER

P2-102915 - PRAIRIE CREEK AND TRIBUTARIES, RUSSELLVILLE, ARKANSAS
SECTION 205, FLOOD RISK MANAGEMENT STUDY
COST ANALYSIS SUMMARY

LOCATION AND DESCRIPTION:
The study was initiated at the request of the mayor of Russellville, Arkansas, in a letter dated 12 July 2010. The authority for this study is Section 205 of the Flood Control Act of 1948 (Public Law 80-858), as amended, which permits the Corps of Engineers to undertake the investigation, design, and construction of flood control projects having a total Federal cost of less than $7 million without specific congressional action.

The flood risk management study area is located within the Arkansas River Basin, extending along main creek of Prairie Creek, including the tributary of Engineers Ditch. The City of Russellville (population 27,920 by 2010 estimate) is located approximately 80 miles West of Little Rock, Arkansas, in the southwest corner of Pope County. The project area is generally centered in the center of the city of Russellville, the non-Federal sponsor. This study area encompasses approximately a six mile reach of Prairie Creek that passes through the city as well as four and a half miles of tributaries, which includes Engineers Ditch.

The MII is developed using October 2014 Price Levels and the latest labor rates for Little Rock District areas. The feasibility estimate is one (1) contract. The contract is organized in accordance with a work breakdown structure. Midpoint dates for the construction contract are developed in conjunction with the project manager for developing the fully-funded costs. The estimate is prepared in accordance with ER 1110-2-1302 Civil Works Cost Engineering, dated 15 Sep 08. The costs are escalated in accordance with the above Engineering Regulation and EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS), dated 31 Mar 2014. All data is input into the Total Project Cost Summary (TPCS) spreadsheet.

Direct costs include a small business set-aside contract mechanism productivity of 85% and sales tax at 9.5%. The sales tax was determined from dfa.arkansas.gov (State Sales and Use Tax of 6.5%; Russellville Tax of 1.5%; and White County Tax of 1.5%). There are no Hazardous, Toxic, and Radioactive Wastes anticipated. The Operation and Maintenance estimate is dated October 2014, with an effective pricing date of October 2014.

An Abbreviated Cost Risk Analyses (ACRA) was performed by the PDT on 28 Aug 14, in coordination with Cost Engineering Directory of Expertise (DX) of the Walla Walla District (October 2014). The risks are quantified and a cost risk model developed to determine a contingency at 80% Confidence Level. An ATR Certification of Cost Estimate is provided by Walla Walla District.

ACCOUNT CODE 01 - LANDS AND DAMAGES:
This contract cost is outlined in the Real Estate Plan.

ACCOUNT CODE 02 - RELOCATIONS:
This contract is based on communication, electric, gas, sewer, and water lines and equipments identified via visual inspections of Google Earth and Bing Map satellite images and site visits, as provided by SWL-EC-DG. The quantities are approximate and based on visual observations only. No investigation for underground utilities was conducted. Risks are noted in the ACRA.

ACCOUNT CODE 09 - CHANNELS AND CANALS:
This contract is based on Engineers Ditch (Reach 01), Prairie Creek (Reach 03), and Prairie Creek (Reach 04-05). Reach 01 work is boring under an active railroad and channel diversion. Reach 03 work is demolition of West Parkway Street Bridge, Commerce Street Bridge, building, asphalt and concrete parking lots, and concrete channel walls; channel improvements and reinforcement; and installation of reinforced concrete culvert bridges at West Parkway Street and Commerce Street Bridge. Reach 04-05 work is channel improvements and riprap stockpiles and reuses (and supplements). Risks are noted in the ACRA.

ACCOUNT CODE 30 - ENGINEERING AND DESIGN:
The cost for this account are developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager. Risk are noted in the ACRA.

ACCOUNT CODE 31 - CONSTRUCTION MANAGEMENT:
The cost for this account are developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager. Risk are noted in the ACRA.

Markup Properties

Direct Cost Markups	**Category**	**Method**
PRODUCTIVITY	Productivity	Productivity
OVERTIME	Overtime	Overtime

	Days/Week	*Hours/Shift*	*Shifts/Day*	*1st Shift*	*2nd Shift*	*3rd Shift*
Standard	*5.00*	*10.00*	*1.00*	*8.00*	*0.00*	*0.00*
Actual	*5.00*	*10.00*	*1.00*	*8.00*	*0.00*	*0.00*

Day	*OT Factor*	*Working*	*OT Percent*	*FCCM Percent*
Monday	*1.50*	*Yes*	*25.00*	*0.00*
Tuesday	*1.50*	*Yes*		
Wednesday	*1.50*	*Yes*		
Thursday	*1.50*	*Yes*		
Friday	*1.50*	*Yes*		
Saturday	*1.50*	*No*		
Sunday	*2.00*	*No*		

SALES TAX	TaxAdj	Running % on Selected Costs
MatlCost		

Contractor Markups	**Category**	**Method**
JOOH	JOOH	Running %
HOOH	HOOH	Running %
PROFIT	Profit	Running %
BOND	Bond	Running %

Owner Markups	**Category**	**Method**
REP CONTINGENCY	Contingency	Running %

	Description	UOM	Quantity	ContractCost	Escalation	Contingency	ProjectCost
Project Cost Summary Report				**10,278,873**	**0**	**0**	**10,278,873**
01 ENGINEERS DITCH - REACH 01		**LS**	**1.00**	**1,409,669**	**0**	**0**	**1,409,669**
01 LANDS AND DAMAGES		**LS**	**1.00**	**270,300**	**0**	**0**	**270,300**
09 CHANNELS AND CANALS		**LS**	**1.00**	**1,139,369**	**0**	**0**	**1,139,369**
02 PRAIRIE CREEK - REACH 03		**LS**	**1.00**	**7,180,093**	**0**	**0**	**7,180,093**
01 LANDS AND DAMAGES		**LS**	**1.00**	**2,475,176**	**0**	**0**	**2,475,176**
02 RELOCATIONS		**LS**	**1.00**	**604,898**	**0**	**0**	**604,898**
09 CHANNELS AND CANALS		**LS**	**1.00**	**4,100,019**	**0**	**0**	**4,100,019**
03 PRAIRIE CREEK - REACH 04-05		**LS**	**1.00**	**1,689,112**	**0**	**0**	**1,689,112**
01 LANDS AND DAMAGES		**LS**	**1.00**	**825,059**	**0**	**0**	**825,059**
02 RELOCATIONS		**LS**	**1.00**	**357,743**	**0**	**0**	**357,743**
09 CHANNELS AND CANALS		**LS**	**1.00**	**506,310**	**0**	**0**	**506,310**

