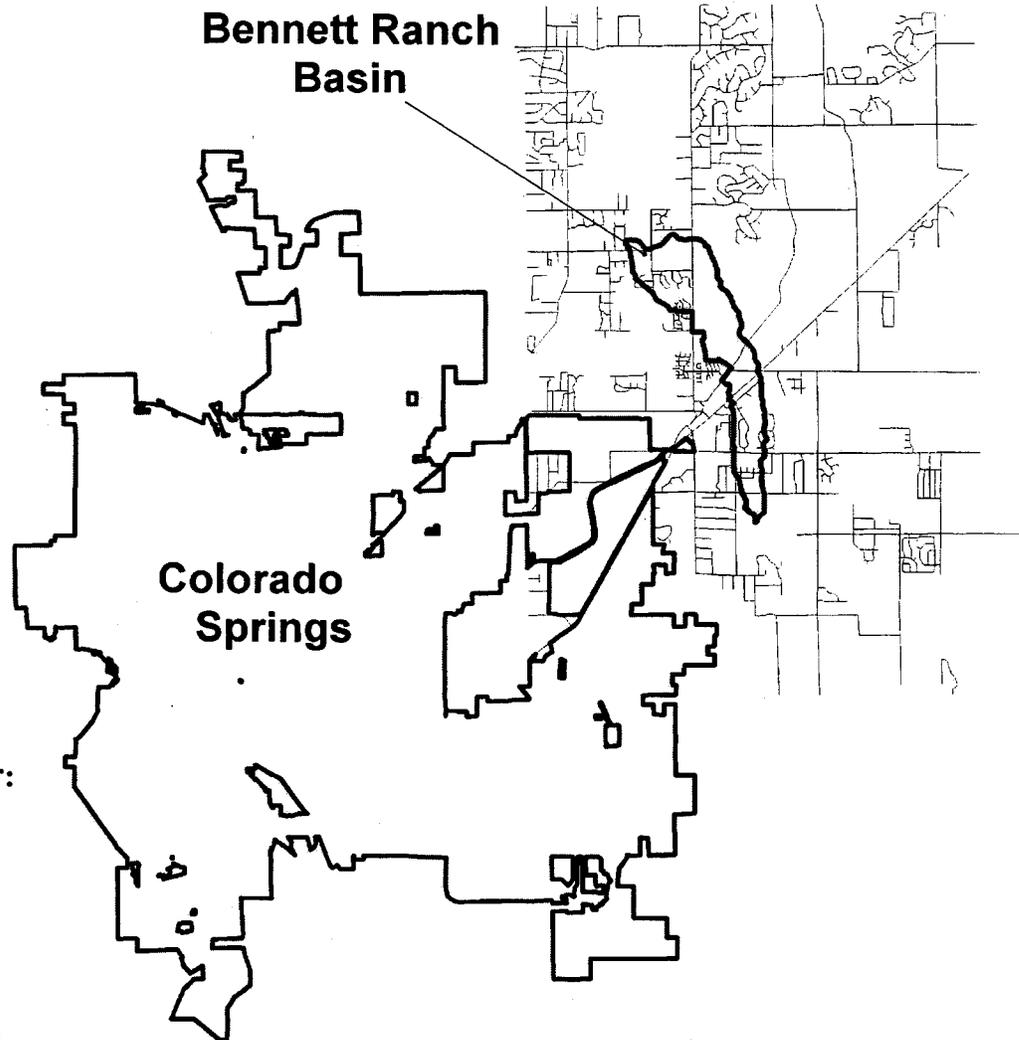


Bennett Ranch Pilot Project Drainage Basin Planning Study

November, 2001



Prepared For:



3460 Marksheffel Road
Colorado Springs, CO 80922

Prepared By:



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EXECUTIVE SUMMARY

Contract Authorization

The Bennett Ranch Drainage Basin Planning Study (DBPS) was authorized under terms of an agreement between El Paso County and Stormwater & Environmental Consultants Inc., A Division of Olsson Associates (SEC OA). This agreement was approved by the El Paso County Procurement and Contracts Department on August 17, 2000.

Agency Jurisdictions

The Bennett Ranch Basin is located within unincorporated El Paso County. The El Paso County Department of Transportation has responsibility for implementation of the approved DBPS. A list of agencies and individuals contacted during the basin planning process are listed below:

- | | |
|--------------------------|---|
| • Anita Culp | United States Army Corps of Engineers |
| • Bob McCue, Lee Carlson | United States Fish and Wildlife Service |
| • Gary Dowler | Colorado Division of Wildlife |
| • John Liou | Federal Emergency Management Agency |
| • Larry Lang | Colorado Water Conservation Board |
| • Bruce Thorson | City of Colorado Springs |
| • Dan Bunting | Regional Floodplain Coordinator |
| • John Valentine | National Resources Conservation Service |
| • Paul Reinswa | Colorado Department of Transportation |
| • Mark Gebhardt | El Paso County Planning |
| • Celia Greenman | Colorado Geological Survey |

The preceding list of agencies and individual were invited to attend an agency coordination meeting on January 30, 2001. The list was also contacted by telephone in October and November of 2001 to ensure that no outstanding issues existed with the DBPS. Please refer to Appendix A of this report for all agency coordination information.

Scope and Purpose

El Paso County is experiencing rapid growth in areas that lack drainage basin planning studies. In an effort to produce basin drainage plans in an expedited manner, El Paso County contracted SEC OA to conduct a Pilot Project that establishes an accelerated planning process for rural basins. The Bennett Ranch drainage basin study was selected to implement the rural basin planning study approach.

The rural basin planning study approach differs from traditional planning studies in that only existing mapping is used (in this case 20-foot contour interval USGS mapping), concept-level design of alternatives is prepared, and budgetary opinions of improvement costs and drainage basin fees are developed. The objectives of the studies are to provide general guidance to land developers and the County until more detailed studies are completed by landowners. In addition, rural basin plans will not include the delineation of floodplains or wetlands, and will not identify and address detailed environmental issues. Finally, rural basin studies consider the Prudent Line

approach as the preferred alternative whenever possible. The Prudent Line approach allows a creek to adjust through erosion and meandering to increased flows from development within a strip of land adjacent to the creek, defined by a "Prudent Line." The hydrology for rural basin planning studies is completed at the same level of detail as conventional DBPS's. Land developers can use the hydrology to delineate floodplains and design improvements based on the concept designs provided in this report.

Existing Conditions

The Bennett Ranch watershed is experiencing rapid development, and peak flows within the watershed are anticipated to increase significantly under future land use conditions. The upper third of the watershed contains a system of well-defined open channel segments with few hydraulic deficiencies. The exception is a set of failing culverts located at Meridian Road.

The middle third of the watershed contains undersized and discontinuous channel segments, undersized culverts and bridges, and all of the reported flood-related problems.

The lower third of the watershed contains continuous and adequately sized channels, one adequately sized bridge, and two undersized culvert crossings.

Hydrology

Estimated 100-year peak flows under current land use conditions is 680 cfs at Meridian Road, 1,420 cfs at Highway 24, and 1,670 cfs at Garrett Road. These flows are estimated to increase to 780 cfs, 1,820 cfs, and 2,210 cfs respectively under future land use conditions if no improvements are made within the basin.

Floodplains

Floodplains are not evaluated in this study. Land developers will be required to delineate floodplains using the hydrology in this report and more detailed mapping, and/or provide a Conditional Letter Of Map Revision (CLOMR).

Approach and Alternatives

The hydrologic model HEC-1 was used to identify and evaluate Prudent Line applicability, system deficiencies, and project alternatives. Study Analysis indicates that the Prudent Line approach is only applicable for use in the upper third of the Bennett Ranch watershed (upstream from Eastonville Road). Over one-half of the evaluated open channel reaches are deficient (25,800 feet of open channel), and nine of the ten existing crossings are deficient (the existing Falcon Highway bridge meets design criteria).

Two alternatives were developed and evaluated. The first alternative upgrades all reaches and hydraulic structures to meet DCM design criteria and/or Prudent Line criteria without providing regional detention storage. The second alternative upgrades all reaches and hydraulic structures by incorporating regional detention upstream of Eastonville Road.

Recommended Alternative and Phasing

The regional detention alternative (second alternative) is the recommended alternative for the Bennett Ranch basin. This alternative is recommended over the first alternative for the following reasons:

- It reflects the detention scenario required by the Board of County Commissioners.
- It requires smaller upgraded structures, smaller cross-sectional area of new channel segments.
- It requires construction of fewer channel check structures.
- It requires less in-stream and riparian-zone construction and associated 404 permitting in the well-established, healthy riparian channels located in the lower 1/3 of the watershed.

The cost of the recommended alternative is estimated at \$7.9 million and includes Prudent Line in the upper-most reaches of the watershed, detention ponds and associated transition channel upstream from Eastonville Road, and new channel between Eastonville Road and Drake Pond. It also replaces all nine of the undersized culverts located throughout the length of the drainage way and check structures along channel reaches located between Sunnyslope Drive and the project outfall to maintain a stable channel slope. This alternative allows the existing bridge located at the Falcon Highway and a proposed new CDOT bridge crossing at Highway 24 to remain unchanged.

The following summarizes the recommended phasing of these improvements.

High Priority Improvements

The highest priority improvements are located in the middle of the watershed between Meridian Road and Drake Pond. These improvements include the detention ponds and associated transition channel located upstream of Eastonville Road and the new channel segments and box culverts located between Eastonville Road and Drake pond. The detention ponds and associated transition channel are considered high priority because of the rapidly developing basins upstream of Eastonville Road. Future condition peak flows from these developing basins need to be attenuated in order to minimize downstream impacts. The improvements between Eastonville Road and Drake Pond are considered high priority because there is an existing drainage system discontinuity in this location that causes flooding problems. Constructing these improvements will reduce peak flows and provide a continuous conveyance system through the project watershed. Replacing the failing culverts located at Meridian Road should also be a high priority because the erosion will soon undermine the roadway.

Medium Priority Improvements

Of secondary importance is the upgrading of culvert crossings located at Sunnyslope Drive and Garrett Road. The existing culverts located at these crossing are undersized and should be replaced to meet DCM design standards but are not considered a high priority because there are no reported flood-related problems at these crossings.

