City of Sealy, Texas

Master Drainage Plan for Little Bernard Creek Watershed 2010 - 2020

SPI Project No. 301401.00

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Submitted by:

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1.0 Executive Summary

Schaumburg & Polk, Inc. (SPI) has been contracted by the City of Sealy to prepare a Master Drainage Plan (MDP). The study area for the MDP is broken down into two sections: the Little Bernard Tributary Watershed (herein referred to as Section 1 of the MDP), and the Allen's Creek Watershed (Section 2 of the MDP). This document represents the Master Plan for Section 1 – the Little Bernard Tributary Watershed.

The objective of this study is to evaluate the projected ultimate development conditions for the City of Sealy, and to identify the drainage facilities needed to support that growth. The resulting projects will be very large-scale projects, and the intent is not to implement and construct these projects immediately or all at one time. The main purpose for this document is to serve as a planning tool for the City in several aspects:

1. To serve as a guide for developing and implementing shorter and nearer term drainage capital improvement plans
2. To provide the City the authority to require right-of-way through the development process
3. To aid in planning for major drainage crossings as new roadways are constructed or existing roadways are improved
4. To work in parallel with the City's other ordinances and regulations, such as Chapter 27, "Drainage Criteria"

Subsequent to the adoption of this Master Plan, the City may adopt a more defined CIP for the nearer-term growth that can build on the projects and concepts outlined in this Plan.

The study was developed as follows:

- Evaluation of existing conditions of the project area, including defining existing land uses, identifying two main basins within the project area (to be introduced later as LBC-100 and LBC-200), and evaluating service levels of existing drainage facilities.

- Identification of anticipated ultimate development conditions, and identifying drainage conveyance and detention infrastructure required to support that growth.

- Calculation of estimated project costs, which include those associated with construction, right-of-way, pipeline and utility adjustments and engineering.

2.0 Introduction

This document describes and presents a master plan for drainage facilities within the current corporate limits of the City of Sealy and its Extra-Territorial Jurisdiction (ETJ) that drain toward Little Bernard

Creek. This includes areas that currently drain toward Hogs Branch, a small tributary to Little Bernard Creek, as well as additional areas this report proposes to redirect drainage to Little Bernard Creek or Hogs Branch. This document serves as Section I of the overall development of the City of Sealy Master Drainage Plan (MDP).

2.1 Purpose

The purpose of the Master Drainage Plan (MDP) is to identify future drainage infrastructure that will improve the economic well being of the City of Sealy (City). This includes the reduction of existing flood risks as well as the overall improvement of drainage during more frequent events. It also includes the encouragement of future investment in the City by providing a mechanism to drain properties and to mitigate their storm water impacts.

The MDP was developed with the following goals, objectives, and constraints:

- Identify future drainage channels that will convey runoff to outfall points along the existing major waterways adjacent to the City
- Identify right-of-way requirements for the proposed channels such that the City may have the authority to require right-of-way through the development process
- Identify a volume of sub-regional stormwater detention that may be utilized by developers
- Provide a sizing criteria for on-site and sub-regional detention
- Avoid channel work within Little Bernard Creek
- Avoid increased flood levels in Little Bernard Creek

This document and accompanying exhibits will assist the City in the future programming of Capital Improvement Plans and will provide guidance in the planning of future development. As a master plan, this document is designed to incorporate built-in flexibility, and is intended to serve as a guide for future activity more so than it is intended to dictate future activity. It is also designed to work in parallel with the City's existing ordinances and regulations, such as Chapter 27, "Drainage Criteria."

2.2 Project Area

The project area for Section I of the MDP is shown on Exhibits 1 and 2. The project area includes the areas within the City or the ETJ that naturally drain toward Little Bernard Creek or its tributary Hogs Branch (as depicted in Exhibit 1). The project area has also been expanded to include some areas that currently do not drain toward Little Bernard Creek, but that would drain toward Little Bernard Creek upon construction of the proposed drainage facilities described in this plan are constructed (as depicted in Exhibit 2).

There is an area along the existing Little Bernard Creek that is outside of the ETJ. However, the proposed infrastructure will serve those areas, so they have been included within the study area. It is anticipated that the ETJ and/or corporate limits may extend to these areas once significant development activity occurs there.

Areas located within close proximity to Little Bernard Creek are not included in the project area, as they can easily drain directly into the creek. For this reason, there is no need to define drainage infrastructure to these areas.

2.3 Previous Projects and Studies

There are six relevant projects and studies that impact this master drainage plan and warrant discussion, and these are discussed this section.

1 - Interstate 10

Interstate Highway 10 was constructed by the Texas State Department of Highways and Public Transportation, now known as the Texas Department of Transportation (TxDOT) in the 1960's. The grade separated highway includes an overpass over an existing railroad (now the location of FM 3538). The highway and the overpass block the natural north-south drainage patterns of the area. The construction of the highway did include some cross structures to facilitate drainage, but there is minimal outfall definition downstream of these facilities, and therefore the highway presents a challenge in conveying additional concentrated runoff from the north to the south.

2 - FM 3538

In about 2006, TxDOT constructed FM 3538 in the location of an abandoned railroad and Brast Road. This roadway connects Interstate 10 on the western perimeter of the City of Sealy with FM 3013, which provides connectivity to State Highway 36. This roadway extends approximately five miles, and is almost entirely within the project area. It provides substantial access to areas south of Interstate 10 and west of Sealy.

The cross culverts along FM 3538 were designed for a 10-year event.

3 - Wal-Mart Regional Distribution Center

In 2004, Wal-Mart constructed a regional distribution center along Brast Road, which later became part of FM 3538. The facility is located on a 239-acre site, and contains a main warehouse covering over 1,100,000 square feet. A drainage analysis was conducted, and the resultant construction included detention basins that provide approximately 232 acre-feet of detention storage during a 100-year event.

The plan also includes perimeter ditches around the detention basins that collect offsite runoff and divert it around the site.

4 - Hogs Branch Extension, Realignment, and Improvements

The City, as part its project to improve Brast Road and to facilitate the Wal-Mart Regional Distribution Center, realigned Hogs Branch to outfall further upstream into Little Bernard Creek. In addition, Hogs Branch was improved and extended north to Brast Road (now FM 3538), just across from the Wal-Mart distribution center. The new channel is 4 to 5 feet deep, and is approximately 50-60 feet wide at the top. Typical side-slopes are 4:1 (h:v).

5 - Hogs Branch Watershed Regional Detention Study

In April, 2008, O'Malley Engineers, L.L.P. prepared a study on behalf of the City entitled *Evaluation of Regional Storm Water Detention for a Portion of the Hog Branch Watershed.* This study identified future channels and a regional detention site to serve portion of the project area described in this Section I of the Sealy MDP. This study area included the portion draining to Hogs Branch upstream of the Wal-Mart facility, including areas north of Interstate 10.

The study recommended channels to accommodate the fully developed 100-year flowrates as well as a regional detention basin providing almost 600 acre-feet of storage. No improvements were proposed downstream of the basin, therefore the current depth of the outfall channels limited the depth of the basin and upstream channels. They also included a second option for a pumped detention basin in order to obtain additional depth.

The study concluded that the proposed infrastructure would cost approximately $13.6 million, and would serve 602 acres of developable land. The pumped detention option would cost approximately $12.5 million.

The City has never acted on the recommendations provided in the O'Malley Engineers report.

6 - Comprehensive Plan

Kendig Keast Collaborative prepared a report entitled *Choices – City of Sealy Comprehensive Plan*. This report provided a comprehensive growth plan and vision for the City, and was adopted on May 13, 2009. The recommendations included a number of provisions related to drainage and stormwater – namely the development of a regional drainage system that adequately and efficiently handles stormwater flows and minimizes flooding of property.

The report included a number of recommendations to reduce the impact of runoff, including the use of detention as well as the recommendation of the utilization of low impact development techniques.

The comprehensive plan also included a Thoroughfare Plan, which is shown on Exhibit 3, and for which any future roadway crossings were planned for as part of this Master Drainage Plan.

2.4 Data

A number of data sources were used in the development of this master plan. The City of Sealy provided GIS coverages of existing infrastructure as well as relevant regional data. Information regarding the Wal-Mart regional distribution facility was taken from its Storm Water Management Report prepared by Carter and Burgess. Existing drainage infrastructure was determined from field observations and measurements as well as from the O'Malley Engineers report for Hogs Branch. Information was also drawn from the Sealy Comprehensive Plan.

The City also provided aerial photography, a digital elevation model, and 1-foot contours for the city limits and ETJ. This information was prepared by DAS, Inc. for the City in mid-2009.

3.0 Project Area Description

3.1 Land Use

The project area consists of mostly currently undeveloped land, with some large lot residential areas as well as the Wal-Mart distribution center. Most of the undeveloped land is agricultural ranch land. There is substantial oil and gas activity on the properties north of Interstate 10 between Peschel Road and Little Bernard Creek. Interstate 10 bisects the study area, dividing it into a north area and a south area. Exhibit 3 provides a depiction of the existing land use categories of the project area, as well as predicted 10-year development conditions. This, along with ultimate land use projections are discussed in a later section.

3.2 Topography

Exhibit 4 shows the topographic contours on an aerial photograph. The land naturally drains from north to south. North of Interstate 10, there is much more topographic relief, as the ground falls about 15 feet per mile. South of Interstate 10, there is a noticeable ridge near the alignment of FM 3538. There is noticeable relief from this ridge; however the remainder of the area south of Interstate 10 is very flat, with slopes of about 5-8 feet per mile.

3.3 Drainage

Based upon the topography, the project area generally drains north to south, as can be seen on Exhibit 4.

Areas north of Interstate 10 drain south toward the Interstate, where drainage is collected and transmitted south of Interstate 10 either through the culverts crossing Interstate 10 or through the ditches adjacent to FM 3538 under Interstate 10. The areas north of and along Interstate 10 drain to the small swale along Interstate 10, where it is conveyed to a cross structure just east of Little Bernard Creek.

During large rainfall events, substantial water ponds along Peschel Road. This is due to the large drainage area north of the roadway. Along the northern portion of Peschel Road, this runoff is slowly conveyed underneath the railroad into the City's detention basin in the Sealy business and professional women's (bp&w) park. Further south along Peschel Road, excess runoff drains toward a detention basin located behind the homes along the east side of the roadway. Closer to Interstate 10, runoff is conveyed west to a collection area where it drains underneath Interstate 10.

South of Interstate 10, there is a defined drainage channel that collects runoff from Interstate 10 and drains toward FM 3538. There is a large crossing underneath FM 3538; however, there is not defined outfall downstream of this point. After rainfall events, substantial runoff ponds downstream and upstream of FM 3538. There is little defined conveyance between this point and the Wal-Mart distribution center. Downstream of the Wal-Mart distribution center is the newly constructed extension to Hogs Branch.

There is limited drainage outfall capacity upstream of Interstate 10, and with the exception of the tracts adjacent to or downstream of the Wal-Mart distribution center, there is limited drainage outfall capacity downstream of Interstate 10. Currently, new development would likely need to construct substantial retention basins with pumped outfalls in order to adequately drain their sites. The lack of drainage outfall capacity is a substantial barrier to economic development in these areas.

4.0 Future Development

This MDP considers two future development scenarios – a 10-year future development scenario and an ultimate full development scenario. The 10-year land use projection map as presented in Exhibit 3 was assembled through a cooperative effort. Initially, an "existing land use" map was developed by O'Malley Engineers, LLP to depict current-day development. SPI and City Planning staff then reviewed the map and made additions and modifications to the map to reflect anticipated 10-year growth based both on known developer interest as well as likely commercial development sites near major street intersections and along the IH-10 corridor. For ultimate conditions, it was assumed that new development would be a proportion of large lot residential, residential, and commercial. However, no specific ultimate land use assignments were made on a per tract basis.