--- NEW WORK ---
P2-102915 - PRAIRIE CREEK AND TRIBUTARIES, RUSSELLVILLE, ARKANSAS
SECTION 205, FLOOD RISK MANAGEMENT STUDY
OCTOBER 2014 PRICE LEVELS
CONTRACT CALENDAR

CONTRACT	DESCRIPTION	DURATION (month)	DESIGN MIDPOINT[1]	L&D MIDPOINT[2]	START DATE[3]	MIDPOINT	END DATE
1	Reach 01: Relocations	0	Oct-16	Jul-18	Jul-19	Jun-20	Jun-21
	Reach 01: Channels	6					
	Reach 03: Relocations	1					
	Reach 03: Channels	13					
	Reach 04-05: Relocations	1					
	Reach 04-05: Channels	3	(2017Q1)	(2018Q4)	(2019Q4)	(2020Q3)	(2021Q3)

1- Milestone/Activity Schedule Dates (10 Jun 2015): Start Plans and Specifications (Oct 2015); Finish Plans and Specifications (Sep 2017
2- Milestone/Activity Schedule Dates (10 Jun 2015): Start Initiate Real Estate Acquisition (Oct 2017); Certify Real Estate Land Acquisition is Complete (Apr 2019
3- Milestone/Activity Schedule Dates (10 Jun 2015): Award Contract for Construction (July 2019)

--- NEW WORK ---
P2-102915 - PRAIRIE CREEK AND TRIBUTARIES, RUSSELLVILLE, ARKANSAS
SECTION 205, FLOOD RISK MANAGEMENT STUDY
OCTOBER 2014 PRICE LEVELS
VISUAL CALENDAR

			FY 2019 - YEAR 1												FY 2020 - YEAR 2												FY 2021 - YEAR 3											
NO.	DESCRIPTION	DURATION	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
CONT 1	Reach 01: Relocations	NA																																				
	Reach 01: Channels	6										1	2	3	4	5	6																					
	Reach 03: Relocations	1																1																				
	Reach 03: Channels	13																	1	2	3	4	5	6	7	8	9	10	11	12	13							
	Reach 04-05: Relocations	1																														1						
	Reach 04-05: Channels	3																															1	2	3			

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **PRAIRIE CREEK AND TRIBUTARIES, RUSSELLVILLE, ARKANSAS**
PROJECT NO: **P2-102915**
LOCATION: **RUSSELLVILLE, AR**

DISTRICT: **SWL LITTLE ROCK**
POC: **CHIEF, GENERAL (COST) ENGINEERING, Nicholas Barner**

PREPARED: **6/10/2015**

This Estimate reflects the scope and schedule in report; Prairie Creek Feasibility Study

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2016									
						Effective Price Level Date: 1 OCT 15									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 10/1/2014 ($K)	TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
02	RELOCATIONS	$963	$307	32%	$1,269	1.5%	$977	$311	$1,288		$1,288	8.9%	$1,064	$339	$1,402
09	CHANNELS & CANALS	$5,746	$1,831	32%	$7,576	1.5%	$5,829	$1,857	$7,686		$7,686	8.9%	$6,348	$2,023	$8,371
	CONSTRUCTION ESTIMATE TOTALS:	$6,708	$2,137		$8,846	1.5%	$6,806	$2,168	$8,974		$8,974	8.9%	$7,412	$2,361	$9,773
01	LANDS AND DAMAGES														
	Non-Federal	$3,251	$650	20%	$3,901	1.5%	$3,298	$660	$3,958		$3,958	5.2%	$3,468	$694	$4,162
	Federal	$319	$64	20%	$383	1.5%	$324	$65	$389		$389	5.2%	$341	$68	$409
30	PLANNING, ENGINEERING & DESIGN	$672	$104	15%	$776	2.3%	$687	$106	$794		$794	5.9%	$728	$113	$841
31	CONSTRUCTION MANAGEMENT	$403	$54	13%	$457	2.3%	$412	$55	$467		$467	18.9%	$490	$66	$556
	PROJECT COST TOTALS:	$11,354	$3,009	27%	$14,363		$11,528	$3,054	$14,582		**$14,582**	7.9%	$12,439	$3,301	$15,740

ESTIMATED TOTAL PROJECT COST:		**$15,740**
ESTIMATED FEDERAL COST:	65%	$10,231
ESTIMATED NON-FEDERAL COST:	35%	$5,509
22 - FEASIBILITY STUDY (CAP studies):		**$350**
ESTIMATED FEDERAL COST:		$225
ESTIMATED NON-FEDERAL COST:		$125
ESTIMATED FEDERAL COST OF PROJECT		**$10,456**

_____ CHIEF, GENERAL (COST) ENGINEERING, Nicholas Barner

_____ PROJECT MANAGER, Julia Smethurst

_____ CHIEF, REAL ESTATE, Donald Balch

_____ CHIEF, PLANNING, Patricia Anslow

_____ CHIEF, ENGINEERING, Martin Hammer

_____ CHIEF, OPERATIONS, Kevin McDaniels

_____ CHIEF, CONSTRUCTION, DeJuan Carter

_____ CHIEF, CONTRACTING, Sandra Easter

_____ CHIEF, PM-PB, Craig Pierce

_____ CHIEF, DPM, Randy Hathaway

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: PRAIRIE CREEK AND TRIBUTARIES, RUSSELLVILLE, ARKANSAS
LOCATION: RUSSELLVILLE, AR
This Estimate reflects the scope and schedule in report; Prairie Creek Feasibility Study