Low Priority Improvements

The following improvements upgrade system deficiencies to DCM standards but do not provide flood-reduction benefits and could therefore be constructed last: replacement of the Snowbrush Drive culvert, demolition of the existing berms located at the ponds just downstream from Snowbrush Drive, construction of the check structures along the existing channel located between Sunnyslope Drive and the project outfall, and purchasing of Prudent Line easement from Snowbrush Drive to Meridian Road.

1. SCOPE AND PURPOSE

El Paso County is experiencing rapid growth in areas that lack drainage basin planning studies. In an effort to produce drainage basin plans in an expedited manner and at less cost, El Paso County contracted with SEC OA to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as a watershed that will likely contain impervious areas totaling less than 15% of the land area under full build-out conditions.

El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies. The approach taken to prepare this Pilot Project differs from the approach taken to prepare traditional basin planning studies in several ways. Table 1-1 lists the major differences between a rural basin planning study scope of work and a traditional basin planning study scope.

Table 1-1 - Major Differences in Study Scopes

Rural Basin Studies will:	Rural Basin Studies will not:
<ul style="list-style-type: none"> • use existing mapping for project topographic information (generally USGS 7.5-minute quadrangle maps with 10 to 20-foot contour intervals). • complete HEC-1 hydrology for existing and future land use conditions. • use GIS to prepare land use and soil themes. These themes can easily be electronically modified, reducing the effort required to recalculate model parameters. • prepare concept-level design of alternatives. • prepare budgetary opinions of cost to implement alternatives. • recommend the Prudent Line Approach as preferred alternative if criteria is met. • generate basin fees. 	<ul style="list-style-type: none"> • complete new aerial photography and contour mapping. • delineate floodplains. • delineate wetlands. • identify or address environmental issues

Issues Requiring Further Consideration

The following list presents topics and report conclusions specific to the Bennett Ranch Pilot Project that will require further analysis during the design phase of project alternatives:

- Wetlands were not delineated in this study. All improvements will require the identification of upland-wetland boundaries to determine 404 permitting requirements and/or any modifications to improvement locations.
- The Bennett Ranch basin may contain habitat or populations of Federally listed threatened or endangered species, including but not limited to the Preble's meadow jumping mouse. Developers will be responsible for complying with the Endangered Species Act.
- Groundwater issues were not evaluated in this study. High groundwater conditions may exist in portions of the Bennett Ranch basin. Developers will be responsible for addressing complications associated with high groundwater, particularly in the design of stormwater detention facilities.
- All new channels and associated check structures are designed based on a flow depth of five feet (El Paso County DCM maximum depth for 100-yr event) and estimated channel slopes based on the USGS mapping. The design assumption of flow depth of five feet should be revisited to optimize channel size when more accurate mapping is completed.
- Design of new channels will require more detailed and current contour mapping to refine sizes, locations, and slopes.
- The alternatives are based on the assumption that new channels can be excavated approximately six feet and still discharge at the watershed outfall to West Squirrel Creek. This assumption needs to be verified with survey information or refined mapping.
- Floodplains were not evaluated in this study. This study assumes that the floodplain covers half of the Prudent Line setback. Cost estimates of Prudent Line easements are based on this assumption. Delineation of the floodplain would allow refinement of the cost associated with purchasing Prudent Line easements.
- Existing utilities were not evaluated in this study. Cost estimates for relocating existing utilities were estimated as five percent of construction costs. More detailed mapping would allow for better estimates of existing utility relocations.
- Prudent Line setbacks are intended to be equal to floodplain limits when the calculated Prudent Line limit falls inside the floodplain limits. However, because floodplains were

not evaluated in this study, it was assumed that the Prudent Line setbacks exceed all floodplain limits. Delineation of floodplains would allow more accurate Prudent Line setbacks.

- The peak flows presented in this study for the existing system (i.e. no upgrades to existing culverts or bridges) are affected by the estimated inadvertent storage upstream of road crossings. This storage was estimated using stage-storage-discharge relationships developed based on field observations and the existing 20-foot contour interval USGS mapping. This does not affect the accuracy of the recommended alternative because peak flows used to develop the alternatives are based on upgraded structures sized to adequately convey design flows.

2. WATERSHED CHARACTERISTICS

Introduction

The Bennett Ranch watershed is located approximately 20 miles northeast of downtown Colorado Springs. The western boundary is located two miles east of the town of Falcon. The approximately seven square-mile watershed is long, narrow, and aligned north to south. The existing development in the watershed is comprised mostly of large-lot (greater than 2.5 acres) single-family homes. Large portions of land within the watershed are currently undeveloped and used as pasturelands for grazing. Soils characteristic to the watershed are relatively permeable and are quick to erode when exposed to water.

Storm water runoff generally flows north to south through the watershed in a series of open channels to its confluence with the West Fork of Squirrel Creek. Several major roads cross the watershed including Meridian Road, Eastonville Road, Highway 24, Falcon Highway, and Garrett Road. A number of culverts under these roads have caused water to back up during large events and this has resulted in flooding problems in the middle reaches of the watershed.

Figure 2-1 shows the watershed boundary, major roads within the watershed, and project location relative to Colorado Springs.

Existing Drainage Patterns and Problems

Stormwater runoff within the watershed is conveyed north to south through a series of open channel reaches, culverts, and bridges as shown on Figure 2-2. This section describes the existing conveyance system and associated flood-related problems.

Northern Reaches

Channels located north of Eastonville Road are predominantly steeper in slope, less vegetated, and more defined than in the middle and southern reaches of the watershed. Photograph 2-1 shows a typical upper-reach channel section and Photograph 2-2 shows a typical lower-reach channel section.

There are no reported flooding-related problems within the northern reaches of the watershed. The three 48-inch diameter culverts used to convey storm water under Meridian Road are, however, failing on the downstream end as shown in Photograph 2-3.

Middle Reaches

Drainage ways located between Eastonville Road and Drake Pond are poorly defined, undersized, and discontinuous. It is in this middle portion of the watershed that most of the identified hydraulic deficiencies occur.

Conveyance problems within the watershed begin approximately ½ mile upstream from Eastonville Road at a berm constructed to divert flow from the original channel configuration. Stormwater runoff now flows south from the berm towards Eastonville Road in a poorly defined channel until entering a short segment of recently constructed trapezoidal channel. The new channel segment ends at Eastonville Road and is shown in Photograph 2-4. As shown in the

photograph, there is currently no bridge or culvert to convey water across the road and water ponds on the roadway during most rainfall events.

A shallow and undersized channel conveys runoff from the downstream side of Eastonville Road to the upstream side of Orr Road. The defined channel ends at Orr Road and stormwater flows overland (Photograph 2-5) to three obstacles: an abandoned railroad embankment, Highway 24, and Blue Gill Drive. One bridge and eight culverts convey water under the rail line, Highway 24, and Blue Gill Drive. The structures were constructed by different entities at different times and each structure has a unique capacity and alignment. Flooding of property is reported to occur frequently near Blue Gill Drive. Figure 2-2 shows the nine structures and the area of flooding.

Southern Reaches

Downstream from Blue Gill Drive stormwater converges and is routed south in a shallow swale. This swale conveys stormwater past a large privately owned pond (Drake Pond) and south to Falcon Highway. A new bridge sized for the 100-year event (BDG-01) conveys flows under the Falcon Highway to Sunnyslope Drive. A 36-inch diameter culvert (CUL-02) conveys flow under Sunnyslope drive. Downstream from CUL-02, the channel becomes less well defined as shown in Photograph 2-6. The channel continues south past one more road crossing, Garrett Road (CUL-01), to the lower watershed boundary. There are no reported flood-related problems in the southern reaches of the watershed. Culvert crossings and channel segments lack the capacity to convey flows from the future conditions 100-year event. (See Deficiency Identification Section).

Land Use

Figure 2-3 presents existing land use conditions within the project watershed. Approximately half of the basin is currently used for pasturelands or is undeveloped. The remaining portion of the basin is comprised of large-lot single-family homes.

Figure 2-4 presents likely future land use conditions within the project watershed¹. A comparison of the two land use figures (Existing and Future) shows that the majority of the land use changes are expected to occur between Meridian Road and Highway 24. Most of the land between these roads is currently undeveloped and used for agriculture. It is anticipated that with the development of the Bennett Ranch, Woodmen Hills, and Meridian Subdivisions, nearly all of the land in this area will be developed into medium to high-density single-family homes. In addition, it is anticipated that the basin will include some commercial and industrial development, two highly impervious land uses that do not currently exist within the watershed. Most of the northern 1/3 (upstream) and southern (downstream) portions of the watershed are to be used for large-lot single family homes.

¹ The future land use scenario was updated in February 2001 to reflect recent development changes within the project watershed. All study figures, peak flows, analysis, and alternatives reflect this updated scenario.