While the major projects identified in this Master Plan have been designed for the ultimate development conditions, there are several reasons for having made 10-year development projections. City staff has intimate knowledge of the current development interests based on the day-to-day interactions they have with these developers. Incorporation of this knowledge provides for more accurate development projections. Identifying the growth anticipated over the next 10 years also assists in the development of a Capital Improvements Plan, as well as facilitating the implementation of drainage impact fees, if the City so chooses.

5.0 Hydrology

In order to facilitate this analysis, it was necessary to determine a method to compute existing and proposed flowrates in the channels, as well as to determine appropriate requirements for detention basins. Flow and detention equations were developed in order to simplify the hydrologic calculations.

5.1 Peak Flow Equation

Parameters such as the amount of impervious cover and the channel slope were adjusted to accurately reflect the characteristics of the Sealy drainage areas, and the resultant flow vs. drainage area were plotted for slope, Manning's "n" value, and channel slope. A regression analysis was utilized to develop the following flow equations:

$$Q = K(1 + 26I)(.06/N)^{.60}(.13S)^{.}21(A/640)^{.77}$$

Where:	Q	=	Flowrate (cubic feet per second)
	I	=	Impervious Cover (%/100)
	N	=	Manning's "n" Value of Channel
	S	=	Slope of Longest Watercourse (ft/ft)
	A	=	Drainage Area (acres)
	K	=	557 (100-yr frequency)
			390 (25-yr frequency)
			295 (10-yr frequency)
			134 (2-yr frequency)

This equation returns estimated flow rates that were consistent with those determined using more detailed methodologies.

5.2 Detention Volume Equation

The following equation was used in determining detention volume requirements, and it is recommended that this equation be applied to determine the volumetric detention requirements for new development. This equation is as follows:

$$V = AI^{1/2}$$

Where:	V	=	Storage Volume (ac-ft)
	I	=	Impervious Cover (%/100)

A = Development Area (ac)

5.3 Detention Outfall Rate

The equation derived for peak flow was used to derive an allowable discharge from detention basins. This equation is shown below:

$$Qout = 557(S/7.5)(A/640)^{.77}$$

Where: Qout = Allowable 100-year discharge from basin

S = Pre-Developed slope of site

A = Development Area in Acres

6.0 Plan Considerations and Assumptions

To facilitate the planning, the project area was developed into three subareas. The area north of Interstate 10 is denoted as LBC100. The area south of Interstate 10 and north of Brast Road (FM 3538) is denoted as LBC200. The area south of Brast Road (FM 3538) is denoted as LBC300. The location of these subareas is shown on Exhibit 2.

There are five primary components to the MDP – stormwater detention, channels, structures, right-of-way, and cost. The following sections describe how they are treated in the plan development and recommendations.

6.1 Stormwater Detention

As land is converted from undeveloped to developed condition, the introduction of impervious cover and drainage facilities results in a substantial increase in the speed and volume of rainfall runoff. Over time, as development occurs, existing flooding problems will become exasperated and new flooding problems will be created. However, the impact of development on downstream flooding can be offset by introducing detention storage basins that attenuate the increased flow, and then meter it out at pre-development rates.

It is generally desirable to have a smaller number of larger detention basins, as opposed to a large number of very small basins. Small basins can negatively impact development plans, are a maintenance headache, are often unattractive, and are not always effective. However, large regional basins require a substantial capital investment.

While this plan does not identify specific locations for regional detention, calculations were performed for each drainage basin to determine the total volume required for providing a certain level of regional detention. For purposes of this plan, it is assumed that smaller commercial developments will choose to participate in a regional detention basin, and will be willing to pay a fee or enter into a development agreement in lieu of providing detention on-site. This requires that a regional detention basin be available or at least a detention site be acquired that a developer can excavate upon; and that sufficient drainage infrastructure is in place to convey the additional runoff between the development and the detention basin if the detention basin is located downstream of the development.

For the most part, subdivision developers often prefer to construct detention basins as part of their development scheme. Subdivision basins are much larger, and the incremental cost to the development is lower. Furthermore, they can be utilized as an amenity for the development. For planning purposes, it is assumed that, in addition to the anticipated commercial development, 10% of the total remaining impervious cover introduced by development will utilize a regional basin.

These assumptions are utilized to prescribe a regional detention volume for each of the three subareas. Specific locations for detention are not prescribed as part of the plan. Location will be highly dependent on development trends and landowner interest in selling or dedicating land to the City to use for regional detention purposes.

6.2 Channels

The proposed channel network forms the backbone of the MDP. The channel network is necessary to provide drainage access to the full extent of the project area. As previously mentioned, portions of the natural watershed were removed from the project area because the affected tracts already have direct access to the Little Bernard Creek. Beyond that, the channel network was developed to provide access to the full project area. Some minor second order systems will be need to be constructed by land developers – this project does not propose to establish the drainage network at this level.

As it pertains to drainage, the primary need for the development of a property is outfall. Specifically, outfall depth is desired. In order to construct a curb and gutter type of subdivision, on outfall depth of at least 8 feet is typically required. Smaller developments do not require as much depth, but depth is a desirable feature to attract the most desirable types of development.

It is assumed that most development will utilize on-site detention, but it is recognized that some will choose to utilize the regional basins. The channel network is sized to accommodate 100-year flowrates based upon existing land use because of the on-site detention assumptions with one-foot of freeboard (freeboard is the difference between the 100-year water surface elevation and the banks of the channel). This will require the placement of small amounts of fill adjacent to the channel where the proposed channel flows through lower areas. The calculated existing 100-year discharge is considered the “design” discharge for the project.

- As mentioned in section 6.1, the utilization of regional detention requires that the channel network have capacity to convey the additional flows from the development to the detention basin if the basin is located downstream of the site. As such, it is desirable to have some extra capacity within the channels. A second analysis was conducted utilizing the existing condition 100-year discharges increased by 20%. This increased discharge is considered the "check" discharge for the project. The proposed channels were evaluated with the criteria that they should convey the increased discharges within their banks, but not necessarily with any freeboard. This analysis indicated that the proposed channels are capable of conveying this additional discharge within their banks.

HEC-RAS, an open channel computer simulation model developed by the U.S. Army Corps of Engineers, was utilized to analyze and size the proposed channels and structures.

In general, the channel cross sections have a minimum bottom width of six feet, side-slopes of 4:1 (h: v), and one foot of freeboard. The largest channel section has a bottom width of twelve feet. Exhibits 9 through 11 include a graphical depiction of the typical section. The minimum channel slope is 0.08% (0.0008 ft/ft), and the maximum channel slope is 0.5%.

The proposed channel flowlines were determined to obtain the desired depth, to minimize right-of-way requirements and to minimize excavation costs. No drop structures are required, although the plan calls for a two-foot drop through a proposed box culvert in order to establish a grade change. This would require some armoring of the channel just downstream of the culvert.

As mentioned earlier, some ground adjacent to the channel may require filling in order to ensure that adequate depth and freeboard are obtained. This would be relatively minor, and may require upsizing of the backslope drains to allow gravity access to the channel while the adjacent lands are in their pre-development condition.

The horizontal alignment of the channel network was determined to minimize costs, maximize the service area, and to minimize impact to landowners. Where possible, the proposed channel straddles a property line in order to share the impact and benefit between two adjacent properties.

A major challenge to the alignment is the crossing of Interstate 10. In the alternatives analysis, one alternative considered box culverts on either side of FM 3538 through the underpass under Interstate 10. The recommended alignment calls for the construction of a 500 linear foot dual 10' x 10' concrete box culvert under Interstate 10. This plan assumes that this construction would be coordinated with the reconstruction of Interstate 10 at some date in the future.

Because of the uncertainty of future construction of Interstate 10, and secondary alternative alignment is included in the recommendation. This alternative includes crossing under IH-10 at FM 3538, and is similar to the one presented in the original alternatives analysis, except it proposes a concrete lined channel with 2h:1v side slopes underneath the overpass. The design and construction of this channel would be done in consideration of the columns supporting Interstate 10.

6.3 Structures

The channel network will cross existing and proposed roadways. The MDP identifies the structure at each existing or future roadway. All of the crossings can be accomplished with box culverts, and the plan identifies the sizes and dimensions of the box culverts, as well as the flowlines.

The culverts were sized using the HEC-RAS model mentioned in Section 6.2. They were sized in a manner to minimize construction cost while providing for minimal headloss through the structure.

Structures are also required for the regional detention basins. For cost estimating purposes, it is assumed that there will be single regional detention basin for each of the three subareas, and the ultimate structure is defined for each.

6.4 Right-of-Way

Right-of-Way is a significant component of the cost of the plan. Right-of-Way is determined from the channel geometry. Thirty-foot maintenance berms are assumed for each side of the channel. The computed right-of-way is then rounded upwards to provide for a more conservative estimate.

In areas where the channel alignment is parallel and adjacent to public roadways, the Right-of-Way was reduced to account for the access provided by the public right-of-way.

The location of the regional detention basins has not been determined. The land required for regional detention is determined by assuming an average depth of 6 feet and 4:1 (H:V) side slopes, and then by increasing this amount by 30% to allow for maintenance berms and aesthetic treatments.

6.5 Costs

Costs for major drainage projects such as those presented in this report are dominated namely by right-way, excavation, engineering, structures, and pipeline relocations. There are other incidental costs associated with these types of projects, such as clearing and grubbing, back-slope swales and drains, hydromulch, etc. These costs are comparatively small and do not impact the selection of the plan. Rather than itemizing the costs for these items separately, the costs have been included in the unit cost for the large ticket items, and a contingency has been added to the estimates to account for items associated with construction that may not be identifiable and/or quantifiable at the current macroscopic planning level.

Costs for right-of-way are based on Austin County Appraisal District information. The average appraised land values throughout the project area are approximately $10,000 per acre. A good rule of thumb when cost planning for land acquisition is to double the appraised values, which essentially will account for the costs associated with surveying, generating parcel maps, negotiating with property owners, legal fees, etc. A land value of $20,000 per acre was used for purposes of this study.

Pipeline adjustment costs are difficult to estimate before detailed information about each specific pipeline is obtained, and is highly dependent on the specific facility owner's preferences and

requirements. Recently negotiated pipeline adjustments between Fort Bend County and various owners came in with figures in the $200,000 to $400,000 dollar range. A unit cost of $500,000 for each pipeline crossing was used for the purposes of this report.

7.0 Plan Elements

This section presents plan concepts for each of the three planning areas. A number of conceptual alternatives were considered for each planning area, and a detailed discussion of these alternatives is discussed further in Appendix A. Subsequent to the development of the alternatives and presentation of the alternatives to the City of Sealy, a thorough analysis of the alternatives was conducted. This analysis included the consideration of refinements to the alternatives, and led to the identification of the recommended plan presented in this section. This recommended plan is a compilation of these refinements, and draws from features presented in the initial alternatives analysis.

Referring to the alternatives analysis presented in Appendix A, the recommended plan consists of a modified version of Alternative 3 for Service Area LBC100, a modified version of Alternative 2 for Service Area LBC200, and a modified version of Alternative 2 for Service Area LBC300. The service area is defined as the area that will drain to the proposed channel network during in the post-development condition. This section presents a description of the recommended alternative, including the specific alternative concept, the arterial channel network, the service area, proposed regional detention volume, required structures, and estimated costs.