DISTRICT: SWL LITTLE ROCK
POC: CHIEF, GENERAL (COST) ENGINEERING, Nicholas Barner
PREPARED: 6/10/2015

Estimate Prepared: 10/1/2014
Effective Price Level: 10/1/2014

Program Year (Budget EC): 2016
Effective Price Level Date: 1 OCT 15

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
02	RELOCATIONS	$963	$307	31.9%	$1,269	1.5%	$977	$311	$1,288	2020Q3	8.9%	$1,064	$339	$1,402
09	CHANNELS & CANALS	$5,746	$1,831	31.9%	$7,576	1.5%	$5,829	$1,857	$7,686	2020Q3	8.9%	$6,348	$2,023	$8,371
	CONSTRUCTION ESTIMATE TOTALS:	$6,708	$2,137	31.9%	**$8,846**		$6,806	$2,168	$8,974			$7,412	$2,361	$9,773
01	LANDS AND DAMAGES													
01	Non-Federal	$3,251	$650	20.0%	$3,901	1.5%	$3,298	$660	$3,958	2018Q4	5.2%	$3,468	$694	$4,162
01	Federal	$319	$64	20.0%	$383	1.5%	$324	$65	$389	2018Q4	5.2%	$341	$68	$409
30	PLANNING, ENGINEERING & DESIGN													
0.50%	Project Management	$34	$5	15.5%	$39	2.3%	$35	$5	$40	2017Q1	3.6%	$36	$6	$42
1.00%	Planning & Environmental Compliance	$67	$10	15.5%	$77	2.3%	$69	$11	$79	2017Q1	3.6%	$71	$11	$82
5.50%	Engineering & Design	$369	$57	15.5%	$426	2.3%	$377	$58	$436	2017Q1	3.6%	$391	$60	$452
0.70%	Engineering Tech Review ITR & VE	$47	$7	15.5%	$54	2.3%	$48	$7	$56	2017Q1	3.6%	$50	$8	$58
0.80%	Contracting & Reprographics	$54	$8	15.5%	$62	2.3%	$55	$9	$64	2017Q1	3.6%	$57	$9	$66
1.50%	Engineering During Construction	$101	$16	15.5%	$117	2.3%	$103	$16	$119	2020Q3	18.9%	$123	$19	$142
	Planning During Construction													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
5.00%	Construction Management	$335	$45	13.4%	$380	2.3%	$343	$46	$389	2020Q3	18.9%	$407	$54	$462
0.50%	Project Operation:	$34	$5	13.4%	$39	2.3%	$35	$5	$39	2020Q3	18.9%	$41	$6	$47
0.50%	Project Management	$34	$5	13.4%	$39	2.3%	$35	$5	$39	2020Q3	18.9%	$41	$6	$47
	CONTRACT COST TOTALS:	$11,354	$3,009		**$14,363**		$11,528	$3,054	$14,582			$12,439	$3,301	**$15,740**

Attachment C

Cost and Schedule Risk Analysis

Abbreviated Risk Analysis

P2-102915 - Prairie Creek and Tributaries, Russellville, Arkansas
Feasibility (Recommended Plan)

Meeting Date: 28-Aug-14

PDT Members

Note: PDT involvement is commensurate with project size and involvement.

Project Management:	Nancy Haseley
Planner:	Nancy Haseley
Study Manager:	Nancy Haseley
Economics:	Cherilyn Plaxco
Real Estate:	Pat Bennett; Ronald Bridges; Michael Fuchs
Engineering Lead:	Aaron Cole (Design Coordinator)
Hydrology & Hydraulics:	Gabriel Knight
Cost Engineering:	Martin Regner
Construction:	Deborah Chapman
Contracting:	Martin Regner (as COR)

Abbreviated Risk Analysis

Project Name & Location: **P2-102915 - Prairie Creek and Tributaries, Russellville, Arkan**
Project Development Stage/Alternative: **Feasibility (Recommended Plan)**
Risk Category: **Moderate Risk: Typical Project Construction Type**

District: **SWL**
Alternative: **4**
Meeting Date: **8/28/2014**

Total Estimated Construction Contract Cost = **$ 6,708,339**

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	**$ 3,570,534**		**20.00%**	$ 714,107	$ 4,284,641
1	**02 03 CEMETERIES, UTILITIES, AND STRUCTURES, Construction Activities**	**Relocations: Engineers Ditch**	**$ -**		0.00%	$ -	$ -
2	**02 03 CEMETERIES, UTILITIES, AND STRUCTURES, Construction Activities**	**Relocations: Reach 03**	**$ 604,898**		23.07%	$ 139,579	$ 744,477
3	**02 03 CEMETERIES, UTILITIES, AND STRUCTURES, Construction Activities**	**Relocations: Reach 04-05**	**$ 357,743**		23.07%	$ 82,548	$ 440,292
4	**09 01 CHANNELS**	**Channel Improvements: Engineers Ditch**	**$ 1,139,369**		53.67%	$ 611,482	$ 1,750,851
5	**09 01 CHANNELS**	**Channel Improvements: Reach 03**	**$ 4,100,019**		30.11%	$ 1,234,718	$ 5,334,738
6	**09 01 CHANNELS**	**Channel Improvements: Reach 04-05**	**$ 506,310**		23.59%	$ 119,455	$ 625,765
7			**$ -**		0.00%	$ -	$ -
8			**$ -**		0.00%	$ -	$ -
9			**$ -**		0.00%	$ -	$ -
10			**$ -**		0.00%	$ -	$ -
11			**$ -**		0.00%	$ -	$ -
12	All Other (less than 10% of construction costs)	**Remaining Construction Items**	**$ -**	*0.0%*	0.00%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	**$ 670,834**		15.46%	$ 103,718	$ 774,552
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	**$ 402,500**		13.37%	$ 53,813	$ 456,314
XX	FIXED DOLLAR RISK ADD (EQUALLY DISPERSED TO ALL, MUST INCLUDE JUSTIFICATION SEE BELOW)					**$ -**	

Totals					
Real Estate	$ 3,570,534	20.00%	$ 714,107	$ 4,284,640.80
Total Construction Estimate	$ 6,708,339	32.61%	$ 2,187,783	$ 8,896,122
Total Planning, Engineering & Design	$ 670,834	15.46%	$ 103,718	$ 774,552
Total Construction Management	$ 402,500	13.37%	$ 53,813	$ 456,314
Total	**$ 11,352,208**	**27%**	**$ 3,059,421**	**$ 14,411,628**
		Base	**50%**	**80%**
	Range Estimate ($000's)	$11,352k	$13,188k	$14,412k

* 50% based on base is at 50% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

P2-102915 - Prairie Creek and Tributaries, Russellville, Arkan

Feasibility (Recommended Plan)

Abbreviated Risk Analysis

Meeting Date: 28-Aug-14

Risk Level

	Negligible	Marginal	Moderate	Significant	Critical
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Register