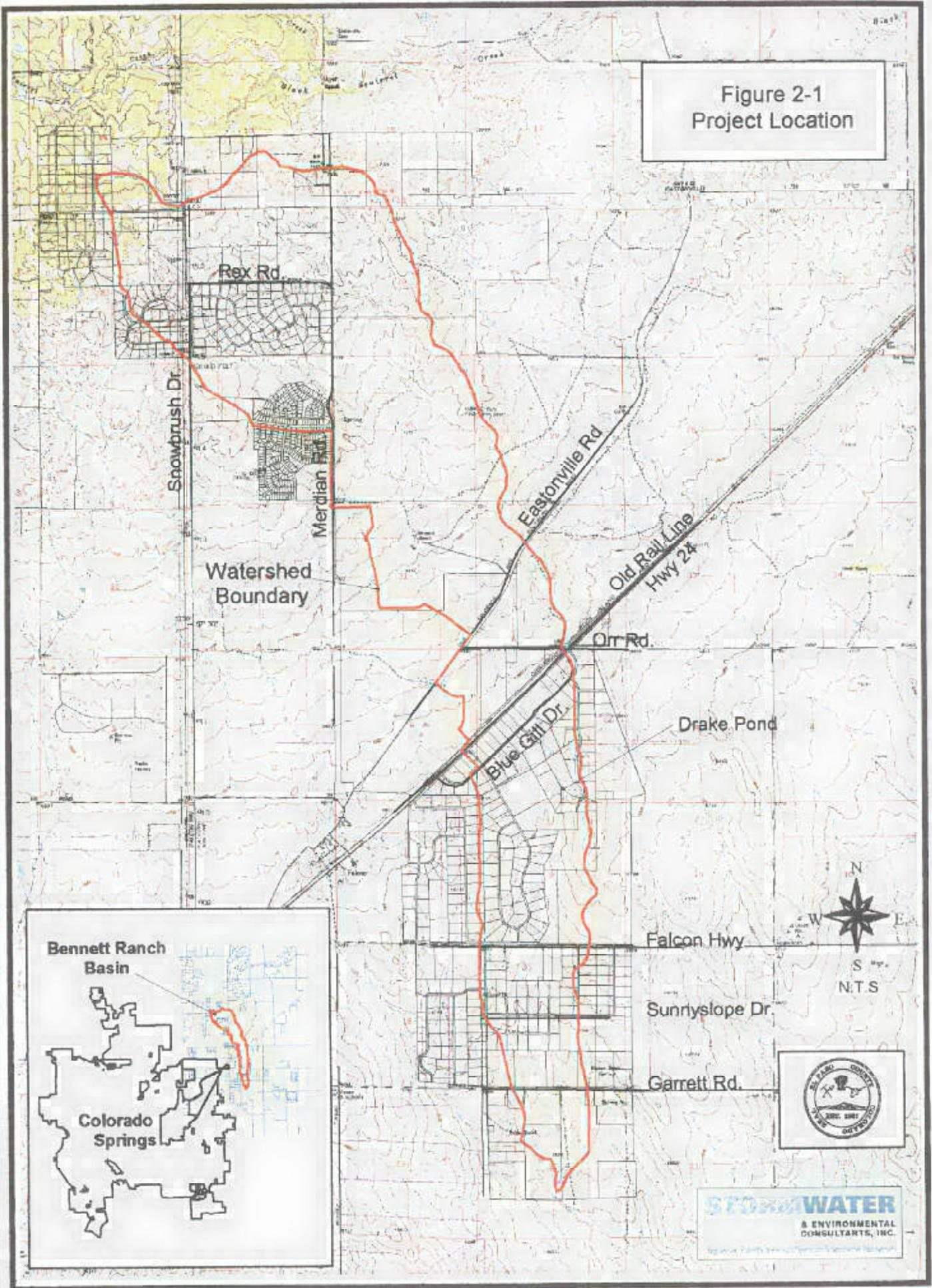
Soils

Figure 2-5 presents the hydrologic soil groups located within the watershed. The soil groups are based on the United States Department of Agriculture Soil Survey of El Paso County². The watershed is comprised of predominantly low-runoff potential soils (Groups A and B). Group A hydrologic soils will produce less rainfall induced runoff than Group D soils. There are no Group C hydrologic soils within the project watershed.

The watershed soils were discussed during an agency coordination meeting held on January 30, 2001. The Natural Resource Conservation Service representative at the meeting recommended modifying the HEC-1 model to reflect the saturated soil conditions found adjacent to Highway 24. The USCOE and Colorado Geological Survey representatives concurred. The HEC-1 model initial infiltration rates have been reduced to 0.5 inches in subcatchments 130, 140, 150, 160, 170, and 180 (Figure 3-1) to simulate this area of wet soil conditions. This is less than half of the HEC-1 default infiltration rates.

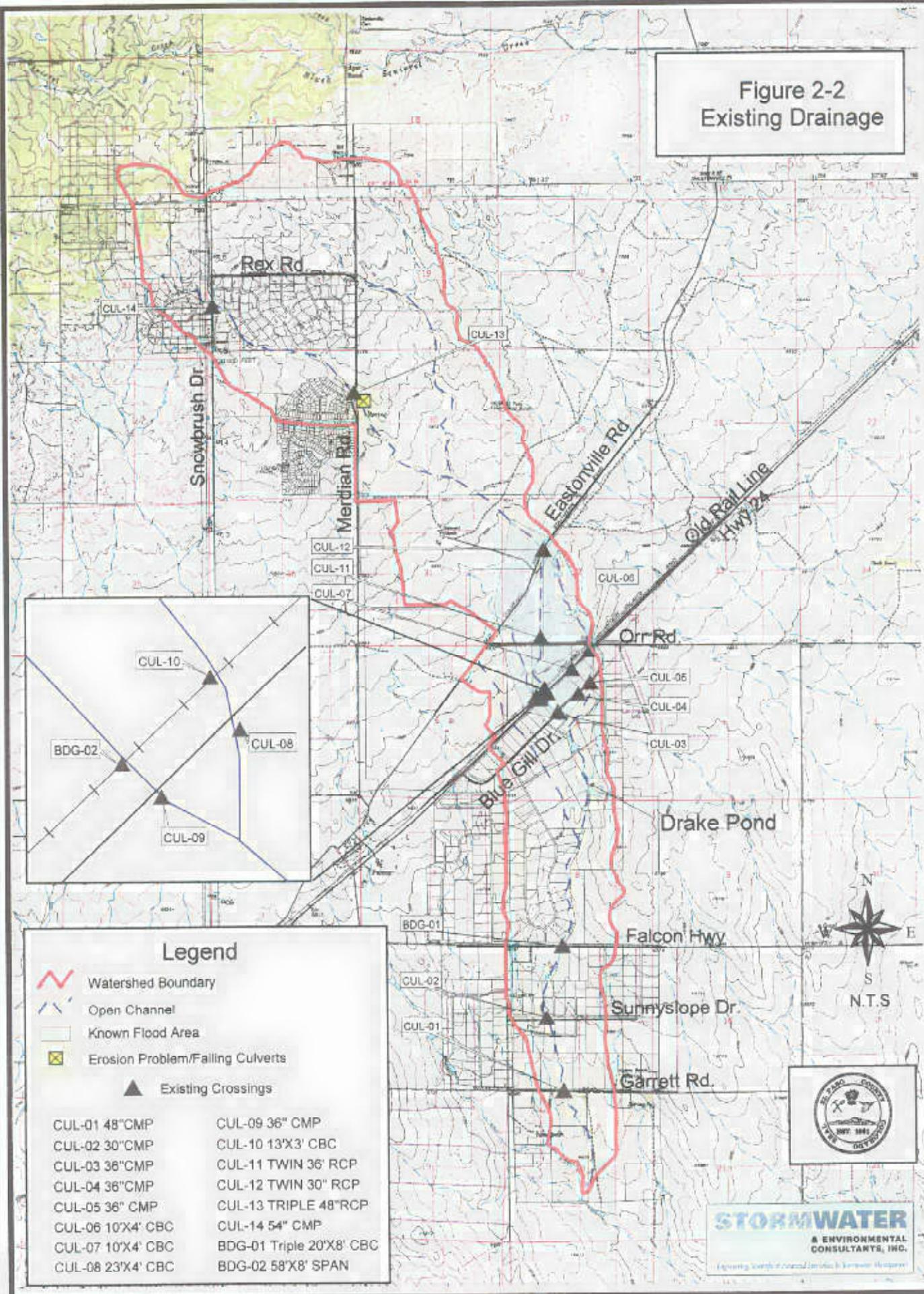
² US Department of Agriculture Soil Conservation Service, 1974, *Soil Survey of El Paso County Area, Colorado*.

Figure 2-1
Project Location



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Figure 2-2
Existing Drainage

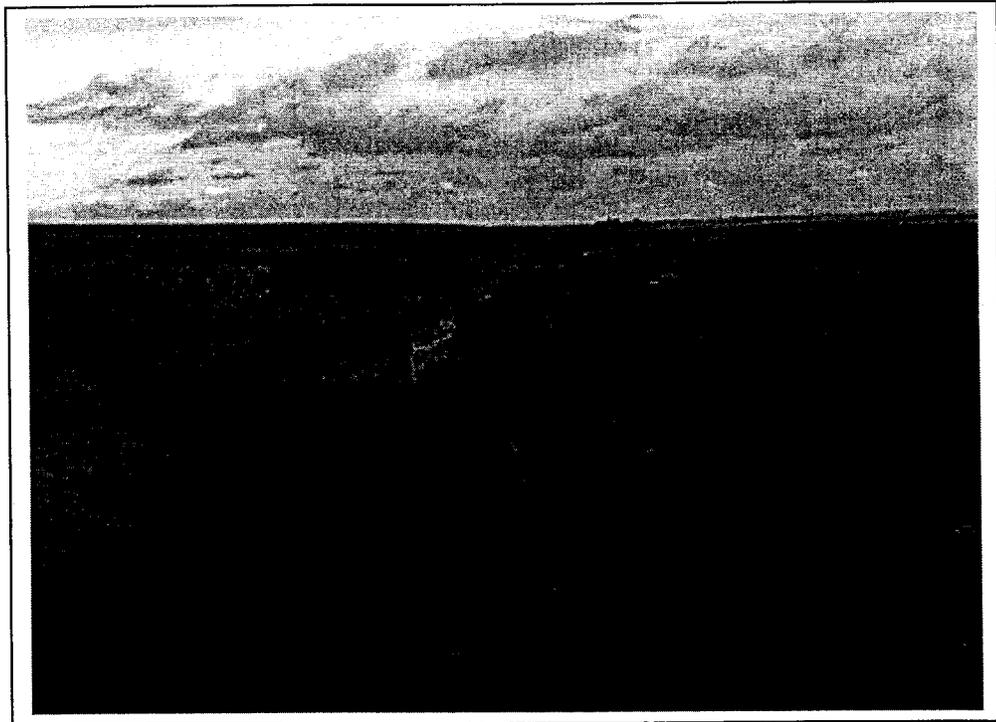


Legend

- Watershed Boundary
- Open Channel
- Known Flood Area
- Erosion Problem/Falling Culverts
- Existing Crossings