7.1 LBC 100

7.1.1 Service Area Description – LBC 100

The overall planning area for Service Area LBC 100 includes the area north of Interstate 10 that currently drains to Little Bernard Creek or that could be directed to drain to Little Bernard Creek. Recommended Service Area LBC 100 is shown on Exhibit 2. This area covers approximately 868 acres of land, most of which is in the ETJ of Sealy. Most of this area is undeveloped pasture land, although there are some areas of large lot residential along and near Peschel Road.

Interstate 10 defines the southern boundary of the service area. Currently, it is estimated that only about 100 acres currently drain from north of Interstate 10 to the south of Interstate 10. Natural sheet flow drainage within the northern portion is collected along Peschel Road, where it is ultimately conveyed toward a detention basin behind the homes south of Peschel Road. From there, flows are conveyed underneath Interstate 10 at FM 3538 and then east toward Allen's Creek. The drainage in this specific area is poor, and after rainfall events this region experiences substantial areas of standing water.

Drainage for the area near the intersection of Peschel Road and US 90 is conveyed underneath Interstate 10 by a large box structure. This structure also received runoff from the Interstate 10

system. However, adequate drainage infrastructure does not exist to convey flows from the upstream areas to the structure, and the overall capacity of this structure is also limited.

The western portion of the planning area drains toward the feeder road to Interstate 10 (US Hwy 90), where it is conveyed west toward Little Bernard Creek. Prior to reaching the creek, however, runoff is conveyed underneath Interstate 10 via a box culvert. This area is extremely flat, and any drainage swale along Interstate 10 is poorly defined. Even while there is substantial ponding upstream, there is minimal noticeable flow in this swale.

Generally speaking, the overall current drainage in the LBC100 area is poor. There is potential for economic development along Interstate 10, especially near Peschel Road and FM 3538; however, limited to no outfall drainage capacity exists. The area experiencing extremely poor drainage along Peschel Road is outside of the corporate limits of the City, but there is concern regarding the potential future development of this area. Currently, future development would be required to find a way to convey runoff through the City of Sealy to Allen Creek, and this would require construction of larger channels in fully developed areas of the City.

As mentioned earlier, a number of alternative concepts were developed to address existing drainage challenges and future infrastructure needs in this planning area, and a detailed description of the evaluation of these alternatives may be found in Appendix A.

7.1.2 Alternative Analysis for LBC 100

In the alternatives analysis presented in Appendix A, three alternatives were considered for the LBC 100 service area. These are presented in more detail in Appendix A, but a brief overview is presented below:

LBC 100 Alternative 1 – This alternative proposes to construct an open channel starting in a large undeveloped area north of Peschel Road that currently naturally drains through the developed portion of the City of Sealy toward Allen's Creek. The proposed channel would cross Peschel Road, and then will also cross the existing railroad allowing it to collect drainage from future development southeast of the railroad. The channel would travel south, and then turn back west and pass just south of the terminus of the railroad. The channel would then follow the alignment of the existing detention basin behind the homes along Peschel, and then turn west parallel to Interstate 10 and then flow toward Little Bernard Creek.

This alignment allows for the connection to a substantial amount of undeveloped land, and allows for the construction of the channel without having to negotiate a crossing of Interstate 10. However, the crossing of the railroad would be a challenge, and the large channel directed west parallel to Interstate 10 would not follow natural grade – requiring a substantial amount of additional excavation. Furthermore, there is knowledge of many pipelines and other oil and gas infrastructure along this westward alignment.

For this alternative and all subsequent alternatives, portions of the planning area that lie near to Little Bernard Creek already have ready access to outfall via the existing channel. Therefore, no infrastructure is proposed for these areas, and they are not shown within the Service Areas for the alternative.

LBC 100 Alternative 2 – This alignment is identical to LBC Alternative 1, however, it does not propose to cross the existing railroad. The advantage of this, when compared to Alternative 1 is the avoidance of challenges associated with the railroad; while the disadvantage is that it does not provide drainage access to areas southeast of the railroad.

LBC 100 Alternative 3 – This upstream half of this alternative is similar to LBC Alternative 1, however it proposes to cross Interstate 10 and drain to the south as opposed to directing runoff to the west. The advantage of this alignment is that it more closely follows natural drainage patterns. However, it does introduce challenges associated with crossing Interstate 10. The plan proposes to cross Interstate 10 below its overpass over FM 3538. The plan calls for the construction of two large box culvert structures parallel and adjacent to each side of the FM 3538 roadway as it crosses underneath Interstate 10.

This alternative also proposes a smaller channel along Interstate 10 that drains toward Little Bernard Creek. This channel differs from the alignment of the western extension of the channel in Alternatives 1 and 2 in that it would be within the Right-of-Way of Interstate 10 (and would require permission and approval by TxDOT). This alternative also recommends a smaller channel as most flows would be conveyed south of Interstate 10. The purpose of this channel is to provide drainage outfall for areas along Interstate 10 as well as to provide interim drainage outfall to potential development near Peschel Road and US 90 than may occur ahead of construction of a drainage channel that would direct flow south of Interstate 10.

7.1.3 Recommended Plan for LBC 100

The recommended plan for LBC 100 borrows primarily from Alternative 3 presented in the alternatives analysis. This alternative proposes a channel that conveys flows south of Interstate 10 in lieu of conveying all of the flows west to Little Bernard Creek. However, the recommended plan differs from Alternative 3 in that it does not extend southeast of the railroad. As such, the upstream portion of the channel alignment is similar to Alternative 2. Furthermore, the alternative proposes a new crossing underneath Interstate 10, as described below.

The recommended channel layout and service area for LBC 100 are shown on Exhibit 5. As shown on the exhibit, a primary channel (LBC 100) is proposed along the alignment shown. This channel would convey flow underneath Interstate 10 via a 500 linear foot dual 10’ x 10’ box culvert. This alternative assumes that this construction could occur at some time in the future as TxDOT reconstructs Interstate 10. However, any future reconstruction of Interstate 10, including its timetable, it highly uncertain at this time. For that reason, an alternative alignment (LBC 100 Alt) is presented that crosses underneath Interstate 10 below the FM 3538 underpass. However, unlike the alternative, this would occur via an open concrete lined channel adjacent to

FM 3538. It is recommended that both of these alignments be adopted, giving city planners future options as the timetable for Interstate 10 reconstruction becomes more certain.

The recommended plan also proposes a channel (LBC 101) running parallel to and adjacent to US 90/Interstate 10 toward Little Bernard Creek. The permanent alignment of this channel would extend upstream from Little Bernard Creek to a point near to the proposed box culvert underneath Interstate 10. This channel would provide outfall for development that may occur on tracts north of the highway. With a smaller drainage area, it would be substantially smaller and shallower (about five feet deep) than the LBC 101 channel. This alignment could be temporarily extended eastward toward Peschel Road to provide interim drainage outfall ahead of construction of the LBC 100 channel.

There is particular challenge associated with the LBC 100 Alt crossing underneath Interstate 10 at FM 3538. There is substantial open area underneath the highway in this location to construct an open channel or to install large box culverts. However, bridge piers extend down at approximate 40-foot spacings that would inhibit the construction of either of these projects. Further investigation including geotechnical work, consultation with structural engineers and completion of some preliminary engineering would be required in order to determine if this project is feasible.

The preferred and primary alignment (LBC 100) was chosen because of the challenges associated with alternative crossing under Interstate 10 at FM 3538. Additionally, that alternative option requires extensive right-of-way acquisition on prime real estate tracts both north and south of the channel. LBC 100 Alt is provided as an alternate route in the event that the challenges presented with the preferred alternative prove to be too prohibitive.

Moving upstream from the Interstate 10 area, the channel would extend across Peschel Road near US 90. By doing so, it would provide drainage access to the potential commercial development in this highly accessible and visible area. From this location, the channel would extend upstream in a northeast direction behind existing development in the City. Finally, the channel would turn to the northwest, cross Peschel Road, and extend up into undeveloped property northwest of the City.

The primary LBC 100 alignment will require three road crossings. From upstream, it would cross Peschel Road twice and then Interstate 10. The LBC 100 Alt alignment will require two crossings. From upstream, it will cross Peschel Road and US 90.

In addition to the channel network shown, this alternative proposes to provide 250 acre-feet of regional detention. The specific location of the detention basin has not been determined.

7.2 LBC 200

7.2.1 Service Area Description – LBC 200

Planning area LBC 200 consists of the area immediately to the south of Interstate 10. It is generally bounded on the west and south by FM 3538, although a portion of the northern service area is west of FM 3538. The location of the planning area is shown on Exhibit 2. This area covers approximately 1,430 acres of land, with portions within Sealy's corporate city limits and the remainder in the ETJ. The area is consists of mostly undeveloped land. The Wal-Mart Distribution Facility occupies 239 acres of land immediately adjacent to the service area. The future land use presented in Exhibit 3 map identifies substantial acreage of new development within LBC200 by 2020. A large amount of this development is anticipated to be residential, as the construction of FM 3538 provides easy access to Interstate 10.

The northern portion of this planning area receives concentrated runoff from Interstate 10. This runoff is conveyed into a well defined channel upstream of FM 3538. There are three 6' x 3' box culverts underneath FM 3538; however there is not a well defined drainage course downstream of this point. During field visits following various rain events, a substantial amount of standing water in the ditches downstream and upstream of the box culverts was observed, but there appeared to be virtually no discernable flow velocity through the culvert due to the lack of downstream drainage capacity.

The land in planning area LBC200 is very flat, and it would be difficult to develop property in this area due to the lack of outfall depth. O'Malley Engineers, L.L.P. completed a regional storm water study for much of this area, and the lack of available outfall depth significantly compromised the potential effectiveness of this plan.

The Wal-Mart Distribution Facility is located adjacent to the southern portion of the planning area. This site consists of multiple detention ponds to offset its development impacts. It also includes a swale that intercepts offsite runoff and conveys it around the site. The majority of the site drains to the extension of Hogs Branch, but the eastern portion of the site naturally drains across FM 3013 to the east and ultimately Allen's Creek.

Areas to the east of LBC200 naturally drain east toward Allen's Creek. However, there is a large geographic distance between these areas and defined outfall drainage, and there is substantial development between these areas and Allen's Creek.

A number of alternative concepts were initially developed to address existing drainage challenges and future infrastructure needs in this planning area, and a detailed description of the evaluation of these alternatives may be found in Appendix A.

7.2.2 Alternatives Analysis for LBC 200

In the alternatives analysis presented in Appendix A, three initial alternatives were considered for the LBC 200 service area. These are presented in more detail in Appendix A, but a brief overview is presented below, followed by a description of the recommended alternative:

LBC 200 Alternative 1 – This alternative calls for the construction of a new channel starting upstream with the alignment of the existing channel that receives runoff from Interstate 10. This channel would utilize the existing crossing of FM 3538, and then a proposed channel would be constructed downstream from this point. This channel would extend east and cross Eagle Lake South Road and Rexville Road. It would continue east, and then turn south bisecting a large tract. It would then cross Harrison Road, and turn westward again to access additional property. It would then extend south around the Wal-Mart facility. It would then run adjacent to FM 3538 within the Wal-Mart facility on land currently occupied by the detention basin.

A second minor channel would extend west across Rexville Road toward Eagle Lake South Road. This channel would provide drainage access to areas along FM 3538.

A third channel would be constructed from areas north of the Wal-Mart facility. This channel would extend into the Wal-Mart property and then around the east side of the facility. It would join the main channel just upstream of the crossing with FM 3538. The purpose of this channel is to provide drainage access to areas north of Wal-Mart and to the eastern portion of Wal-Mart itself.

The primary advantage of this alignment is that it provides drainage access to a large amount of area, including areas that currently drain east toward Allen's Creek. The primary disadvantage is that this alignment would require substantial coordination with the Wal-Mart facility.