Risk Element	Feature of Work	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Impact	Likelihood	Risk Level
Project Scope Growth				**Maximum Project Growth**		**60%**
PS-1	Relocations: Engineers Ditch	* Potential for scope growth, added features and quantities.	* Pipeline (communications, gas, electric, sewer, water and/or unidentified) relocations would have a marginal impact but are not anticipated.	Negligible	Unlikely	0
PS-2	Relocations: Reach 03	* Potential for scope growth, added features and quantities.	* Pipeline (communications, gas, electric, sewer, water and/or unidentified) quantities are approximate and based on visual observations. No underground communication and/or electrical lines are quantified. Additional relocations are anticipated and would cause a moderate impact.	Moderate	Likely	3
PS-3	Relocations: Reach 04-05	* Potential for scope growth, added features and quantities.	* Pipeline (communications, gas, electric, sewer, water and/or unidentified) quantities are approximate and based on visual observations. No underground communication and/or electrical lines are quantified. Additional relocations are anticipated and would cause a moderate impact.	Moderate	Likely	3
PS-4	Channel Improvements: Engineers Ditch	* Potential for scope growth, added features and quantities. * Investigations not sufficient to support design assumptions. * Design of culverts under railroad need further analysis. * Plan for care of water not analyzed.	* Channelization requires significant clearing and grubbing. Tree replacement and temporary watering are not included. A need for tree replacement plan could increase project scope; the likelihood is unknown. * Soil characterization has not been conducted through channel and/or diversion channel; material may not be adequate for channelization and anticipated water velocities. The need for select fill material is not likely; however, to haul in select fill material would be a significant impact. Hard rock is not anticipated; however, unearthing a significant amount of hard rock would reduce productivity. * Erosion plan not created for diversion channel. Project subject to marginal impacts due to changes in pumping requirements, creek crossings, temporary culverts, etc. * With limited LIDAR data, 8FT RCPs may not fit under the railroad; however, technical experts are not concerned from a technical standpoint as smaller culverts can be used. Concern is with the railroad not allowing a six-foot cover; this is a moderate impact since installing a new railroad and/or adding additional, smaller culverts would be costly. Uncertainty with the railroad is found within External Project Risks.	Moderate	Likely	3
PS-5	Channel Improvements: Reach 03	* Potential for scope growth, added features and quantities. * Investigations not sufficient to support design assumptions. * Plan for care of water not analyzed.	* Channelization requires significant clearing and grubbing. Tree replacement and temporary watering are not included. A need for tree replacement plan could increase project scope; the likelihood is unknown. * Soil characterization has not been conducted through channel; material may not be adequate for channelization and anticipated water velocities. The need for select fill material is not likely; however, to haul in select fill material would be a significant impact. Hard rock is not anticipated; however, unearthing a significant amount of hard rock would reduce productivity. * Erosion plan not created for channel. Project subject to marginal impacts due to changes in pumping requirements, creek crossings, temporary culverts, etc. * Relief wells and/or underground drainage tied into proposed concrete work (walls and bottom) not considered. Relief wells could add a considerable cost. * With limited LIDAR data, proposed channelization work around West Parkway Street Bridge, Commerce Street Bridge, and North Arkansas Avenue could result in additional structure demolition and/or conflicts with existing infrastructure, e.g. underground utilities, foundations, etc. This is likely and of moderate impact. LIDAR data are considered good enough for estimate purposes. New survey data are required during PED. * Identification of all sub-inputs (storm sewer, side channels, etc.) has not be conducted. Major inputs could require additional channel reinforcement.	Moderate	Likely	3

PS-6	Channel Improvements: Reach 04-05	* Potential for scope growth, added features and quantities. * Investigations not sufficient to support design assumptions. * Plan for care of water not analyzed.	* Channelization requires significant clearing and grubbing. Tree replacement and temporary watering are not included. A need for tree replacement plan could increase project scope; the likelihood is unknown. * Soil characterization has not been conducted through channel; material may not be adequate for channelization and anticipated water velocities. The need for select fill material is not likely; however, to haul in select fill material would be a significant impact. Hard rock is not anticipated; however, unearthing a significant amount of hard rock would reduce productivity. * Erosion plan not created for channel. Project subject to marginal impacts due to changes in pumping requirements, creek crossings, temporary culverts, etc. * Identification of all sub-inputs (storm sewer, side channels, etc.) has not be conducted. Major inputs could require additional channel reinforcement.	Marginal	Likely	2
PS-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
PS-13	Planning, Engineering, & Design	* Design is at 10-15% and subject to scope growth.	* Resources have been insufficient to adequately conduct research during the feasibility stage, i.e. 10-15% design confidence. As a result, project scope growth (and changes as more data become available) will lead to increased labor in design plan and development.	Marginal	Possible	1
PS-14	Construction Management	* Potential for scope growth, added features and quantities during construction due to differing site conditions.	* Unknown underground utilities could be unearthed, requiring relocation, tapping, and/or possible design re-work and management. Cultural resources are not anticipated as Environmental Assessment notes all proposed construction areas are previously disturbed.	Marginal	Possible	1
Acquisition Strategy				**Maximum Project Growth**		**40%**
AS-1	Relocations: Engineers Ditch	* Challenges with acquiring land easements	* No relocations anticipated/identified within Engineers Ditch.	Negligible	Unlikely	0
AS-2	Relocations: Reach 03	* Challenges with acquiring land easements	* It is likely work will be performed by an 8A or small business. This is the assumption. * It is likely an 8A or small business prime contractor would subcontract with a large business. 8A or small business prime contractor to large business subcontractor hiearchy would reduce project efficiency and increase total project costs. This is the assumption. * If numerous separate 8A or small business contracts are acquired, then duplicate requirements may be realized, e.g. Supervision, Security, Safety, QC, etc. In addition, conflicts between work reaches could be realized, which would likely result in a marginal impact. The assumption is one contract.	Negligible	Possible	0
AS-3	Relocations: Reach 04-05	* Challenges with acquiring land easements	* It is likely work will be performed by an 8A or small business. This is the assumption. * It is likely an 8A or small business prime contractor would subcontract with a large business. 8A or small business prime contractor to large business subcontractor hiearchy would reduce project efficiency and increase total project costs. This is the assumption. * If numerous separate 8A or small business contracts are acquired, then duplicate requirements may be realized, e.g. Supervision, Security, Safety, QC, etc. In addition, conflicts between work reaches could be realized, which would likely result in a marginal impact. The assumption is one contract.	Negligible	Possible	0
AS-4	Channel Improvements: Engineers Ditch	* Contracting mechanism is not established * Limited bid competition is not anticipated	* It is likely work will be performed by an 8A or small business. This is the assumption. * It is likely an 8A or small business prime contractor would subcontract with a large business. For example, it is not anticipated that a small business has the experience and capability to bore two 8FT RCPs beneath an active railroad. 8A or small business prime contractor to large business subcontractor hiearchy would reduce project efficiency and increase total project costs. This is the assumption. * If numerous separate 8A or small business contracts are acquired, then duplicate requirements may be realized, e.g. Supervision, Security, Safety, QC, etc. In addition, conflicts between work reaches could be realized, which would likely result in a marginal impact. The assumption is one contract.	Negligible	Possible	0
AS-5	Channel Improvements: Reach 03	* Contracting mechanism is not established * Limited bid competition is not anticipated	* It is likely work will be performed by an 8A or small business. This is the assumption. * It is likely an 8A or small business prime contractor would subcontract with a large business. 8A or small business prime contractor to large business subcontractor hiearchy would reduce project efficiency and increase total project costs. This is the assumption. * If numerous separate 8A or small business contracts are acquired, then duplicate requirements may be realized, e.g. Supervision, Security, Safety, QC, etc. In addition, conflicts between work reaches could be realized, which would likely result in a marginal impact. The assumption is one contract.	Negligible	Possible	0