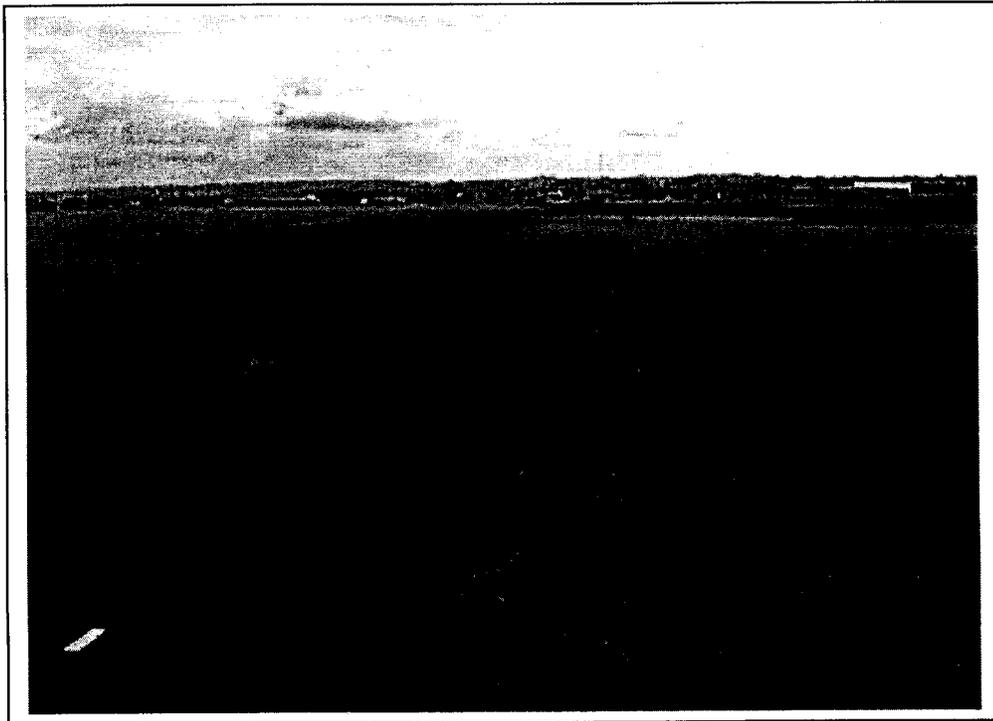
CUL-01 48" CMP	CUL-09 36" CMP
CUL-02 30" CMP	CUL-10 13'X3' CBC
CUL-03 36" CMP	CUL-11 TWIN 36' RCP
CUL-04 36" CMP	CUL-12 TWIN 30" RCP
CUL-05 36" CMP	CUL-13 TRIPLE 48" RCP
CUL-06 10'X4' CBC	CUL-14 54" CMP
CUL-07 10'X4' CBC	BDG-01 Triple 20'X8' CBC
CUL-08 23'X4' CBC	BDG-02 58'X8' SPAN

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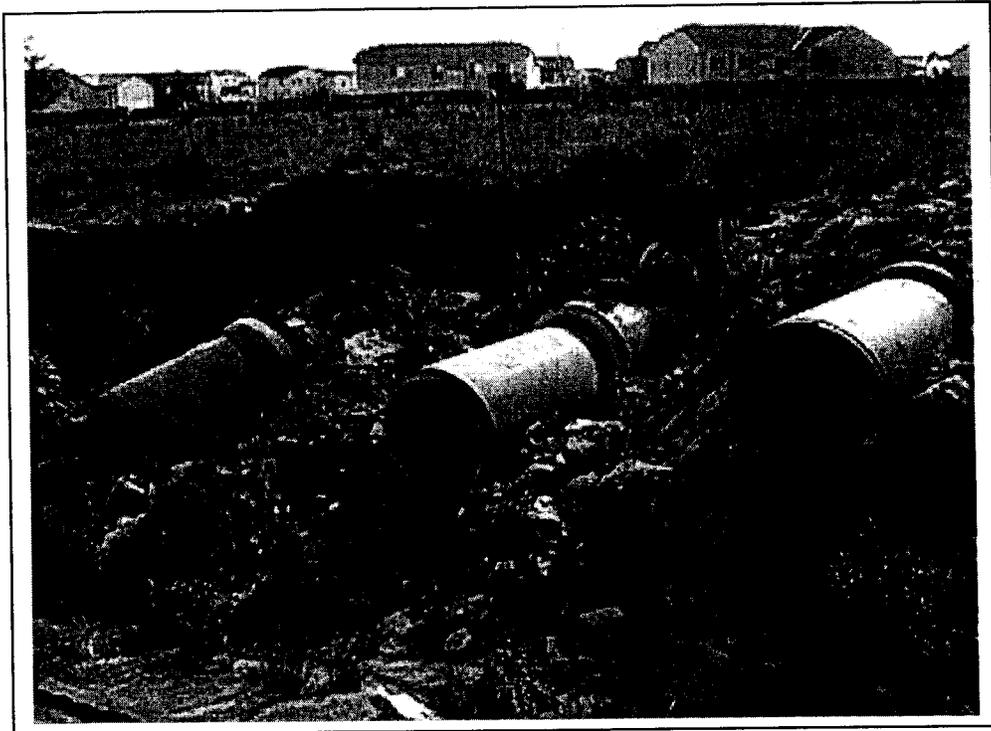
Photograph 2-1:

Looking downstream from Meridian Road at a channel section typical of the upper reaches of the watershed.

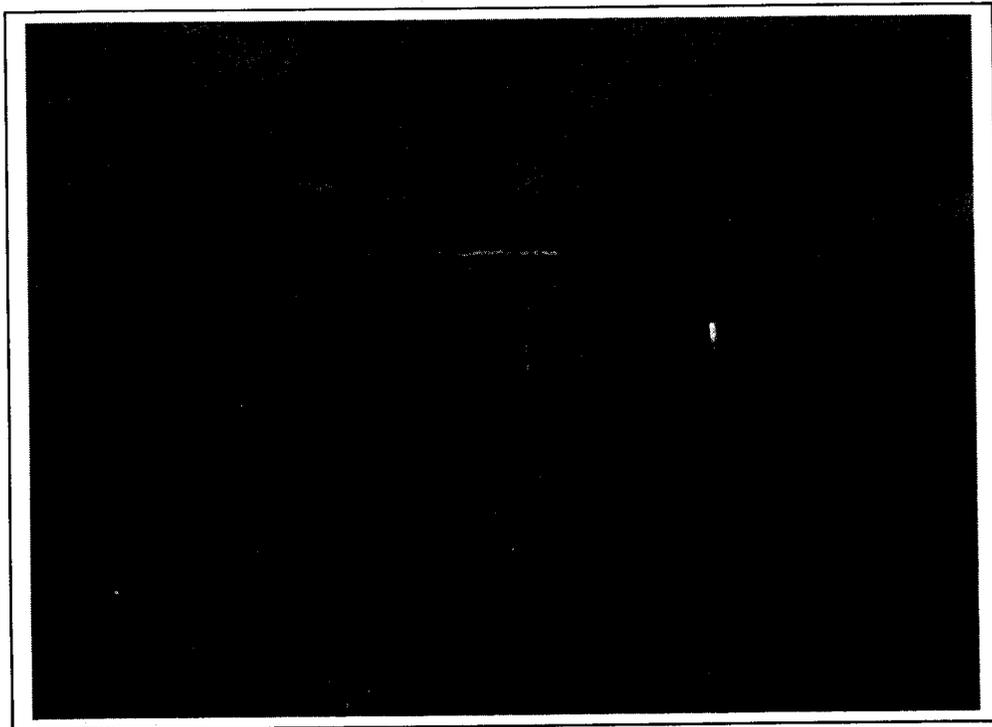


Photograph 2-2:

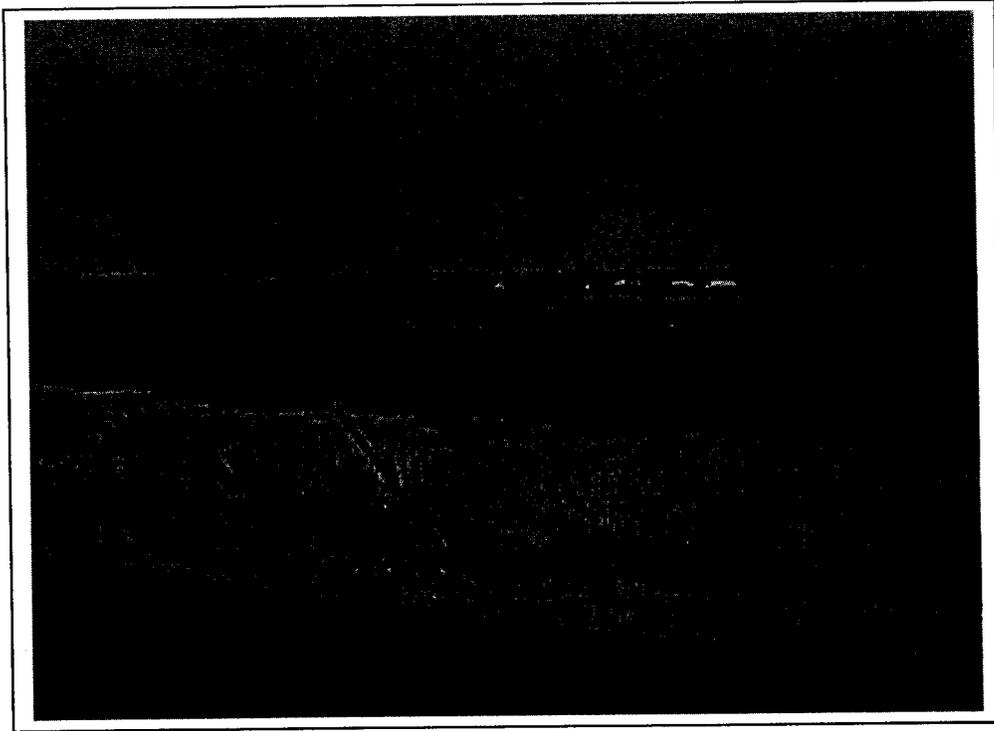
Looking downstream from Falcon Highway at a channel section typical of the lower reaches of the watershed.