LBC Alternative 2 – This alternative is similar to LBC Alternative 1 except that it avoids alignment on Wal-Mart property. This alignment maintains a more direct southern course, avoiding Wal-Mart, and eventually travels south directly to a new crossing of FM 3538. In addition, this option does not include a proposed channel around the eastern side of Wal-Mart.

LBC Alternative 3 – This alternative is similar in alignment as Alternative 2, except that it is sized to accommodate the flows from LBC 100 Alternative 3. Additionally, there is a proposed channel around the east side of Wal-Mart that conveys flows to the existing crossing of FM 3538.

7.2.3 Recommended Plan for LBC 200

The recommended plan for LBC 200 is a modified version of LBC 200 Alternative 3. The modification includes the elimination of the channel around the east side of the Wal-Mart facility. It also includes the provision of an alternative alignment to match with the LBC 100 Alt alignment recommended for LBC 100. In addition, the primary north-south alignment has been moved to the west, and now is directly adjacent to Rexville Road as opposed to bisecting a large tract of developable property.

The channel layout and service area for LBC 200 are shown on Exhibit 3. This alternative strives to address the area's current issue of limited outfall capacity by proposing a large arterial

drainage channel, designed as LBC 100 extending from the Interstate 10 outfall, generally along the natural sheet flow path, along the east side of Rexville Road and toward FM 3538.

In addition, the plan provides a minor feeder channel, referred to in this report as LBC 201. This feeder provides drainage to areas adjacent to FM 3538 in the western portion of the planning area.

This alignment would provide access to drainage to areas that have a high development potential. It would provide sufficient depth to allow for curb and gutter subdivisions with underground storm sewers.

The alternative will require structures to cross four roadways. The crossings are FM 3538, Eagle Lake Road South, Rexville Road, and Harrison Road. The LBC 100 Alt alignment will also require the crossing of the service road south of Interstate 10. There is a need for a two-foot grade change in the vicinity of FM 3538. The plan calls for the utilization of the proposed box structure to provide the two-foot drop. This will require additional channel armoring of the outfall at this point. There are also four pipeline crossings.

In addition to the channel network shown, this alternative proposes to provide 400 acre-feet of regional detention. The specific location of the detention basin has not been determined.

7.3 LBC 300

7.3.1 Service Area Description – LBC 300

Planning area LBC 300 consists of the area immediately south of FM 3538. The northern portion of this planning area is within the ETJ of Sealy. However, the vast majority of the planning area is outside the ETJ. Since the extended Hogs Branch channel provides outfall for the LBC 200 area, and since the need for upstream depth results in recommended channel enlargements to the extended Hogs Branch channel, the areas that have the potential to benefit from these improvements were included in the planning area.

Planning area LBC 300 is made up of 818 acres, and is entirely undeveloped.

A number of alternative concepts were developed to address future infrastructure needs in this planning area, and a detailed discussion of these alternatives is provided in Appendix A.

7.3.2 Alternative Analysis for LBC 300

In the alternatives analysis presented in Appendix A, three alternatives were considered for the LBC 300 service area. These are presented in more detail in Appendix A, but a brief overview is presented below:

LBC 300 Alternative 1 – This alternative proposes the utilization of an enlargement to an existing channel to provide drainage outfall. There is an existing channel that conveys outfall from the

Wal-Mart facility to Hogs Branch, a tributary of Little Bernard Creek. This alternative called for the enlargement of this channel to receive flow from the LBC 200 channel. Since this channel originates at the crossing of FM 3538 near Wal-Mart, it would require the utilization of the alignment described in LBC 200 Alternative 1.

The advantage of this alignment is that it utilizes an existing channel with some existing right-of-way. The disadvantage of this alignment is that it will require substantial enlargement of the channel, and the actual channel length is quite long. Furthermore, it requires an upstream alignment that encroaches upon the Wal-Mart facility property.

LBC 300 Alternative 2 – This alternative proposes an entirely new channel running parallel and east of the existing channel south of Wal-Mart. This channel would require a new crossing of FM 3538, and would define a service area east of and different than the service area for Alternative 1. This alternative must match up with the alignment described in LBC 200 Alternative 2.

The advantage of this alignment is that although it requires a new channel, the route to Little Bernard Creek is substantially shorter than the route to Hogs Branch along the existing channel. The primary disadvantage is that it would require a new crossing of FM 3538, and it would preclude an opportunity to extend service area to areas north of and east of Wal-Mart.

LBC 300 Alternative 3 – This alternative combines elements of Alternative 1 and Alternative 2. It includes the enlargement of the existing channel as well as a new channel and crossing of FM 3538. The new alignment would extend from a new crossing of FM 3538 (similar to Alternative 2), and then extend south and then west toward the existing channel. After reaching the existing channel, the existing channel would be enlarged to convey flows south as described in Alternative 1. In addition, the northern part of the existing channel could be enlarged to receive any additional flow if a new channel is proposed to access areas north of and east of the Wal-Mart facility.

The primary advantage of this alternative is that it allows the utilization of the existing channel alignment and Right-of-Way while not requiring encroachment upon the Wal-Mart facility. The primary disadvantage is the cost, as this alternative proposes more total linear feet of channel.

7.3.3 Recommended Plan for LBC 300

The recommended plan for LBC 300 closely resembles that presented in Alternative 2 of the alternatives analysis. This calls for a new crossing of FM 3538 and a new channel extending south to Little Bernard Creek. It does not involve any improvements to the existing channel.

The channel layout and service area for LBC 300 are shown on Exhibit 3. This alternative proposes a new channel to connect planning area LBC 200 to Little Bernard Creek.

The service area for this Alternative was defined to be the tracts which could direct drainage to the new channel LBC 100, which is a service area of approximately 818 acres. All of this acreage is currently undeveloped.

There are no lateral systems proposed in this alternative, but none would likely be necessary as the contributing area is rather small and the channel is easily accessible from all areas of the service area.

In addition to the channel network shown, this alternative proposes to provide 50 acre-feet of regional detention. The specific location of the detention basin has not been determined.

7.4 Channel Rights-of-Way

The channel right-of-ways associated with the proposed projects are presented on Exhibits 6 through 8. The proposed rights-of-way include the width required for the channels themselves plus 30-foot maintenance berms on each side of the channel. These exhibits are extremely important to this drainage master plan from an implementation standpoint, as they serve as a guide for requesting land dedications from property owners and developers as the service areas continue to grow.

As noted on the exhibits, the centerline of the proposed channels should typically be centered on property lines and/or run adjacent to existing rights-of-way. Unfortunately, the GIS-based parcel maps obtained from the Austin County Appraisal District do not exactly line up as they should. Because the aerial imagery was so recently obtained by DAS, Inc., the proposed channel alignments were generated based on this information. When overlaying the parcel maps with the aerial imagery, the parcel lines and right-of-way lines do not exactly line up. A note has been added to the exhibits to recognize this, and also specifies that right-of-way dedications shall be coordinated through the City of Sealy to ensure accurate acquisition limits.

7.5 Channel Profiles

Channel profiles have been generated for the recommended projects, and are provided in Exhibits 9-11. The digital elevation information gathered by DAS, Inc. in 2009 was used as a base for generating these profiles. These profiles identify the proposed channel flowlines, roadway crossings and structures, the 100-year water surface elevation, ROW widths, 100-year flows in cubic feet per second (cfs) and 100-year water surface elevations. This information will be invaluable to the City as development continues. This information may be used to serve as the preliminary engineering for the final design of any segment of the proposed channels, whether the design is being completed by the City, or by a private developer. Additionally, in the event that developers or dirt contractors wish to obtain fill dirt, these profiles may be used as a guide for the general limits and depths of excavation.

These documents will be powerful tools as development continues. GIS-based tools may be developed and used in many capacities to help implement the plan as well as track dedications, excavation, etc. These tools and procedures may be further investigated during the next implementation phase.

7.6 Cost Summary

As discussed previously, costs for major drainage projects are dominated namely by right-way, excavation, structures, pipeline relocations and engineering; and that the minor costs such as clearing and grubbing, back-slope swales and drains, hydromulch, etc. are comparatively small and have simply been accounted for in the unit costs of the large ticket items. A 20% contingency was included with each project estimate to account for items associated with construction that may not be identifiable and/or quantifiable at the current macroscopic planning level.

In addition to detailed discussion on all of the alternatives considered for this master plan, Appendix A also includes a cost analysis comparison of the alternatives. A detailed construction cost breakdown for the recommended alternatives is also provided as Table 1.

The total estimated project cost for the recommended channel conveyance projects are as follows:

Service Area LBC 100

- Channel Construction, Pipeline Adjustments, Engineering: $8,459,000.00
- Channel ROW $315,000.00
- **Total Channel Project Cost: $8,774,000.00**

Service Area LBC 200 (including minor channel LBC 201)

- Channel Construction, Pipeline Adjustments, Engineering: $9,715,000.00
- Channel ROW $582,000.00
- **Total Channel Project Cost: $10,297,000.00**

Service Area LBC 300

- Channel Construction, Pipeline Adjustments, Engineering: $4,437,000.00
- Channel ROW $303,000.00
- **Total Channel Project Cost: $4,747,000.00**

Total Master Plan Channel Cost:

- Channel Construction, Pipeline Adjustments, Engineering: $22,611,000.00
- Channel ROW $1,055,000.00
- **Total Channel Project Cost: $23,811,000.00**

As discussed for each project, a recommended detention volume was established for all three basins based on the various assumptions outlined previously. As mentioned, specific detention pond site locations were not identified as part of this study, but the following cost estimates represent the

anticipated costs for the construction of a single pond in each area. Note that these costs also include the site acquisition costs:

Service Area LBC 100

- Pond Construction & Engineering: $4,030,000.00
- Land cost for Pond Site (57 AC) $1,125,000.00
- **Total Pond Project Cost: $5,155,000.00**

Service Area LBC 200

- Pond Construction & Engineering: $6,348,000.00
- Land cost for Pond Site (91 AC) $1,800,000.00
- **Total Pond Project Cost: $8,148,000.00**

Service Area LBC 300

- Pond Construction & Engineering: $938,000.00
- Land cost for Pond Site (12 AC) $225,000.00
- **Total Pond Project Cost: $1,163,000.00**

Total Master Plan Channel Cost:

- Pond Construction & Engineering: $11,316,000.00
- Land cost for Pond Site $3,150,000.00
- **Total Pond Project Cost: $14,466,000.00**