AS-6	Channel Improvements: Reach 04-05	* Contracting mechanism is not established * Limited bid competition is not anticipated	* It is likely work will be performed by an 8A or small business. This is the assumption. * It is likely an 8A or small business prime contractor would subcontract with a large business. 8A or small business prime contractor to large business subcontractor hiearchy would reduce project efficiency and increase total project costs. This is the assumption. * If numerous separate 8A or small business contracts are acquired, then duplicate requirements may be realized, e.g. Supervision, Security, Safety, QC, etc. In addition, conflicts between work reaches could be realized, which would likely result in a marginal impact. The assumption is one contract.	Negligible	Possible	0
AS-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
AS-13	Planning, Engineering, & Design	* Contracting mechanism is not established	* Unless acquisition strategies switch midstream, e.g. multiple small contracts versus one large contact, costs for PED are not anticipated to change. A move to multiple 8A or small business contracts would result in a moderate increases to PED costs, i.e. separate solicitation packages. * The Non-federal Sponsor (City of Russellville) does not know federal relocation project policies. The Non-federal Sponsor shall lead the relocation effort but could baulk. This may lead to an increase in federal effort.	Marginal	Possible	1
AS-14	Construction Management	* Increased oversight of 8A or small business prime contractor	* An 8A or small business prime contractor will likley require greater Government oversight. The impact is negligible but likely.	Negligible	Likely	1
Construction Elements				**Maximum Project Growth**		**30%**
CON-1	Relocations: Engineers Ditch	* No construction element risks anticipated	* No construction element risks anticipated. Relocations are not identified in this reach.	Negligible	Unlikely	0
CON-2	Relocations: Reach 03	* No construction element risks anticipated	* No construction element risks anticipated; however, delays could be realized due to correspondence and availability windows with utility companies.	Negligible	Possible	0
CON-3	Relocations: Reach 04-05	* No construction element risks anticipated	* No construction element risks anticipated; however, delays could be realized due to correspondence and availability windows with utility companies.	Negligible	Possible	0
CON-4	Channel Improvements: Engineers Ditch	* An above average rainy year is possible. * Construction obstacles could reduce productivity. * Boring 8FT under a railroad could produce challenges given the low cover between top of culvert and railroad.	* An above average rainy year could result in construction expenditure increases, e.g. changes in quantities (erosion/shoaling) due to storms during construction. The proposed construction area will possibly flood. * Any changes in quantities due to severe flooding after construction are handled in OM. * Overhead electrical wires not considered. Significant overhead obstacles could reduce productivity. * Shifts in foundation of railroad during bore could cause significant impacts.	Significant	Possible	3
CON-5	Channel Improvements: Reach 03	* An above average rainy year is possible. * Construction obstacles could reduce productivity.	* An above average rainy year could result in construction expenditure increases, e.g. changes in quantities (erosion/shoaling) due to storms during construction. The proposed construction area will possibly flood. * Any changes in quantities due to severe flooding after construction are handled in OM. * Overhead electrical wires not considered. Significant overhead obstacles could reduce productivity.	Moderate	Possible	2
CON-6	Channel Improvements: Reach 04-05	* An above average rainy year is possible. * Construction obstacles could reduce productivity.	* An above average rainy year could result in construction expenditure increases, e.g. changes in quantities (erosion/shoaling) due to storms during construction. The proposed construction area will possibly flood. * Any changes in quantities due to severe flooding after construction are handled in OM. * Overhead electrical wires not considered. Significant overhead obstacles could reduce productivity.	Moderate	Possible	2
CON-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
CON-13	Planning, Engineering, & Design	* Construction modifications are anticipated as part of work.	* Construction modifications are anticipated as part of normal work, i.e. changes in earthwork material and quantities.	Marginal	Possible	1