Photograph 2-3:
Downstream ends of failing 48 inch-diameter culverts under Meridian Road.

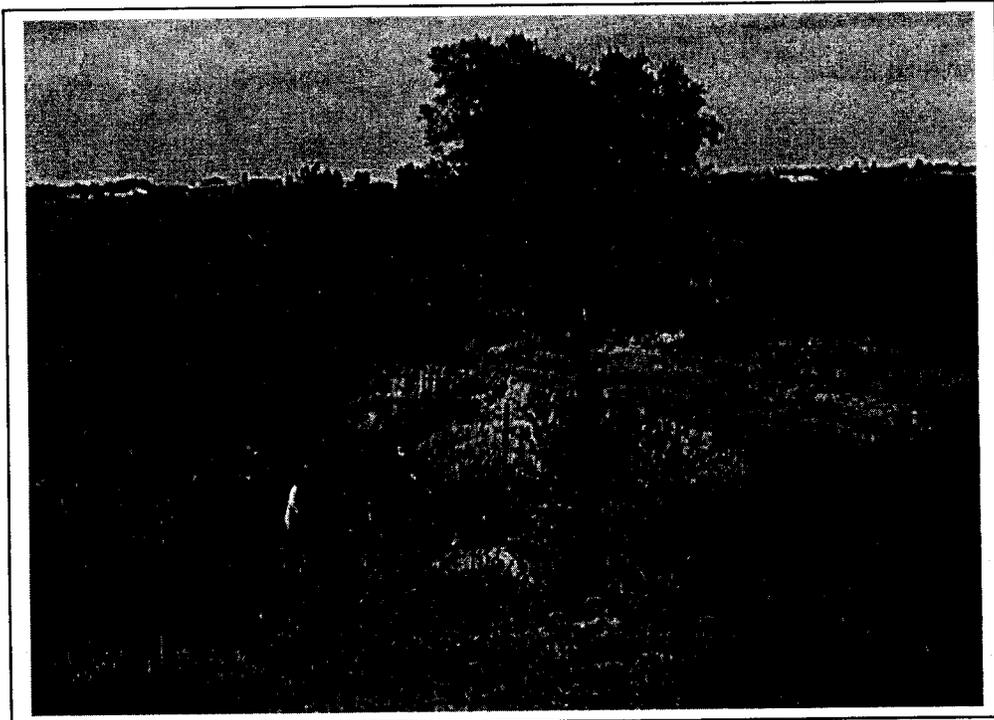


Photograph 2-4:
Looking upstream at the constructed channel segment from Eastonville Road. There is currently no culvert or bridge under the road to convey the channel flows.



Photograph 2-5:

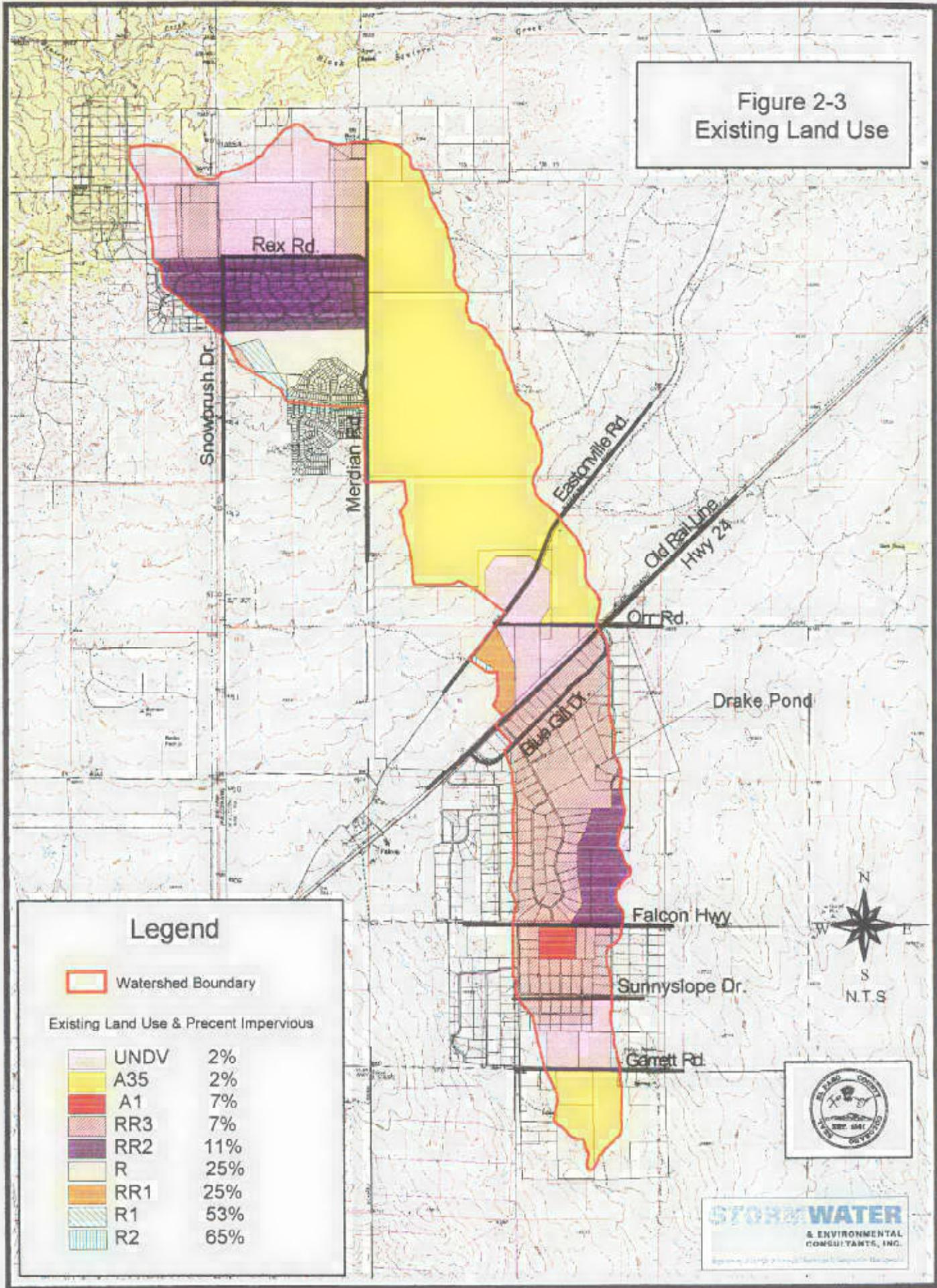
Looking downstream from Orr Road at undefined drainage way. Highway 24 and the abandoned railroad embankment are on the horizon.



Photograph 2-6:

Looking upstream from Garrett Road towards Sunnyslope Drive. Shows poorly defined channel characteristic of the downstream reaches.