Table 1

Cost Estimate Break-Down for Proposed Master Plan Projects

City of Sealy Master Drainage Plan - Little Bernard Creek

Item	Description	Qty	Unit	Unit Cost	Extension	Subtotal
LBC-100 Conveyance System						
1	Channel Construction	205,000	CY	$10.00	$2,050,000	
2	(2) 7'X7' RCBC Peschel Roadway Crossing, including headwalls, roadway restoration, etc.	120	LF	$900	$108,000	
3	(2) 10'X9" RCBC Peschel Roadway Crossing, including headwalls, roadway restoration, etc.	120	LF	$1,850	$222,000	
4	(2) 10'X10' RCBC IH-10 Roadway Crossing, including headwalls, roadway restoration, etc.	1,000	LF	$2,250	$2,250,000	
5	Pipeline (3) and Utility Adjustments	1	LS	$1,500,000	$1,500,000	
Subtotal Construction Costs						$6,130,000
Contingencies (approximately 20%)						$1,226,000
Subtotal						$7,356,000
Engineering (approximately 15%)						$1,103,000
Total Estimated						**$8,459,000**
LBC-100 Detention						
1	Pond Construction	410,000	CY	$7.00	$2,870,000	
2	Outfall Structure & Rip Rap	1	LS	$50,000	$50,000	
Subtotal Construction Costs						$2,920,000
Contingencies (approximately 20%)						$584,000
Subtotal						$3,504,000
Engineering (approximately 15%)						$526,000
Total Estimated						**$4,030,000**
LBC-200 Conveyance System, Including LBC-201 Channel						
1	Channel Construction	363,000	CY	$10.00	$3,630,000	
2	(2) 9'X9' RCBC FM 3538 Roadway Crossing, including headwalls, roadway restoration, etc.	200	LF	$1,500	$300,000	
3	(2) 10'X9' RCBC Eagle Lake Roadway Crossing, including headwalls, roadway restoration, etc.	120	LF	$1,850	$222,000	
4	(3) 10'X9' Rexville Roadway Crossing, including headwalls, roadway restoration, etc.	240	LF	$1,850	$444,000	
5	(3) 10'X9' Harrison Roadway Crossing, including headwalls, roadway restoration, etc.	240	LF	$1,850	$444,000	
4	Pipeline (4) and Utility Adjustments	1	LS	$2,000,000	$2,000,000	
Subtotal Construction Costs						$7,040,000
Contingencies (approximately 20%)						$1,408,000
Subtotal						$8,448,000
Engineering (approximately 15%)						$1,267,000
Total Estimated						**$9,715,000**
LBC-200 Detention						
1	Pond Construction	650,000	CY	$7.00	$4,550,000	
2	Outfall Structure & Rip Rap	1	LS	$50,000	$50,000	
Subtotal Construction Costs						$4,600,000
Contingencies (approximately 20%)						$920,000
Subtotal						$5,520,000
Engineering (approximately 15%)						$828,000
Total Estimated						**$6,348,000**

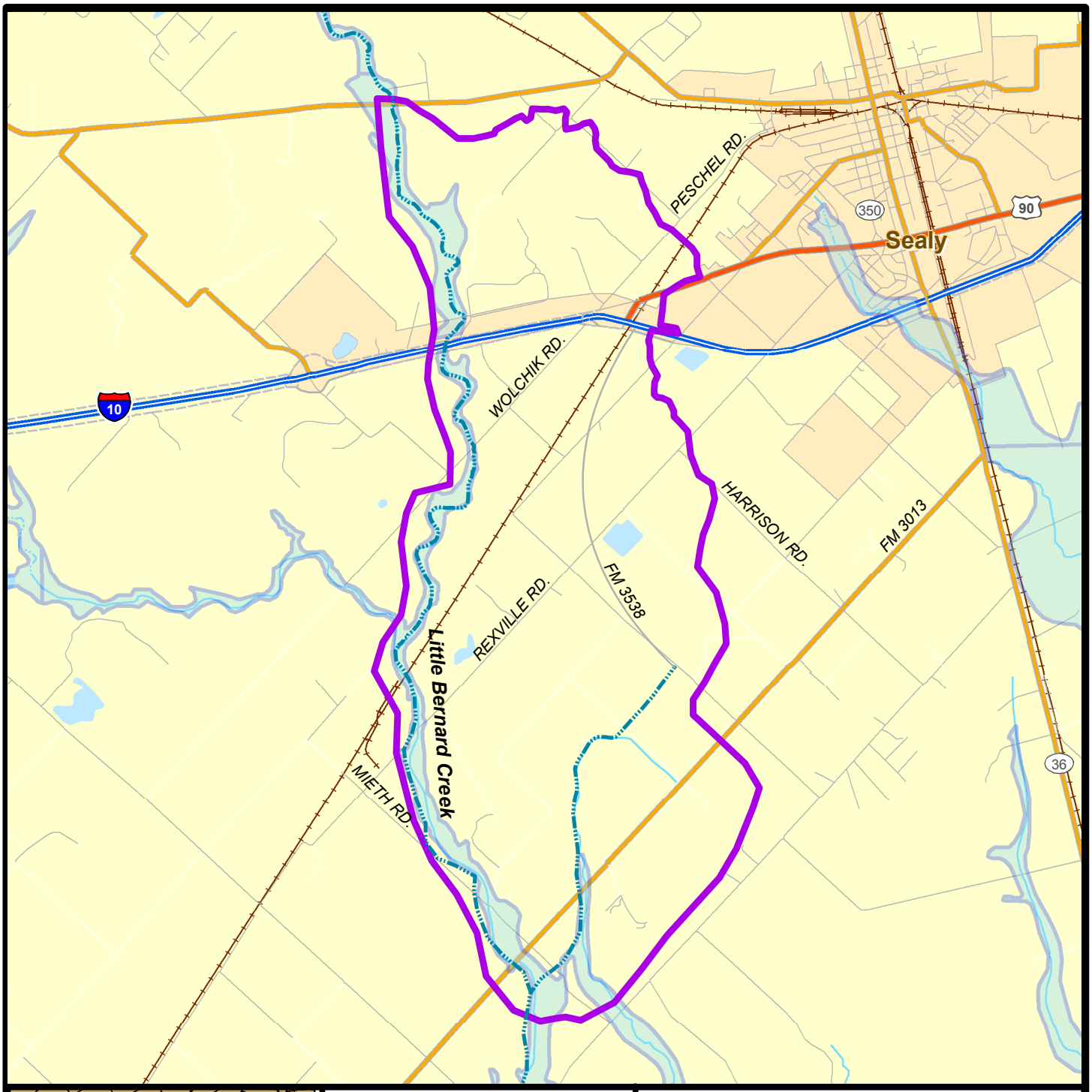
Table 1

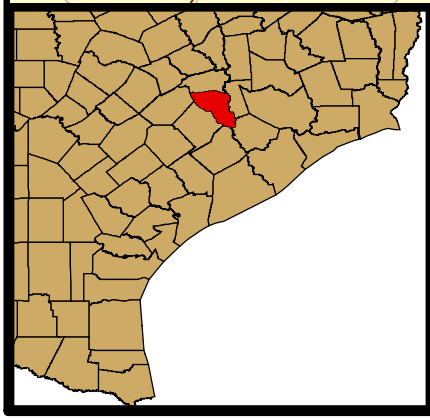
Cost Estimate Break-Down for Proposed Master Plan Projects

City of Sealy Master Drainage Plan - Little Bernard Creek

LBC-300 Conveyance System						
1	Channel Construction	249,000	CY	$10.00	$2,490,000	
2	Little Bernard Creek Outfall & Rip Rap	1	LS	$50,000	$50,000	
3	(3) 10'X10' FM 3538 Roadway Crossing, including headwalls, roadway restoration, etc.	300	LF	$2,250	$675,000	
Subtotal Construction Costs						$3,215,000
Contingencies (approximately 20%)						$643,000
Subtotal						$3,858,000
Engineering (approximately 15%)						$579,000
Total Estimated						**$4,437,000**
LBC-300 Detention						
1	Pond Construction	90,000	CY	$7.00	$630,000	
2	Outfall Structure & Rip Rap	1	LS	$50,000	$50,000	
Subtotal Construction Costs						$680,000
Contingencies (approximately 20%)						$136,000
Subtotal						$816,000
Engineering (approximately 15%)						$122,000
Total Estimated						**$938,000**

* Note: Above-listed prices include built-in costs for site preparation and restoration, traffic control, SWPPP, and other anticipated costs associated with construction





Legend

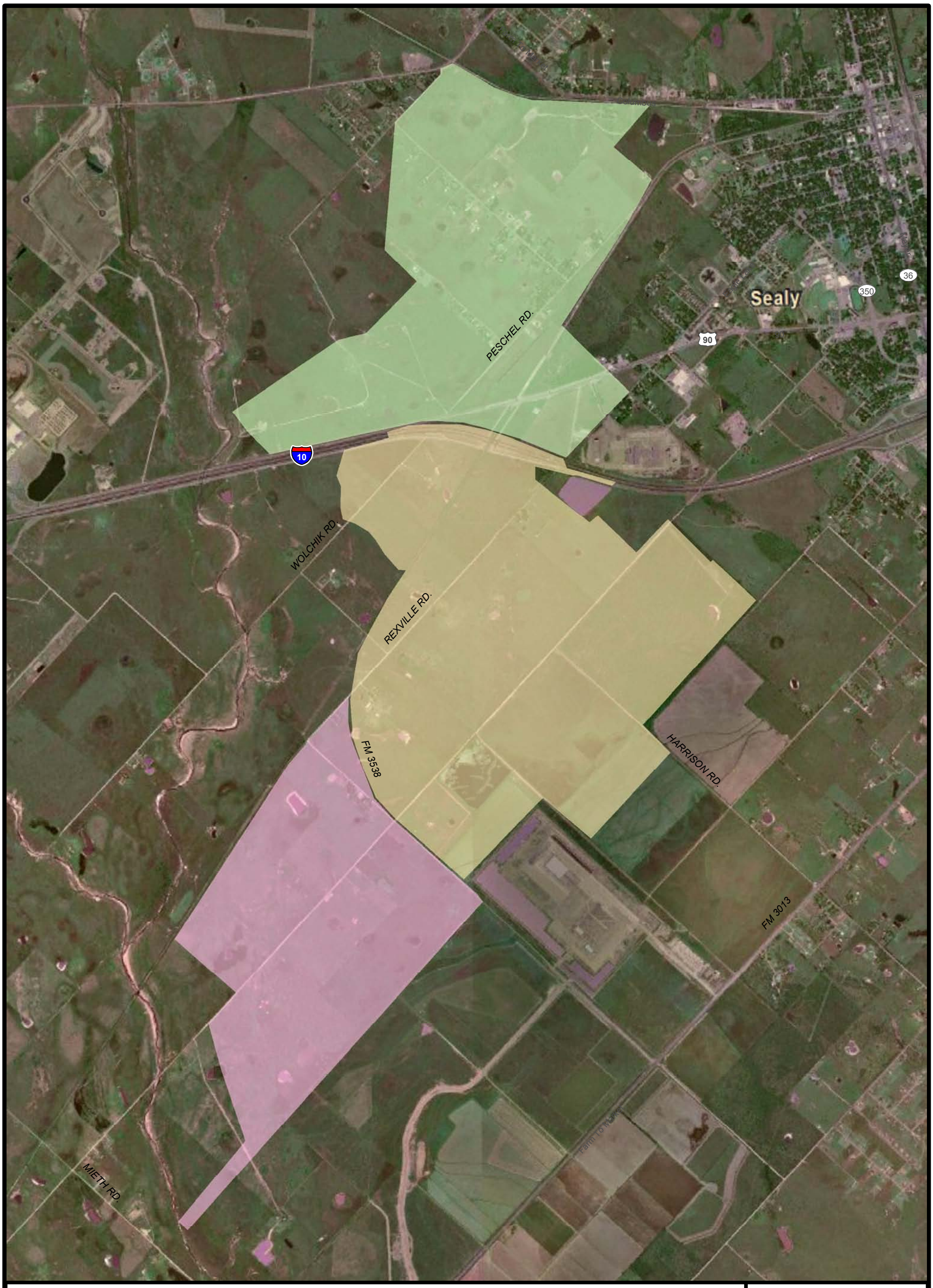
- Little Bernard Creek
- Natural Watershed
- Floodplain

0 2,500 5,000 Feet

SPI

Exhibit 1
Project Area
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 5000'
File: Figure1.mxd	Date: JUNE 2010



Legend

- LBC 100 Service Area
- LBC 200 Service Area
- LBC 300 Service Area

0 1,000 2,000 Feet

SPI

Exhibit 2
Proposed Service Areas
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 5000'
File: DrainageAreas.mxd	Date: JUNE 2010

PESCHEL RD.

WOLCHIK RD.

REAVILLE RD.

FM 3538

HARRISON RD.

FM 3013

MIETH RD.