CON-14	Construction Management	* Construction modifications are anticipated as part of work.	* Construction modifications are anticipated as part of normal work, i.e. changes in earthwork material and quantities.	Marginal	Possible	1
Quantities for Current Scope					**Maximum Project Growth**	**20%**
Q-1	Relocations: Engineers Ditch	* Quantities based on Google Earth and Bing Map satellite images; site visit. * Additional investigations are needed, e.g. above ground and below ground.	* Pipeline (communications, gas, electric, sewer, water and/or unidentified) relocations would have a marginal impact but are not anticipated.	Negligible	Unlikely	0
Q-2	Relocations: Reach 03	* Quantities based on Google Earth and Bing Map satellite images; site visit. * Additional investigations are needed, e.g. above ground and below ground.	* This risk is covered under Project Scope Growth	Negligible	Unlikely	0
Q-3	Relocations: Reach 04-05	* Quantities based on Google Earth and Bing Map satellite images; site visit. * Additional investigations are needed, e.g. above ground and below ground.	* This risk is covered under Project Scope Growth	Negligible	Unlikely	0
Q-4	Channel Improvements: Engineers Ditch	* Quantities based on Google Earth and Bing Map satellite images; site visit. Quantities are neatline. * Additional investigations are needed, e.g. survey, geotechnical, etc.	* Excavation quantities are based on LIDAR. The LIDAR data is not detailed, i.e. quantities are neatline (do not include contingencies) and based on a typical cross section and fill/cut assumption, resulting in plus/minus errors in quantities. * Electrical quantities are based on Google Earth and Bing Map satellite images. Quantities are based on visible utilities; underground utilities were not quantified. * Diversion channel will be to the west; however, the exact path of the diversion channel (and typical cut section) are not available at this stage. * Temporary access road is a possible issue since the land is currently for sale.	Moderate	Likely	3
Q-5	Channel Improvements: Reach 03	* Quantities based on Google Earth and Bing Map satellite images; site visit. Quantities are neatline. * Additional investigations are needed, e.g. survey, geotechnical, etc.	* Excavation quantities are based on LIDAR. The LIDAR data is not detailed, i.e. quantities are neatline (do not include contingencies) and based on a typical cross section and fill/cut assumption, resulting in plus/minus errors in quantities. * Electrical quantities are based on Google Earth and Bing Map satellite images. Quantities are based on visible utilities; underground utilities were not quantified.	Moderate	Possible	2
Q-6	Channel Improvements: Reach 04-05	* Quantities based on Google Earth and Bing Map satellite images; site visit. Quantities are neatline. * Additional investigations are needed, e.g. survey, geotechnical, etc.	* Excavation quantities are based on LIDAR. The LIDAR data is not detailed, i.e. quantities are neatline (do not include contingencies) and based on a typical cross section and fill/cut assumption, resulting in plus/minus errors in quantities. * Electrical quantities are based on Google Earth and Bing Map satellite images. Quantities are based on visible utilities; underground utilities were not quantified.	Moderate	Possible	2
Q-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
Q-13	Planning, Engineering, & Design	* Potential for modifications due to changes in quantities	* There is a marginal impact should quantities need to be revisted due to over/under runs. Construction Manager will need to verify. This is covered under Construction Elements. * No QC of feasibility quantities at this stage.	Negligible	Unlikely	0
Q-14	Construction Management	* Potential for modifications due to changes in quantities	* There is a marginal impact should quantities need to be revisted due to over/under runs. Construction Manager will need to verify. This is covered under Construction Elements.	Negligible	Unlikely	0
Specialty Fabrication or Equipment					**Maximum Project Growth**	**75%**
FE-1	Relocations: Engineers Ditch	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
FE-2	Relocations: Reach 03	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
FE-3	Relocations: Reach 04-05	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
FE-4	Channel Improvements: Engineers Ditch	* Not anticipated	* Not anticipated. 2- 8FT RCPs covered under Project Scope Growth.	Negligible	Unlikely	0

FE-5	Channel Improvements: Reach 03	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
FE-6	Channel Improvements: Reach 04-05	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
FE-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
FE-13	Planning, Engineering, & Design	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
FE-14	Construction Management	* Not anticipated	* Not anticipated	Negligible	Unlikely	0
Cost Estimate Assumptions				**Maximum Project Growth**		**35%**
EST-1	Relocations: Engineers Ditch	* No cost estimate assumption risks	* Concern that there could be relocations that have not been identified, as noted in Project Scope Growth.	Negligible	Unlikely	0
EST-2	Relocations: Reach 03	* Assumed haul/source	* Assumed haul route 8-10 miles for select underfill and/or haul away. Number of pipelines, crossings, and/or channel parallel runs estimated. Impact could be marginal.	Marginal	Possible	1
EST-3	Relocations: Reach 04-05	* Assumed haul/source	* Assumed haul route 8-10 miles for select underfill and/or haul away. Number of pipelines, crossings, and/or channel parallel runs estimated. Impact could be marginal.	Marginal	Possible	1
EST-4	Channel Improvements: Engineers Ditch	* Lack confidence in 8FT bore under railroad * Assumed haul/source	* Do not think an 8FT bore is possible in this area due to topography and cover requirement from top of culvert to railroad. The LIDAR data is poor, and the railroad must remain active. It seems reasonable to move from 2- 8FT RCPs to multiple, smaller RCPs. This is captured in Project Scope Growth. Project estimate assumes conservative 2- 8FT RCPs. * Assumed haul route 8-10 miles for haul away.	Moderate	Possible	2
EST-5	Channel Improvements: Reach 03	* Lack confidence in structural erosion measures * Assumed haul/source	* No structural erosion measures proposed along the channel where bridges and/or other structures cross/adjacent. Assumptions made in various locations, e.g. stockpile and replace (and supplement) riprap, based on Google Maps. This is not inclusive of all structures. * Assumed haul route 8-10 miles for haul away.	Marginal	Likely	2
EST-6	Channel Improvements: Reach 04-05	* Lack confidence in structural erosion measures * Assumed haul/source	* No structural erosion measures proposed along the channel where bridges and/or other structures cross/adjacent. Assumptions made in various locations, e.g. stockpile and replace (and supplement) riprap, based on Google Maps. This is not inclusive of all structures. * Assumed haul route 8-10 miles for haul away.	Marginal	Likely	2
EST-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
EST-13	Planning, Engineering, & Design	* Changes in construction method	* Changes to 8FT bore not likley to impact PED costs, i.e. costs will be calculated regardless of method. Costs will be impacted if additional screening is required to determine an alternate, best construction method. * Construction start date is estimated via verbal exchanges, i.e. an updated P2 schedule does not exist. Construction schedule is based primarily on excavation productivities and other tasks.	Marginal	Possible	1
EST-14	Construction Management	* Changes in construction method	* Changes to 8FT bore not likley to impact PED costs, i.e. costs will be calculated regardless of method. Costs will be impacted if additional screening is required to determine an alternate, best construction method.	Marginal	Possible	1
External Project Risks				**Maximum Project Growth**		**40%**