Figure 2-3
Existing Land Use



Legend

Watershed Boundary

Existing Land Use & Percent Impervious

	UNDV	2%
	A35	2%
	A1	7%
	RR3	7%
	RR2	11%
	R	25%
	RR1	25%
	R1	53%
	R2	65%

Figure 2-4
Future Land Use

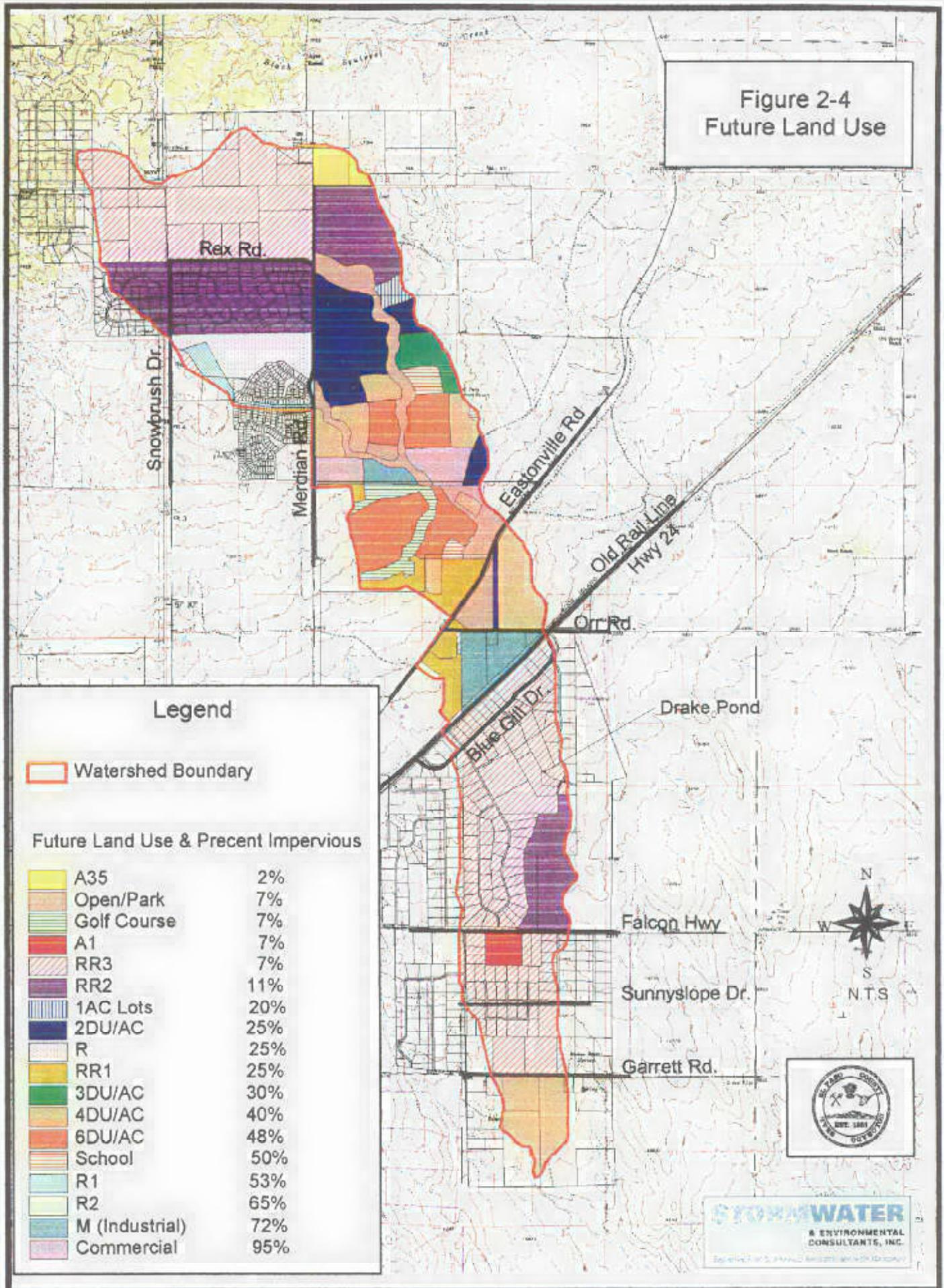
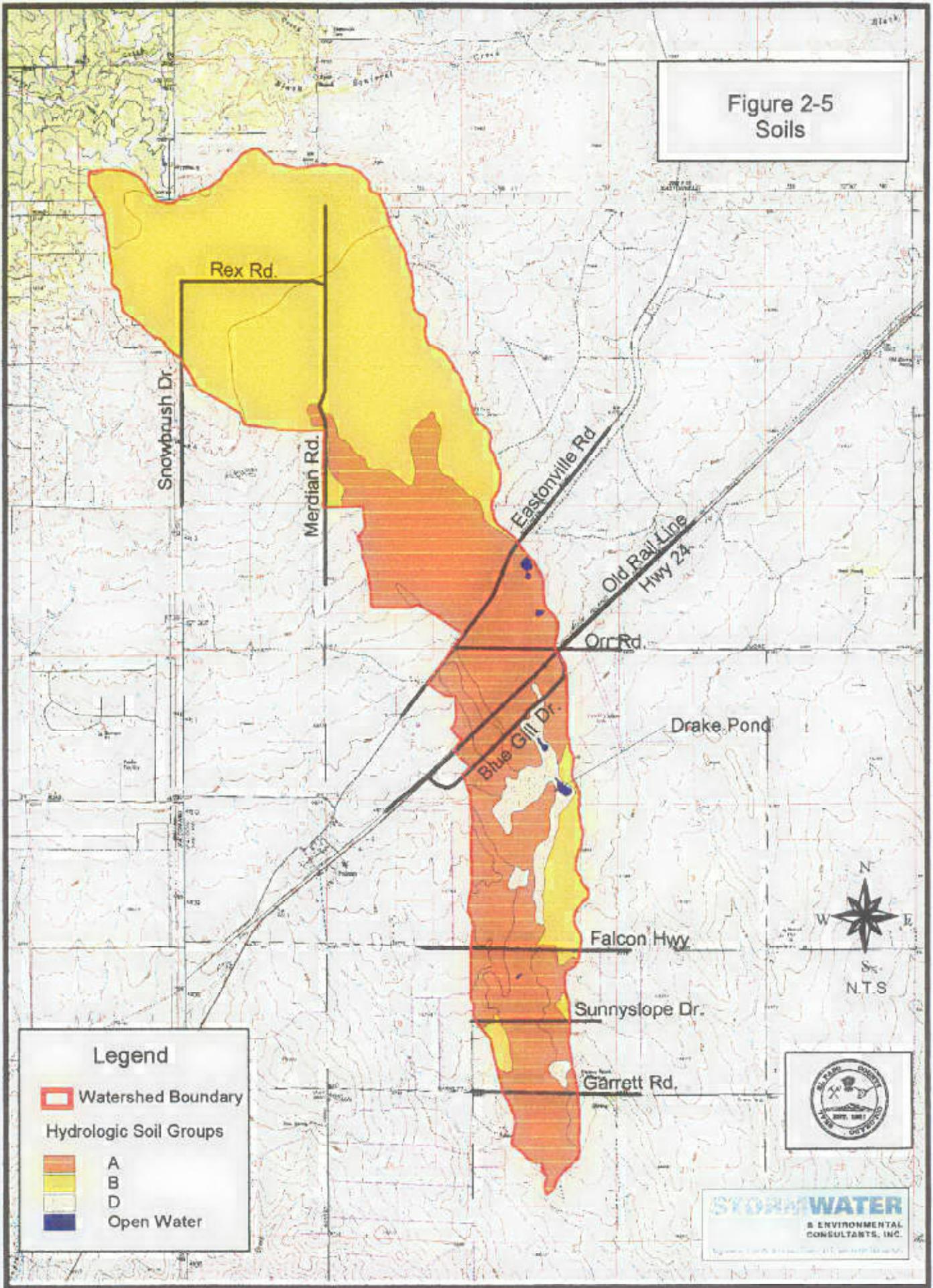


Figure 2-5
Soils



Legend

-  Watershed Boundary
- Hydrologic Soil Groups**
-  A
-  B
-  D
-  Open Water



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3. HYDROLOGIC MODELING AND PEAK FLOWS

Introduction

The US Army Corps of Engineers rainfall/runoff model HEC-1 was used to develop runoff hydrographs and peak flows at selected locations within the Bennett Ranch project watershed. This section summarizes how the study models were developed, presents model results, and explains the comparisons used to verify the model results. The Bennett Ranch Pilot Project Technical Appendices (separate document) presents these topics in more detail.

Model Parameters

HEC-1 develops runoff hydrographs based on user input parameters that define basin, routing, and rainfall characteristics. Table 3-1 lists the data source used to develop each of the following input parameters.

Basin Parameters

The USGS 7.5-minute quadrangle maps were used to delineate the approximately 7 square-mile project watershed into 27 subcatchments based on topography. The subcatchment bounds were refined based on land use conditions, structure locations, and desired hydrograph output locations. HEC-1 uses the parameters of Travel Time and SCS Curve Numbers to define the runoff potential for each of the subcatchments. The USGS 7.5-minute quadrangle maps were used to define Travel Times for each of the model subcatchments. The SCS Curve Numbers were developed based on El Paso County DCM guidance criteria and the existing and future land use scenarios presented in Figures 2-3 and 2-4. Figure 3-1 shows the project watershed and model subcatchments.

Note that three of the subcatchments (250, 260, and 270) define land that is hydrologically disconnected from the remainder of the watershed. This area of land is located in the southern end of the Bennett Ranch watershed and discharges runoff directly to the West Fork of Squirrel Creek. Peak flows are reported for these three subcatchments but no further analysis is conducted on this area.

Routing Parameters

HEC-1 routes runoff hydrographs through a series of independent open channel segments, culverts, or bridges. These routing elements are defined by input parameters based on slope, cross section, Manning roughness coefficients, and elevation versus discharge relationships.

Forty different routing elements were developed to simulate conveyance of the storm water runoff hydrographs through the watershed. The USGS 7.5-minute quadrangle maps, field observations, and aerial photographs were used to define the input parameters for these routing elements. Figure 3-2 presents a schematic of the HEC-1 routing system³ used to simulate conveyance of stormwater through the Bennett Ranch watershed.

³ The HEC-1 model schematic used to simulate and evaluate the detention alternative is presented in the Technical Appendices.

Rainfall Parameters

The El Paso County DCM requires an evaluation of both the 2-hour and 24-hour rainfall events to determine the design storm for the particular study basin. The standard SCS cumulative rainfall distribution presented in the El Paso County Drainage Criteria Manual was used to define the model rainfall events. An evaluation of both events determined that the 24-hour event defines the design storm for the Bennett Ranch watershed. The SCS unit hydrograph method with a computational time step of 5 minutes was used for all model runs.

Table 3-1 - Model Input Parameters

Parameter	Data Source
Land Use: Existing and Future Conditions	El Paso County, URS Corporation as representatives for the Bennett Ranch and Meridian Subdivision developers
SCS Curve Numbers	El Paso County DCM based on land use designations and hydrologic soil groups
Hydrologic Soils	SCS Soil Survey of El Paso County
Travel Time: distance and slope	USGS 20-foot contour-interval Falcon, Falcon NW, Eastonville, and Black Forest 7.5-minute quadrangle maps
Culvert/Bridge stage discharge relationships	Field observations, aerial photographs, USGS quadrangle maps
Rainfall: 5-year, 24-hour 100-year, 24-hour	NOAA Atlas 2, Volume III and SCS distribution from El Paso County DCM
Manning's n-value	Field observations and aerial photographs
Structure/channel Cross Sections	Field observations

Model Results

The following table (Table 3-2) presents model results as peak flows at major crossings within the project watershed. Model results are presented for both the 5-year and 100-year, 24-hour rainfall events.

The first four columns in the table present peak flows in cubic feet per second based on the capacities and associated backwater effects of the existing culverts and bridges within the watershed. The first and third columns present flow estimates resulting from existing land use conditions.

The second and fourth columns present flow estimates that will likely result under future land use conditions. Comparison of the estimated peak flows from existing land use conditions to corresponding future land use condition flows indicate that flows may increase significantly in the future.

The last column in the table (100-yr DCM) presents peak flows resulting from upgrading all of the culverts and bridges to comply with DCM conveyance capacities. Comparison of this column to the 100-year future land use conditions column shows that the existing culverts and bridges are undersized and provide significant flood peak attenuation.

Peak flows within the watershed are shown in Figure 3-3. Results are also shown graphically in Figure 3-4 as peak flow by stream length. The Bennett Ranch Pilot Project Technical Appendices present the HEC-1 model input and output files.

Table 3-2 - HEC-1 Model Results: Peak Flows at Major Crossings

Location	Event Peak Flows (cfs) ⁴				
	5-yr Existing ¹	5-yr Future ²	100-yr Existing ¹	100-yr Future ²	100-yr DCM ³
Snowbrush Drive	29	53	166	223	223
Meridian Road	130	190	680	780	840
Eastonville Road	300	415	1570	1860	1930
Judge Orr Road	300	415	1560	1850	1910
Blue Gill/Hwy 24	300	415	1420	1820	1950
Falcon Highway	340	490	1670	2250	2550
Sunnyslope Drive	335	490	1680	2250	2550
Garrett Road	330	485	1670	2210	2545
Areas Outside Main System:					
Sunnyslope Drive (Subcatchment 250)	-	-	9	9	9
Garrett Road (Subcatchments 250 and 260)	1	3	20	28	28

¹ Existing: land use condition and existing conveyance system

² Future: land use conditions and existing conveyance system

³ DCM: future land use conditions, upgraded conveyance system to El Paso County DCM standards

⁴ Flows are rounded to the nearest 10 cfs.