Legend

Future Use	Existing Use		
Commercial	Commercial	Large Lot Residential	Utility
Educational	Educational	Multi-Family	ETJ
Industrial	Fabricated	Park	City Limits
Park	Industrial	Residential	
Residential		Undeveloped	

N

0 1,000 2,000 Feet

SPI

Exhibit 3
Land Use
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 2000'
File: Figure3.mxd	Date: JUNE 2010

Legend

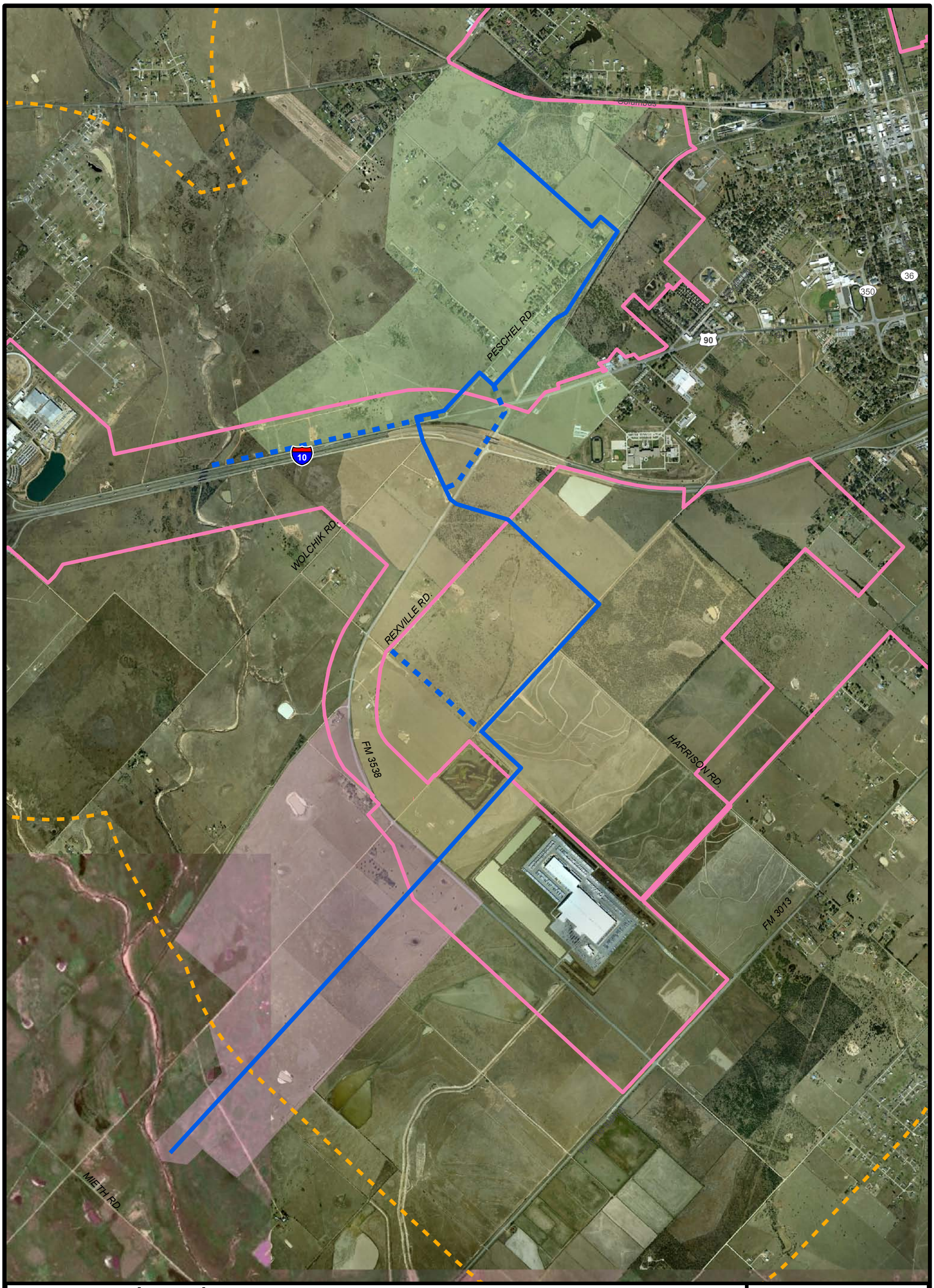
- Watershed
- Contours
- Drainage Areas

0 1,500 3,000 Feet

SPI

Exhibit 4
Topographic Data
with 1-foot Contours
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 3000'
File: Figure4.mxd	Date: JUNE 2010



Legend

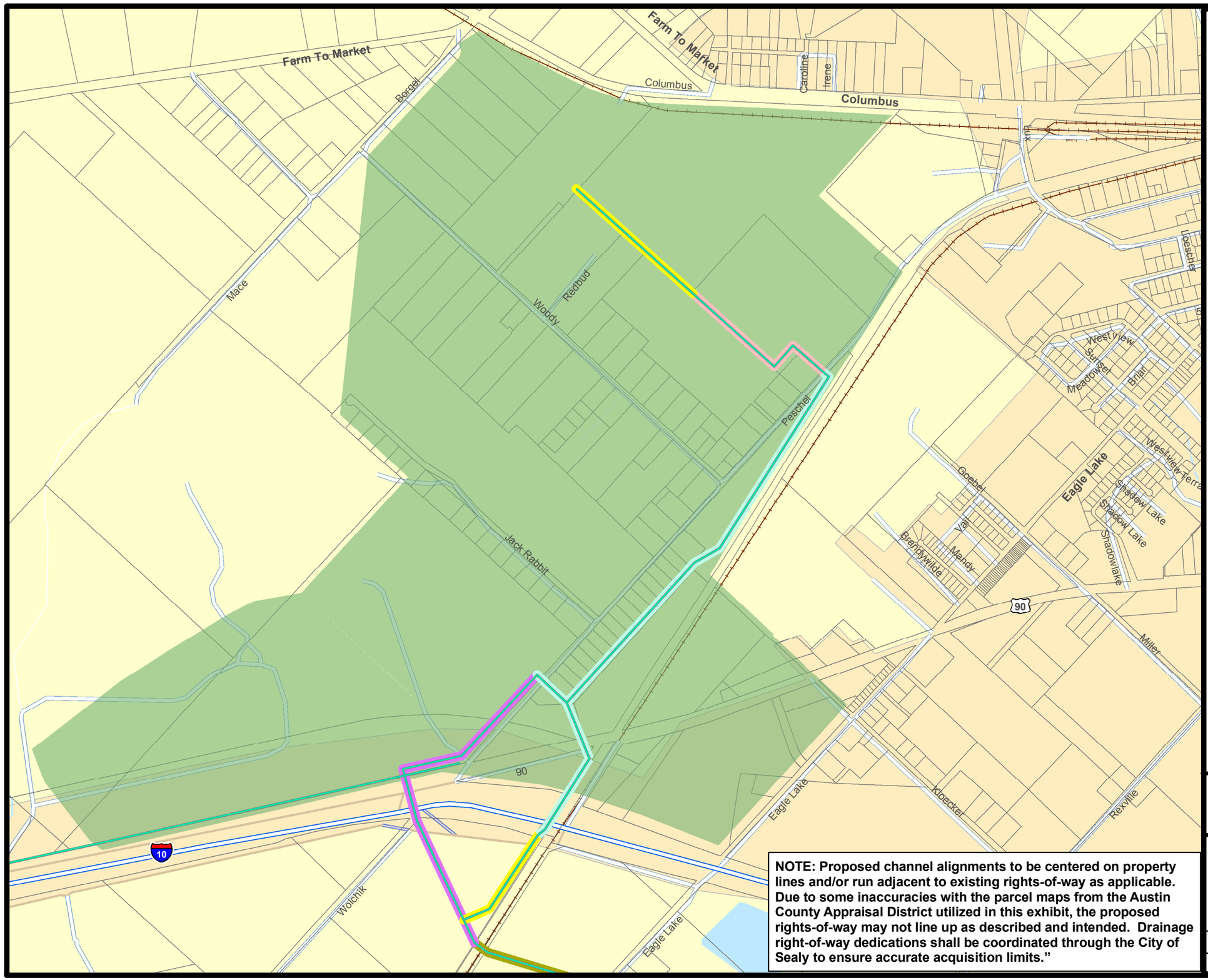
- Proposed Minor/Alternate Drainage Channel
- Proposed Major Drainage Channel
- City Limits
- ETJ
- LBC 100 Service Area
- LBC 200 Service Area
- LBC 300 Service Area

0 1,000 2,000 Feet

SPI

Exhibit 5
Proposed Channel Network
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 2000'
File: Figure5.mxd	Date: JUNE 2010



Legend

ROW Widths

- 120'
- 140'
- 145'
- 150'
- 160'
- 165'
- 170'

- Proposed Channel
- LBC 100 Service Area
- Parcels

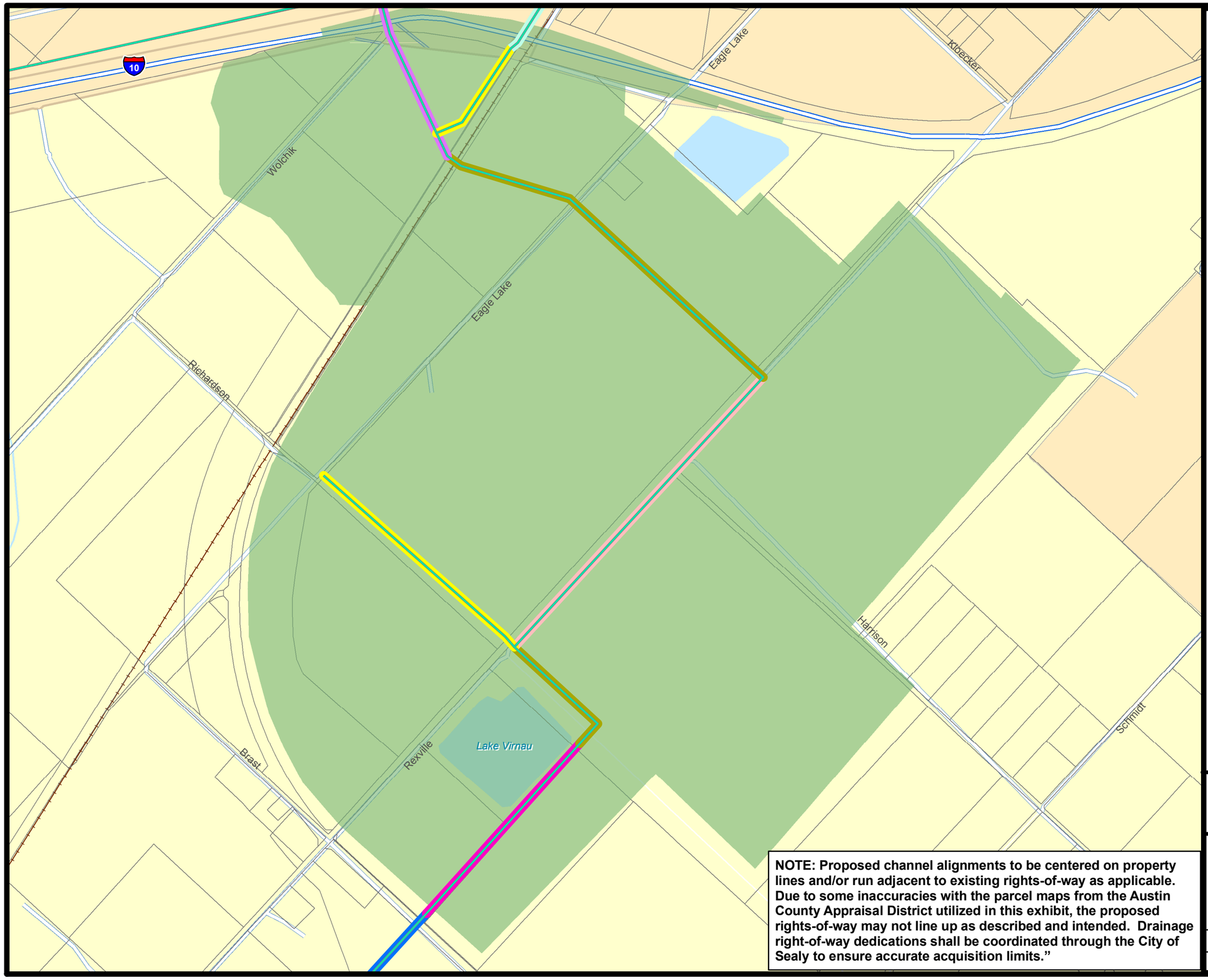
0 500 1,000 Feet

N

SPI

Exhibit 6
LBC 100 Required Channel ROW
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 1000'
File: ROW_Data.mxd	Date: JUNE 2010