EX-1	Relocations: Engineers Ditch	* Political issues and lack of support	* The public works director resigned in August 2014. A new public works director may shift City of Russellville priorities. The Sponsor shares may become a critical constraint and cost share delayed. No work anticipated for this reach. * New Mayor anticipated January 2015. It is likely the new Mayor will not be familiar with Fed PL 91-646.	Negligible	Unlikely	0
EX-2	Relocations: Reach 03	* Political issues and lack of support	* The public works director resigned in August 2014. A new public works director may shift City of Russellville priorities. The Sponsor shares may become a critical constraint and cost share delayed. * New Mayor anticipated January 2015. It is likely the new Mayor will not be familiar with Fed PL 91-646. * Project is likely to experience delays in acquiring land easements due to land owner concerns. This is a possible, moderate impact. * The Non-federal Sponsor (City of Russellville) does not know federal relocation project policies. The Non-federal Sponsor shall lead the relocation effort but could baulk.	Moderate	Possible	2
EX-3	Relocations: Reach 04-05	* Political issues and lack of support	* The public works director resigned in August 2014. A new public works director may shift City of Russellville priorities. The Sponsor shares may become a critical constraint and cost share delayed. * New Mayor anticipated January 2015. It is likely the new Mayor will not be familiar with Fed PL 91-646. * Project is likely to experience delays in acquiring land easements due to land owner concerns. This is a possible, moderate impact. * The Non-federal Sponsor (City of Russellville) does not know federal relocation project policies. The Non-federal Sponsor shall lead the relocation effort but could baulk.	Moderate	Possible	2
EX-4	Channel Improvements: Engineers Ditch	* Political issues and lack of support * Lack of support from railroad * Unanticipated environmental concerns	* The public works director resigned in August 2014. A new public works director may shift City of Russellville priorities. The Sponsor shares may become a critical constraint and cost share delayed. * New Mayor anticipated January 2015. It is likely the new Mayor will not be familiar with Fed PL 91-646. * It is unknown (and critical) whether the railroad will approve the 2- 8FT RCPs under their railroad with limited cover (about 6FT). The railroad will not visit with the PDT until a complete set of plans/specs are available. It has been suggested that the issue be raised up the chain. * Possibility exists for unaccounted for wildlife to be discovered in the area and/or nesting, which may delay project schedule. Unanticipated discoveries could lead to cost increases in order to account for environmental oversight.	Critical	Possible	4
EX-5	Channel Improvements: Reach 03	* Political issues and lack of support * Unanticipated environmental concerns	* The public works director resigned in August 2014. A new public works director may shift City of Russellville priorities. The Sponsor shares may become a critical constraint and cost share delayed. * New Mayor anticipated January 2015. It is likely the new Mayor will not be familiar with Fed PL 91-646. * Possibility exists for unaccounted for wildlife to be discovered in the area and/or nesting, which may delay project schedule. Unanticipated discoveries could lead to cost increases in order to account for environmental oversight.	Marginal	Possible	1
EX-6	Channel Improvements: Reach 04-05	* Political issues and lack of support * Unanticipated environmental concerns	* The public works director resigned in August 2014. A new public works director may shift City of Russellville priorities. The Sponsor shares may become a critical constraint and cost share delayed. * New Mayor anticipated January 2015. It is likely the new Mayor will not be familiar with Fed PL 91-646. * Possibility exists for unaccounted for wildlife to be discovered in the area and/or nesting, which may delay project schedule. Unanticipated discoveries could lead to cost increases in order to account for environmental oversight.	Marginal	Possible	1
EX-12	Remaining Construction Items	* N/A	* N/A	Negligible	Unlikely	0
EX-13	Planning, Engineering, & Design	* Political issues and lack of support	* It is uncertain whether all CAP funding for PED will be made available in a timely manner. Delays in funding may result in additional PED expenses as well as escalation in schedule growth.	Marginal	Possible	1
EX-14	Construction Management	* No risks anticipated for Construction Management	* No external risks anticipated for Construction Management.	Negligible	Unlikely	0

Attachment D

Cost Difference Summary

P2-102915 - PRAIRIE CREEK AND TRIBUTARIES, RUSSELLVILLE, ARKANSAS
SECTION 205, FLOOD RISK MANAGEMENT STUDY
COST DIFFERENCE SUMMARY

This summary is to show differences between estimated costs from October 2013 to October 2014.

CATEGORY	OCTOBER 2013	OCTOBER 2014
Productivity	100%	85%
Sales Tax	8% (MatlCost)	9.5% (MatlCost)
JOOH	20%	15%
HOOH	8%	10%
Profit	10%	10%
Bond	1.0%	1.5%
Allowance	15%	0%
Contingency (Average)	30% (no ARA)	27% (ARA)
PED	12%	10%
Construction Management	10%	6%
TOTAL ESTIMATE	$9,376,000	$14,363,000

Project Scope Growth:
October 2013 does not assume demolition, except for West Parkway Street Bridge and Commerce Street Bridge. Estimate assumes limited cast-in-place vertical concrete work (3000PSI).

October 2014 assumes demolition to include: West Parkway Street Bridge, Commerce Street Bridge, 4000SF masonry building, asphalt parking lots, concrete parking lots, and cast-in-place concrete channel and vertical, slope walls. Estimate assumes increased cast-in-place vertical, slope, and floor concrete work (4000PSI). Estimate includes 4000SF masonry building relocation.

Acquisition Strategy:
October 2013 assumes a large business. Estimate does not assume contract personnel requirements: superintendent, site safety and health officer, contractor quality control, and security.

October 2014 assumes 8A or small business prime contractor, which reduces productivity and changes subcontractor hierarchy. Estimate assumes contract personnel requirements: superintendent, site safety and health officer, contractor quality control, and security.

Construction Elements:
October 2013 includes erosion and sediment control: silt fence, dust control, and turf and grasses.

October 2014 includes erosion and sediment control: silt fence, inlet sediment traps, erosion control matting blankets, temporary stream crossings, care of water during construction, dust control, and turf and grasses.

Quantities for Scope:
October 2013 quantities remain consistent with a 1-15% project definition.

October 2014 quantities remain consistent with a 1-15% project definition. Update includes a 2000LF temporary access road (and demolition of temporary access road) in order to reach pipe jacking location.

Specialty Fabrication or Equipment:
October 2013 pipe jacking includes the bore, pipe, and sheet pile retaining walls.

October 2014 pipe jacking includes the bore, pipe, sheet pile retaining walls, sink launch and reception shafts, control containment, and diversion channel away from existing bridge. In addition, pipe jacking includes railroad engineer (Union Pacific) tack-on throughout construction.

Cost Estimate Assumptions:
Estimate Class 4 (Generic Cost Estimate Classification Matrix, AACE International 2012):
Level of Project Definition is 1-15%
End Usage: Study or Feasibility
Methodology: Primarily Stochastic
Expected Accuracy Range: +30/-15% to +120/-60%

October 2013 and October 2014 prepared by different cost estimators, which is a basic risk on any project risk register.

Reviewed by Cost MCX Walla Walla via pre-cost ATR and documented via ProjNet.

External Project Risks:
October 2013 assumed a 30% contingency (no definition).