Model Verification

The Bennett Ranch Pilot Project HEC-1 model was verified by comparing it to three existing studies: 1) a HEC-1 model prepared by the URS Corporation to simulate development of the Meridian Ranch Subdivision in the Bennett Ranch watershed; 2) a Conceptual Drainage Report completed by URS Corporation for the Colorado Department of Transportation; and 3) a planning study completed by Muller Engineering for El Paso County. All three compare favorably. The remainder of this section summarizes the comparisons.

URS Meridian Subdivision Model

The URS Corporation developed an HEC-1 model in the spring of 2000 as part of the Meridian Ranch Subdivision Master Development Drainage Plan. The URS model simulates a portion of the Bennett Ranch watershed centrally located between Meridian Road and Eastonville Road. Model networks allow comparisons at both Stapleton Road and Eastonville Road. A comparison of results from both models show, even though the models were developed independently, that both existing and future conditions 100-year peak flows are within 2% and 18% of each other.

URS HWY 24 Report

The URS Corporation prepared a Conceptual Drainage Report⁴ to support the Colorado Department of Transportation upgrades to Highway 24 between the towns of Falcon and Peyton. The report was prepared in September 1999 and presents a 100-year peak flow estimate of 1,650 cfs at the Highway 24 bridge (Bennett Ranch Pilot Project CUL-08). The Pilot Project estimated a peak flow of 1,820 cfs at this location. The difference in peak flow estimates is likely due to the following reasons:

- 1) URS performed the hydrologic analysis using SCS curve numbers based on partially developed conditions using SCS curve numbers ranging from 62 to 74.
- 2) The Pilot Project curve numbers reflect fully developed land and range from 69 to 71.
- 3) The URS analysis did not consider inadvertent detention within the watershed and approximately 600 cfs of additional runoff from the watershed was routed to two other existing culverts along Highway 24.

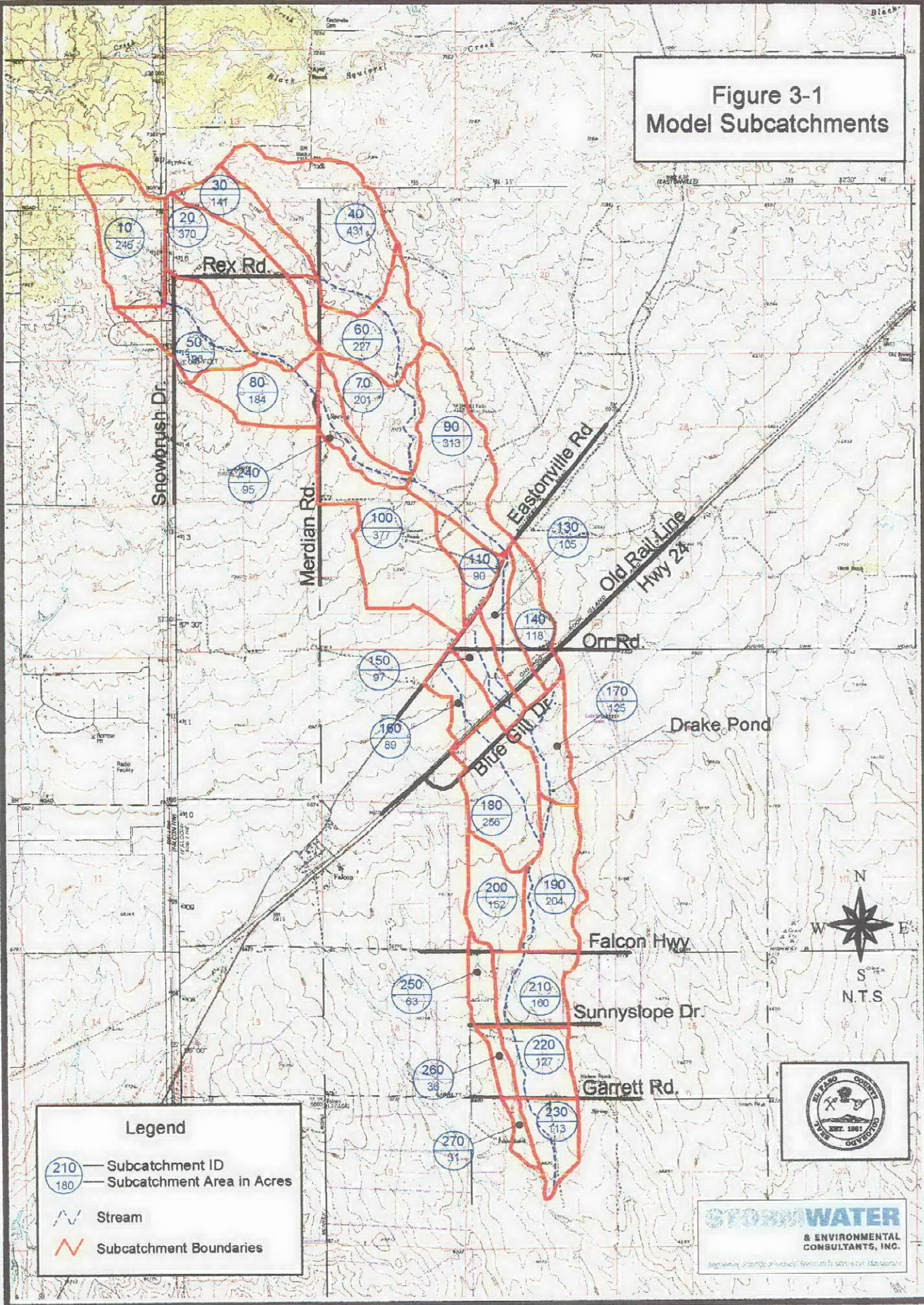
Muller Study

Muller Engineering prepared a planning study in 1986 for El Paso County⁵. The study presents average peak discharge rates derived for rural basins located in El Paso County. Muller Engineering derived the discharge curves based on hydrologic data assembled from existing master drainage planning studies for watersheds located in El Paso County. Peak flows from the Pilot Project compare within 6% of the average peak flow derived from the Muller study curves.

⁴ URS Corporation. September 1999. *SH: 24: Falcon to Peyton Conceptual Drainage Report*

⁵ Muller Engineering. 1986. *Drainage Data Base, El Paso County Drainage Basin Identification and Fee Estimation Report.*

**Figure 3-1
Model Subcatchments**



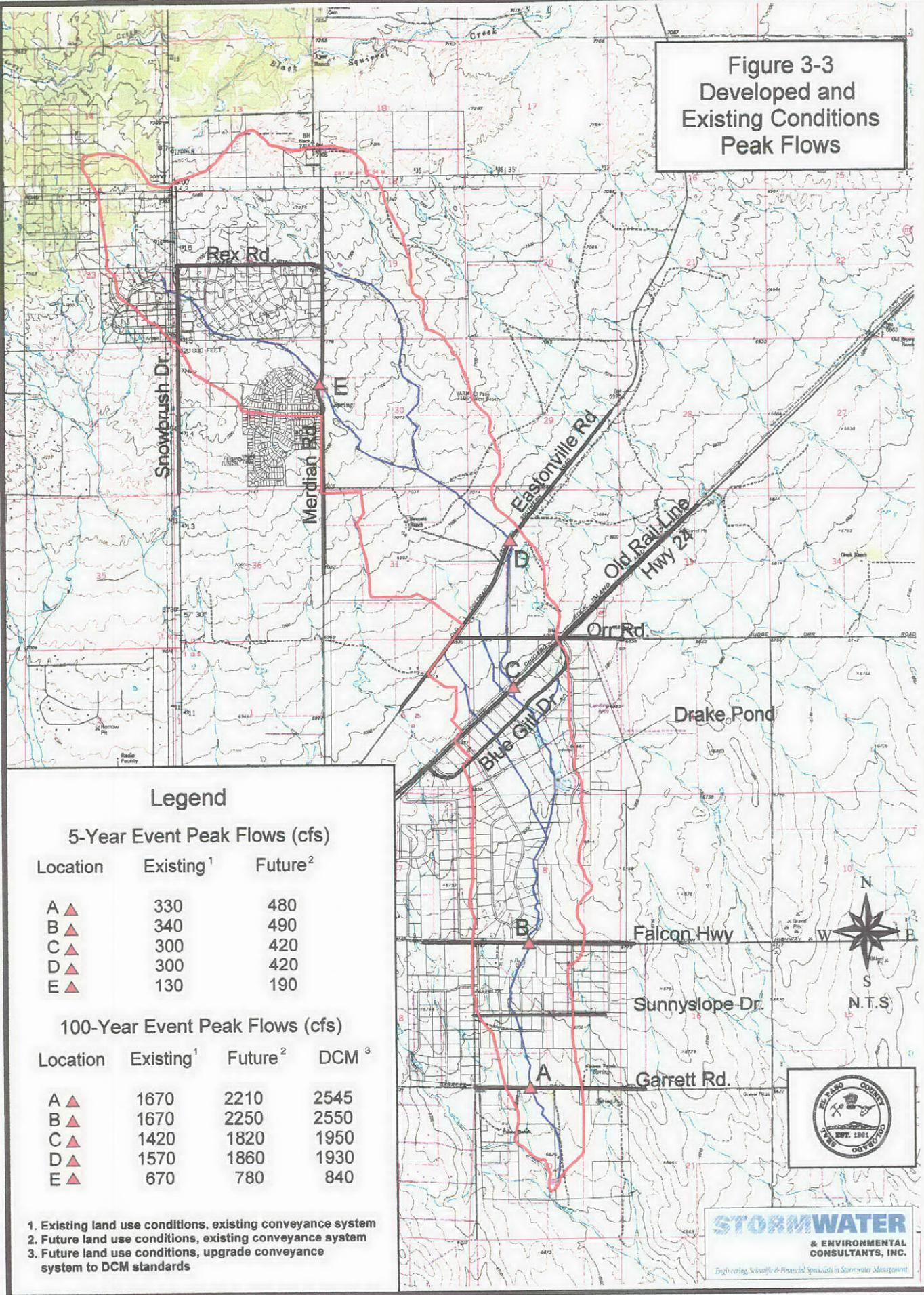
Legend

- 210 — Subcatchment ID
- 180 — Subcatchment Area in Acres
- Stream
- Subcatchment Boundaries