Legend

ROW Widths

- 120'
- 140'
- 145'
- 150'
- 160'
- 165'
- 170'

- Proposed Channel
- LBC 200 Service Area
- Parcels

0 500 1,000 Feet

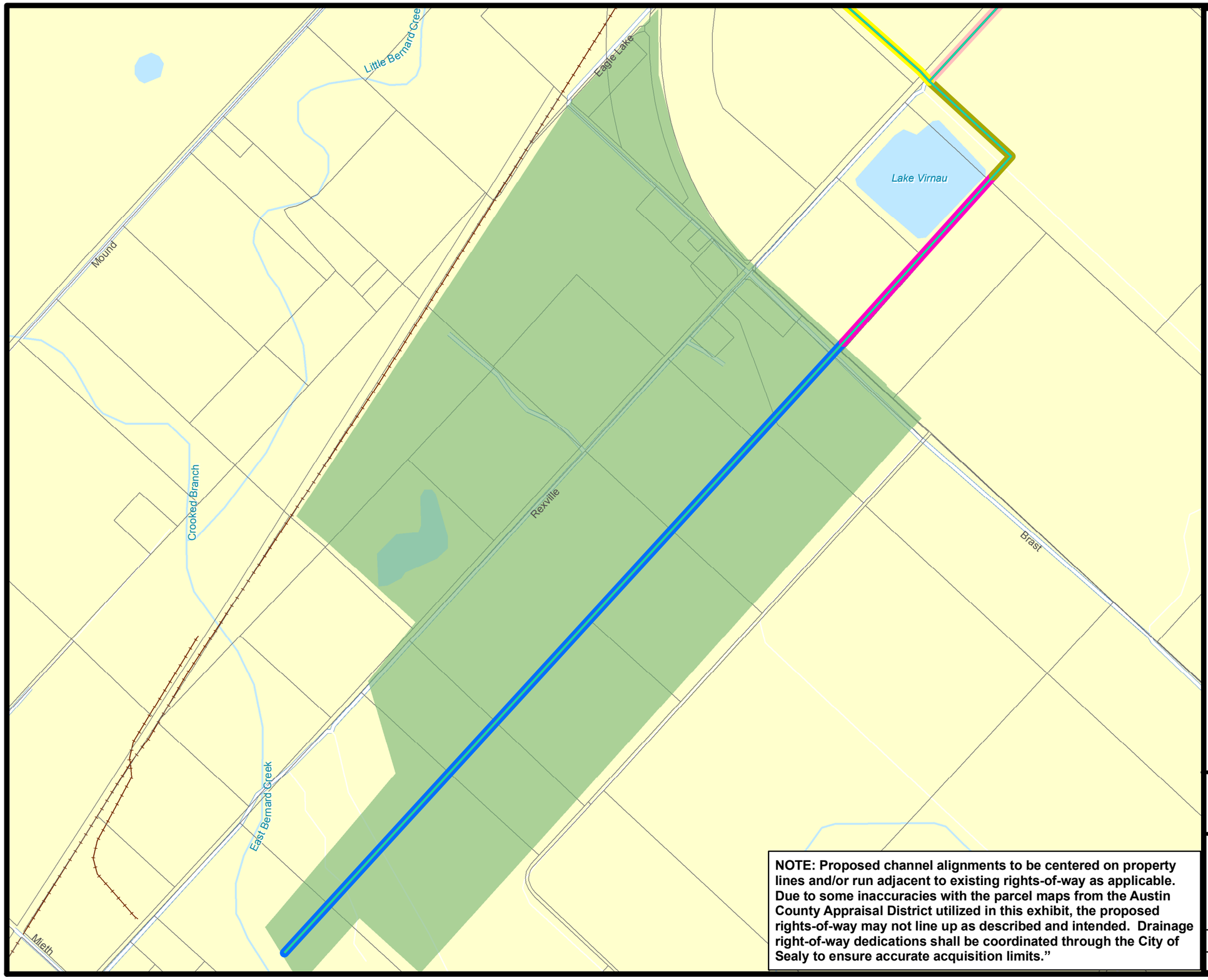
N

NOTE: Proposed channel alignments to be centered on property lines and/or run adjacent to existing rights-of-way as applicable. Due to some inaccuracies with the parcel maps from the Austin County Appraisal District utilized in this exhibit, the proposed rights-of-way may not line up as described and intended. Drainage right-of-way dedications shall be coordinated through the City of Sealy to ensure accurate acquisition limits."

SPI

Exhibit 7
LBC 200 Required Channel ROW
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 1000'
File: ROW_Data.mxd	Date: JUNE 2010



Legend

ROW Widths

- 120'
- 140'
- 145'
- 150'
- 160'
- 165'
- 170'

- Proposed Channel
- LBC 300 Service Area
- Parcels

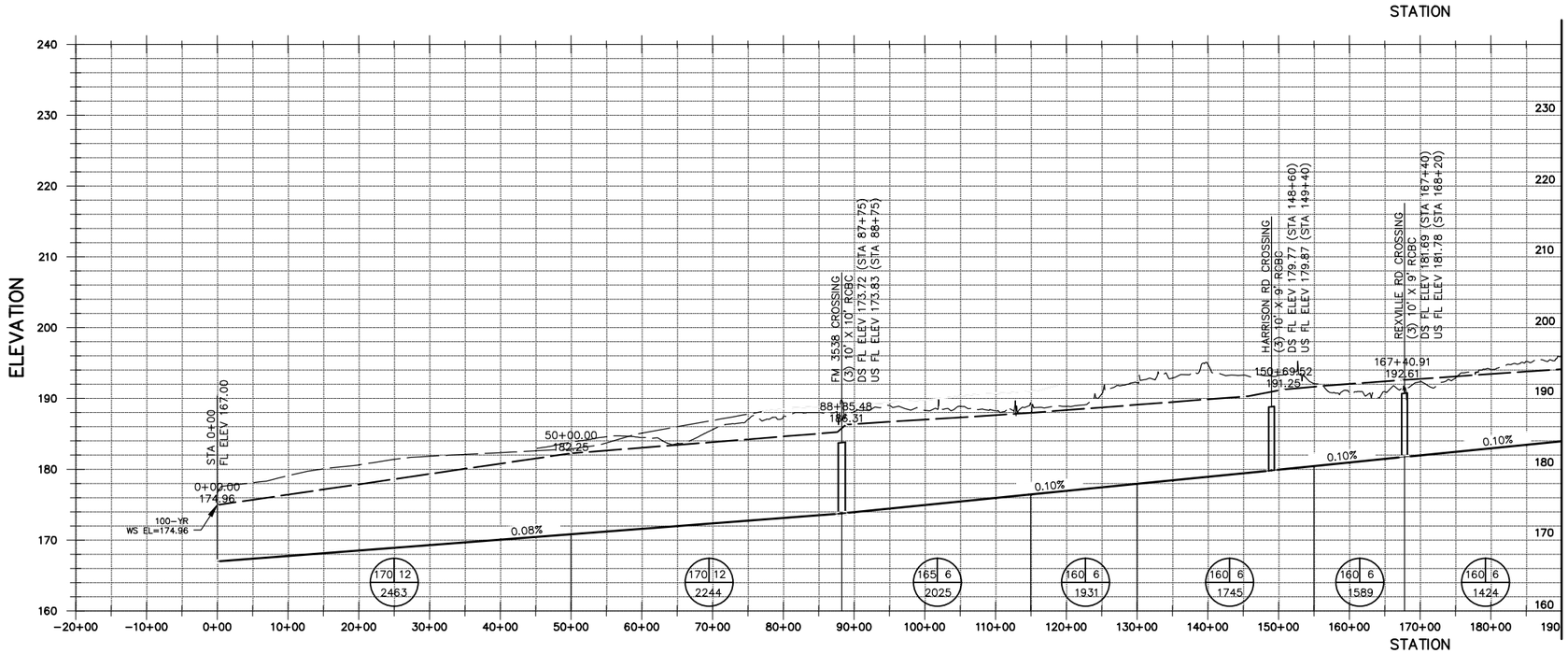
0 500 1,000 Feet

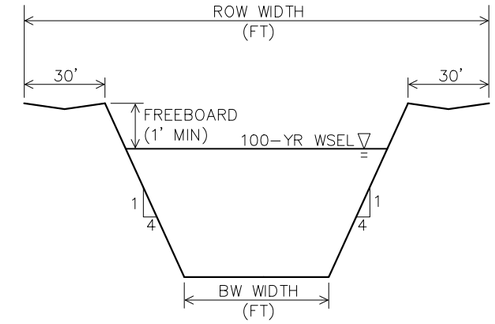
NOTE: Proposed channel alignments to be centered on property lines and/or run adjacent to existing rights-of-way as applicable. Due to some inaccuracies with the parcel maps from the Austin County Appraisal District utilized in this exhibit, the proposed rights-of-way may not line up as described and intended. Drainage right-of-way dedications shall be coordinated through the City of Sealy to ensure accurate acquisition limits."