October 2014 includes a 27% contingency based on an Abbreviated Risk Analysis. External threats identified in the risk register (developed by PDT), e.g. resignation of public works director (August 2014), announcement of new mayor (January 2015), non-federal sponsor does not know federal relocation project policies, etc.

Real Estate:
Not discussed by CESWL-EC-DG; however, CESWL-EC-DG recognizes that prices increased due to the addition of a 4000SF masonry building relocation and temporary access road for pipe jacking.

Attachment E

O&M Cost Estimates

With Project Estimate – Prairie Creek and Tributaries
October 2014 Price Level 50 Year O&M Cost

	ENGINEERS DITCH	REACH 03	REACH 04-05	TOTAL
YEAR 1	2,513	7,326	10,063	19,902
YEAR 2	2,513	7,326	10,063	19,902
YEAR 3	2,513	7,326	10,063	19,902
YEAR 4	2,513	7,326	10,063	19,902
YEAR 5	2,513	7,326	10,063	19,902
YEAR 6	2,513	7,326	10,063	19,902
YEAR 7	2,513	7,326	10,063	19,902
YEAR 8	2,513	7,326	10,063	19,902
YEAR 9	2,513	7,326	10,063	19,902
YEAR 10	4,064	17,014	21,026	42,104
YEAR 11	2,513	7,326	10,063	19,902
YEAR 12	2,513	7,326	10,063	19,902
YEAR 13	2,513	7,326	10,063	19,902
YEAR 14	2,513	7,326	10,063	19,902
YEAR 15	2,513	7,326	10,063	19,902
YEAR 16	2,513	7,326	10,063	19,902
YEAR 17	2,513	7,326	10,063	19,902
YEAR 18	2,513	7,326	10,063	19,902
YEAR 19	2,513	7,326	10,063	19,902
YEAR 20	4,064	17,014	21,026	42,104
YEAR 21	2,513	7,326	10,063	19,902
YEAR 22	2,513	7,326	10,063	19,902
YEAR 23	2,513	7,326	10,063	19,902
YEAR 24	2,513	7,326	10,063	19,902
YEAR 25	2,513	7,326	10,063	19,902
YEAR 26	2,513	7,326	10,063	19,902
YEAR 27	2,513	7,326	10,063	19,902
YEAR 28	2,513	7,326	10,063	19,902
YEAR 29	2,513	7,326	10,063	19,902
YEAR 30	4,064	17,014	21,026	42,104
YEAR 31	2,513	7,326	10,063	19,902
YEAR 32	2,513	7,326	10,063	19,902
YEAR 33	2,513	7,326	10,063	19,902
YEAR 34	2,513	7,326	10,063	19,902
YEAR 35	2,513	7,326	10,063	19,902
YEAR 36	2,513	7,326	10,063	19,902
YEAR 37	2,513	7,326	10,063	19,902
YEAR 38	2,513	7,326	10,063	19,902
YEAR 39	2,513	7,326	10,063	19,902
YEAR 40	4,064	17,014	21,026	42,104
YEAR 41	2,513	7,326	10,063	19,902
YEAR 42	2,513	7,326	10,063	19,902
YEAR 43	2,513	7,326	10,063	19,902
YEAR 44	2,513	7,326	10,063	19,902
YEAR 45	2,513	7,326	10,063	19,902
YEAR 46	2,513	7,326	10,063	19,902
YEAR 47	2,513	7,326	10,063	19,902
YEAR 48	2,513	7,326	10,063	19,902
YEAR 49	2,513	7,326	10,063	19,902
YEAR 50	4,064	17,014	21,026	42,104
TOTAL O&M:	$133,405	$414,740	$557,965	$1,106,110

Without Project Estimate – Prairie Creek and Tributaries

October 2014 Price Level 50 Year O&M Cost

	ENGINEERS DITCH	REACH 03	REACH 04-05	TOTAL
YEAR 1	75	7,326	10,063	17,464
YEAR 2	75	7,326	10,063	17,464
YEAR 3	75	7,326	10,063	17,464
YEAR 4	75	7,326	10,063	17,464
YEAR 5	75	7,326	10,063	17,464
YEAR 6	75	7,326	10,063	17,464
YEAR 7	75	7,326	10,063	17,464
YEAR 8	75	7,326	10,063	17,464
YEAR 9	75	7,326	10,063	17,464
YEAR 10	288	16,752	20,488	37,528
YEAR 11	75	7,326	10,063	17,464
YEAR 12	75	7,326	10,063	17,464
YEAR 13	75	7,326	10,063	17,464
YEAR 14	75	7,326	10,063	17,464
YEAR 15	75	7,326	10,063	17,464
YEAR 16	75	7,326	10,063	17,464
YEAR 17	75	7,326	10,063	17,464
YEAR 18	75	7,326	10,063	17,464
YEAR 19	75	7,326	10,063	17,464
YEAR 20	288	16,752	20,488	37,528
YEAR 21	75	7,326	10,063	17,464
YEAR 22	75	7,326	10,063	17,464
YEAR 23	75	7,326	10,063	17,464
YEAR 24	75	7,326	10,063	17,464
YEAR 25	75	7,326	10,063	17,464
YEAR 26	75	7,326	10,063	17,464
YEAR 27	75	7,326	10,063	17,464
YEAR 28	75	7,326	10,063	17,464
YEAR 29	75	7,326	10,063	17,464
YEAR 30	288	16,752	20,488	37,528
YEAR 31	75	7,326	10,063	17,464
YEAR 32	75	7,326	10,063	17,464
YEAR 33	75	7,326	10,063	17,464
YEAR 34	75	7,326	10,063	17,464
YEAR 35	75	7,326	10,063	17,464
YEAR 36	75	7,326	10,063	17,464
YEAR 37	75	7,326	10,063	17,464
YEAR 38	75	7,326	10,063	17,464
YEAR 39	75	7,326	10,063	17,464
YEAR 40	288	16,752	20,488	37,528
YEAR 41	75	7,326	10,063	17,464
YEAR 42	75	7,326	10,063	17,464
YEAR 43	75	7,326	10,063	17,464
YEAR 44	75	7,326	10,063	17,464
YEAR 45	75	7,326	10,063	17,464
YEAR 46	75	7,326	10,063	17,464
YEAR 47	75	7,326	10,063	17,464
YEAR 48	75	7,326	10,063	17,464
YEAR 49	75	7,326	10,063	17,464
YEAR 50	288	16,752	20,488	37,528
TOTAL O&M:	$4,815	$413,430	$555,275	$973,520