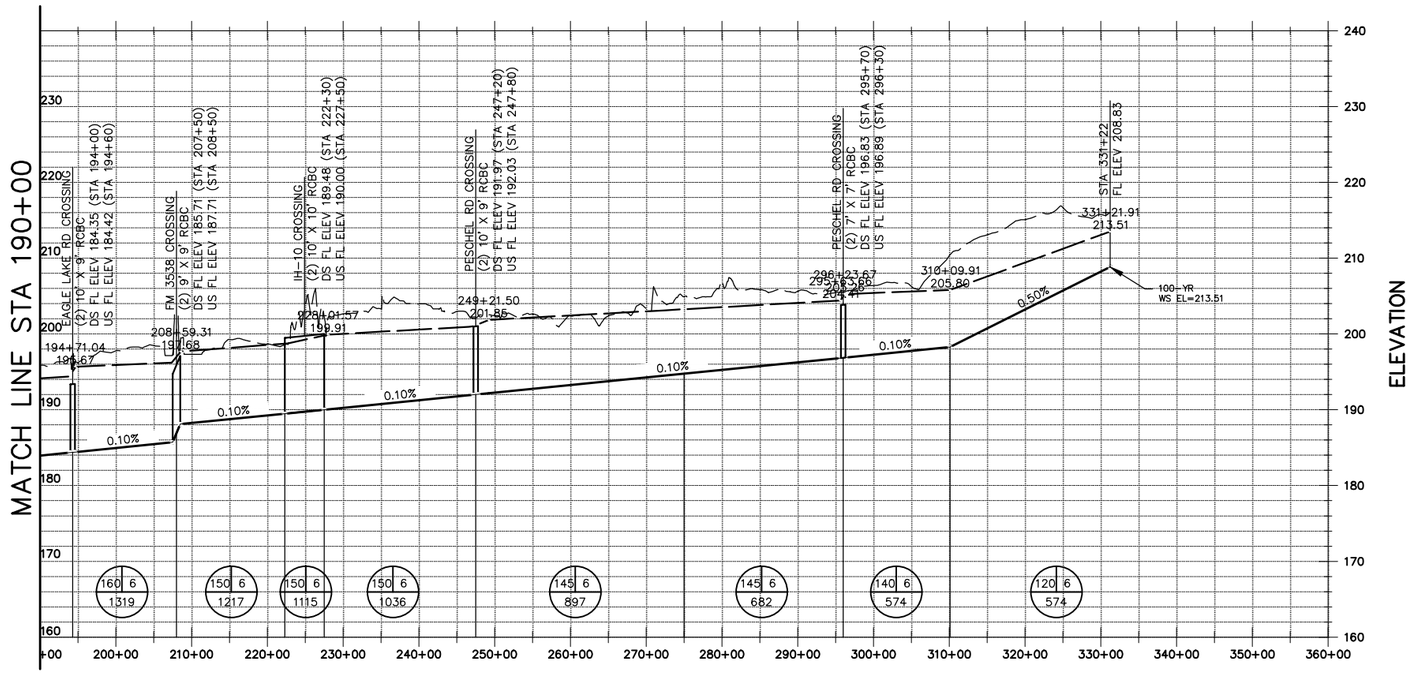
SPI

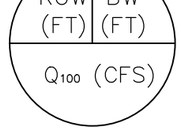
Exhibit 8
LBC 300 Required Channel ROW
Little Bernard Creek Watershed

Job No: 1003011	Scale: 1"= 1000'
File: ROW_Data.mxd	Date: JUNE 2010









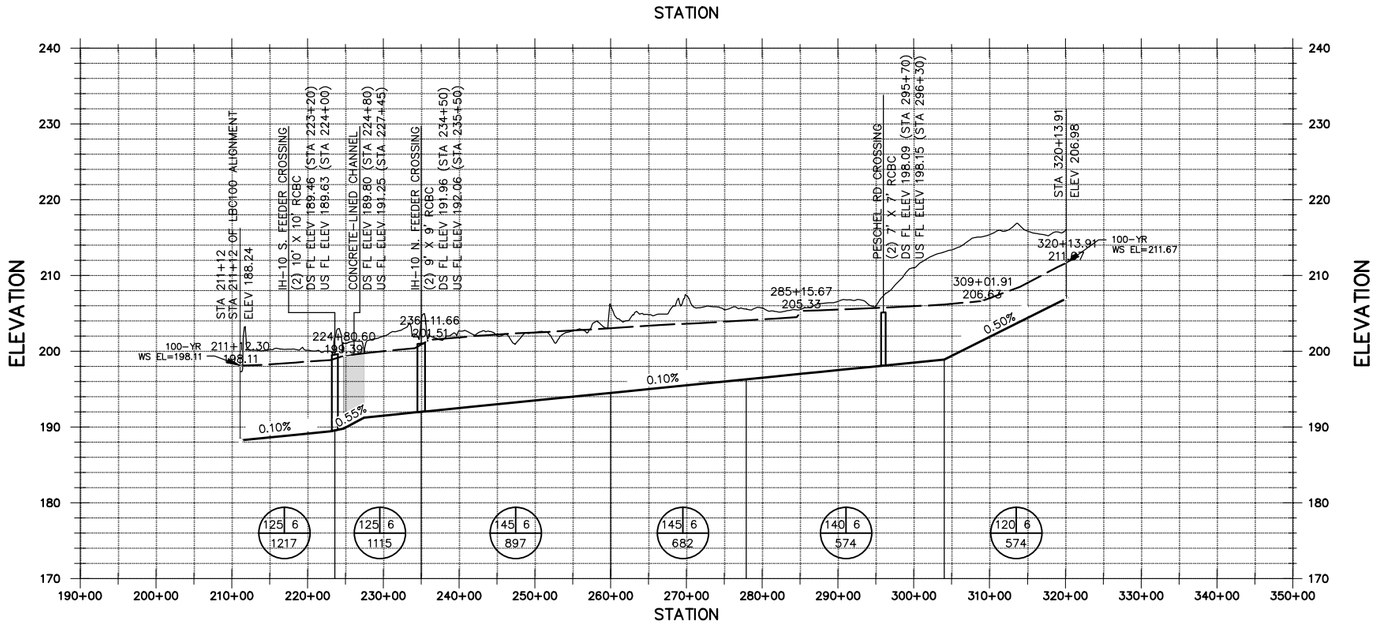
CITY OF SEALY, TEXAS
1879

SPK SCHAUMBURG & POLK, INC.
BEAUMONT ★ HOUSTON ★ TYLER

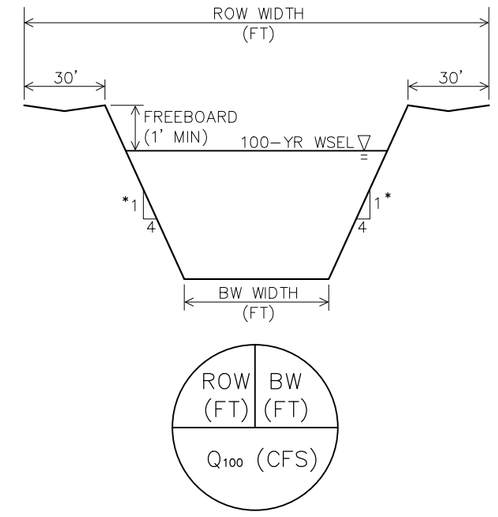
11767 KATY FREEWAY, SUITE 900
HOUSTON, TEXAS 77079-1779
281 . 920 . 0487
FIRM REGISTRATION No F-520

EXHIBIT 9
CHANNEL PROFILE
LBC100

SCALE	PROJECT NUMBER
1" = 2000'	301401.00
DATE	SHEET
JUNE 2010	00 OF 00



NOTE:
THE ABOVE PROFILE REPRESENTS THE ALTERNATE ALIGNMENT OF LBC100 ALONG FM 3538 AND CONTINUES TO THE UPSTREAM-MOST END OF PROPOSED CHANNEL.



* 2:1 SIDE SLOPES FOR CONCRETE-LINED SEGMENT UNDER IH-10

CITY OF SEALY, TEXAS 1879

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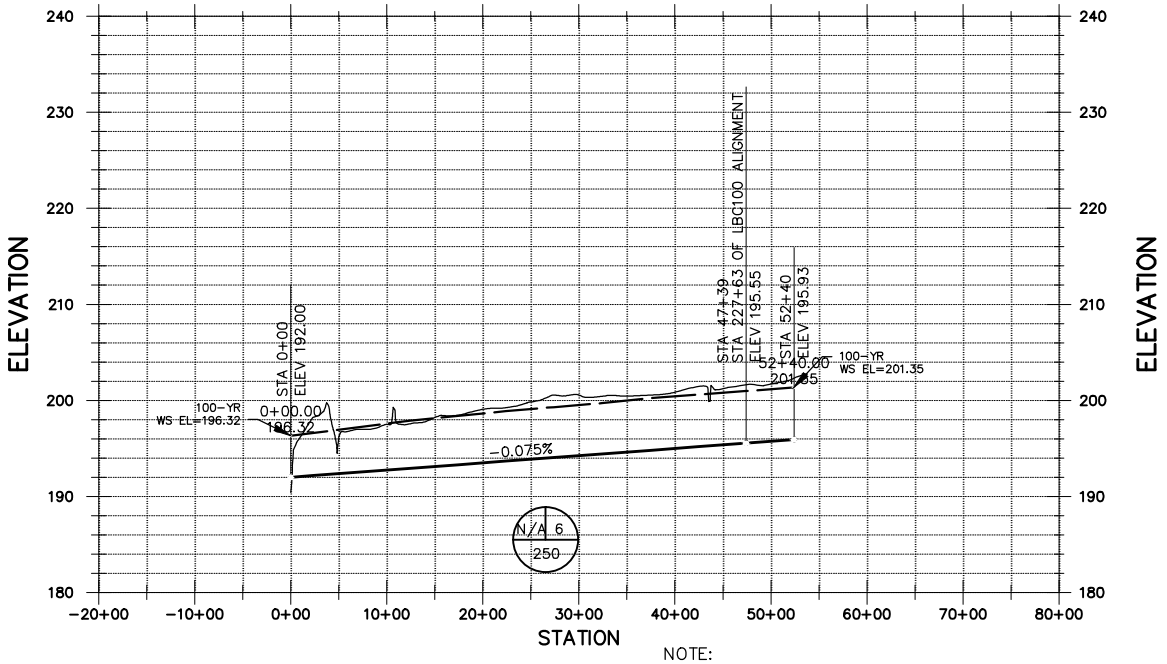
HOUSTON, TEXAS 77079-1779
281.920.0487
FIRM REGISTRATION No F-520

EXHIBIT 10
CHANNEL PROFILE
ALTERNATE LBC100

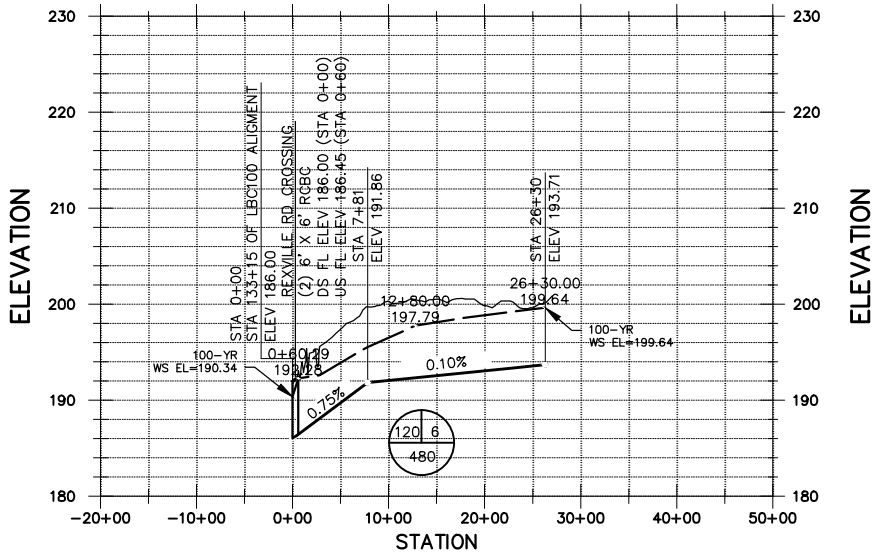
SCALE	PROJECT NUMBER
1" = 1000'	301401.00
DATE	SHEET
JUNE 2010	00 OF 00

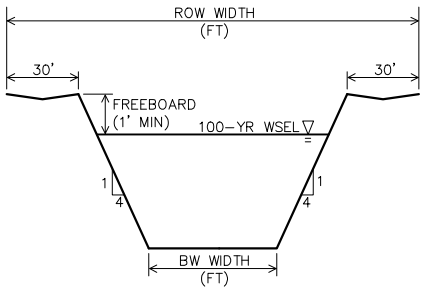
LBC101
STATION



NOTE:
LBC101 IS LOCATED WITHIN EXISTING TXDOT ROW.

LBC201
STATION





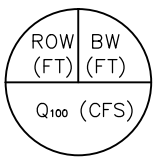


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EXHIBIT 11
CHANNEL PROFILE
LBC101 – LBC201

SCALE	PROJECT NUMBER
1" = 1000'	301401.00
DATE	SHEET
JUNE 2010	00 OF 00