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**Figure 3-3
Developed and
Existing Conditions
Peak Flows**



Legend

5-Year Event Peak Flows (cfs)

Location	Existing ¹	Future ²
A ▲	330	480
B ▲	340	490
C ▲	300	420
D ▲	300	420
E ▲	130	190

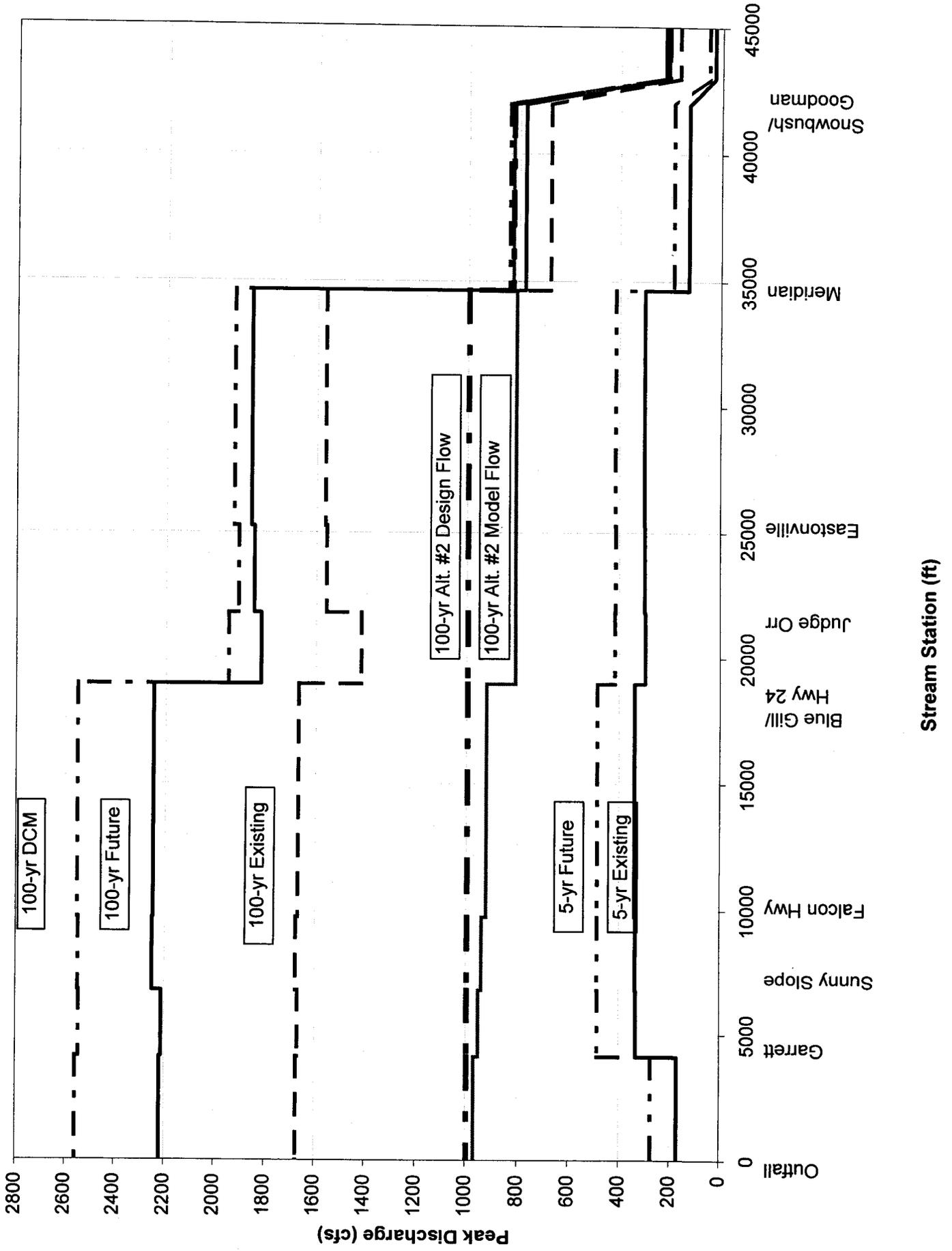
100-Year Event Peak Flows (cfs)

Location	Existing ¹	Future ²	DCM ³
A ▲	1670	2210	2545
B ▲	1670	2250	2550
C ▲	1420	1820	1950
D ▲	1570	1860	1930
E ▲	670	780	840

1. Existing land use conditions, existing conveyance system
 2. Future land use conditions, existing conveyance system
 3. Future land use conditions, upgrade conveyance system to DCM standards



Figure 3-4
HEC-1 Model Results Peak Flows at Major Crossings



4. PRUDENT LINE

Definition

The Prudent Line approach is an alternative approach to traditional channel improvements. The approach allows a creek to adjust through erosion and meandering to increased flows from lower density development by constructing a limited number of grade control structures and providing a strip of land adjacent to the creek, defined by a "Prudent Line", within which the stream is allowed to move naturally over time. Limited bank stabilization would also be implemented in places where erosion may occur such as on the outside of bends. If future erosion would threaten land beyond the Prudent Line, the County would have the responsibility to stabilize the erosion.

The Prudent Line setback is protected with an easement, similar to a floodplain easement, where development is not allowed and maintenance access is provided. This approach is illustrated in Figure 4-1. The land in the Prudent Line setback can be owned by individual homeowners, by a Homeowners' Association, or can be land dedicated to the County. Lots in the medium density areas (between 0.5 and 2.5 acres) are probably too small for the Prudent Line land to be included in the lot. The larger lots (2.5 acres and greater), however, are large enough that the setback can be included. With the Prudent Line approach, fewer channel stabilization measures are used than in drainages with conventional channel improvements. In most cases, the Prudent Line approach is less costly than the conventional approach. More land is required for the Prudent Line approach and the cost is therefore dependent on land costs.

Table 4-1 presents criteria defining applicability of the Prudent Line approach as outlined in the new addendum to the El Paso County DCM. The Prudent Line approach is the recommended alternative for all rural basins unless the watershed characteristics preclude its use. For further documentation and development policy regarding the Prudent Line approach, see the El Paso County DCM.

Applicability

As presented in Table 4-1, Prudent Line applicability is based on intensity of tributary development and existing channel capacity.

The following process was used to determine Prudent Line applicability within the Bennett Ranch basin:

- 1) The cumulative percent of impervious land area (based on the Future Land Use scenario presented in Figure 2-4) was calculated along the main channel reaches. All segments located downstream from land having greater than 20% cumulative impervious surface cover were identified as not being applicable for Prudent Line.
- 2) The existing channel capacities were then estimated along all of the segments meeting the land density criterion.
- 3) Existing capacities were compared to the estimated future land use conditions; 10-year event flows to determine if the capacity criterion is met.

Results of the analysis show that the main channel segments located upstream from Eastonville Road meet the Prudent Line applicability criteria. Segments located between

Eastonville Road and Drake Pond are discontinuous and/or do not provide adequate capacity to allow the Prudent Line approach. The Prudent Line approach is not appropriate for segments located downstream of Drake Pond because the cumulative percent of impervious land for these segments is greater than 20%. Figure 4-2 graphically summarizes the applicability of the Prudent Line Approach within the Bennett Ranch watershed.

Table 4-1 - El Paso County DCM Prudent Line Applicability Criteria

DCM Prudent Line approach is applicable and recommended for:

Open channel segments located downstream from land having less than or equal to 15% cumulative impervious surface cover under future conditions and when the main channel can adequately convey future conditions 10-year event flows.

DCM Prudent Line approach may apply to:

Open channel segments located downstream from land having between a 15% and 20% cumulative impervious surface cover under future conditions and when the main channel can adequately convey future conditions 10-year, flows.

These reaches require justification for recommending the prudent line approach.

DCM Prudent Line approach is not recommended for:

Open channel segments located downstream from land having greater than a cumulative 20% impervious surface cover under future conditions or when the main channel lacks adequate conveyance capacity for the future conditions 10-year flows.

However, the Prudent Line may still be considered if a detailed analysis of the Prudent Line is conducted using more advanced analytical techniques. The detailed approach must be completed by a firm that is experienced in conducting this advanced Prudent Line analysis.

Maintenance Notes:

1. The County will be responsible for performing channel rehabilitation measures on the prudent line channel resulting from significant hydrologic events or from long-term erosion.
2. The landowner will be responsible for performing routine maintenance including mowing, weed treatment, trash pickup, etc.
3. The landowner will be responsible for providing protection to his or her structures.
4. Refer to table below for maintenance access requirements

Type of Development	Maintenance Access Requirements	Other Conditions
Lot sizes \leq 2.5 acres along channel	Provide access to channel at a maximum one-quarter mile interval along lots with a minimum 15-foot-wide easement dedicated to El Paso County	<ul style="list-style-type: none"> • Property plats to show exact easement locations. • Routine maintenance (mowing, weed treatment, trash pickup) to be responsibility of landowner. • County to be responsible for restoration due to County-sponsored construction activity.
Lot sizes $>$ 2.5 acres along channel	Provide access to channel through each lot via a minimum 15-foot-wide easement dedicated to El Paso County	<ul style="list-style-type: none"> • Each platted lot to contain a note that a 15-foot-wide easement has been provided to El Paso County. • The lot owner has discretion over the location of the access easement as long as it is passable by typical construction equipment. • Routine maintenance (mowing, weed treatment, trash pickup) to be responsibility of landowner. • County to be responsible for restoration due to County-sponsored construction activity.

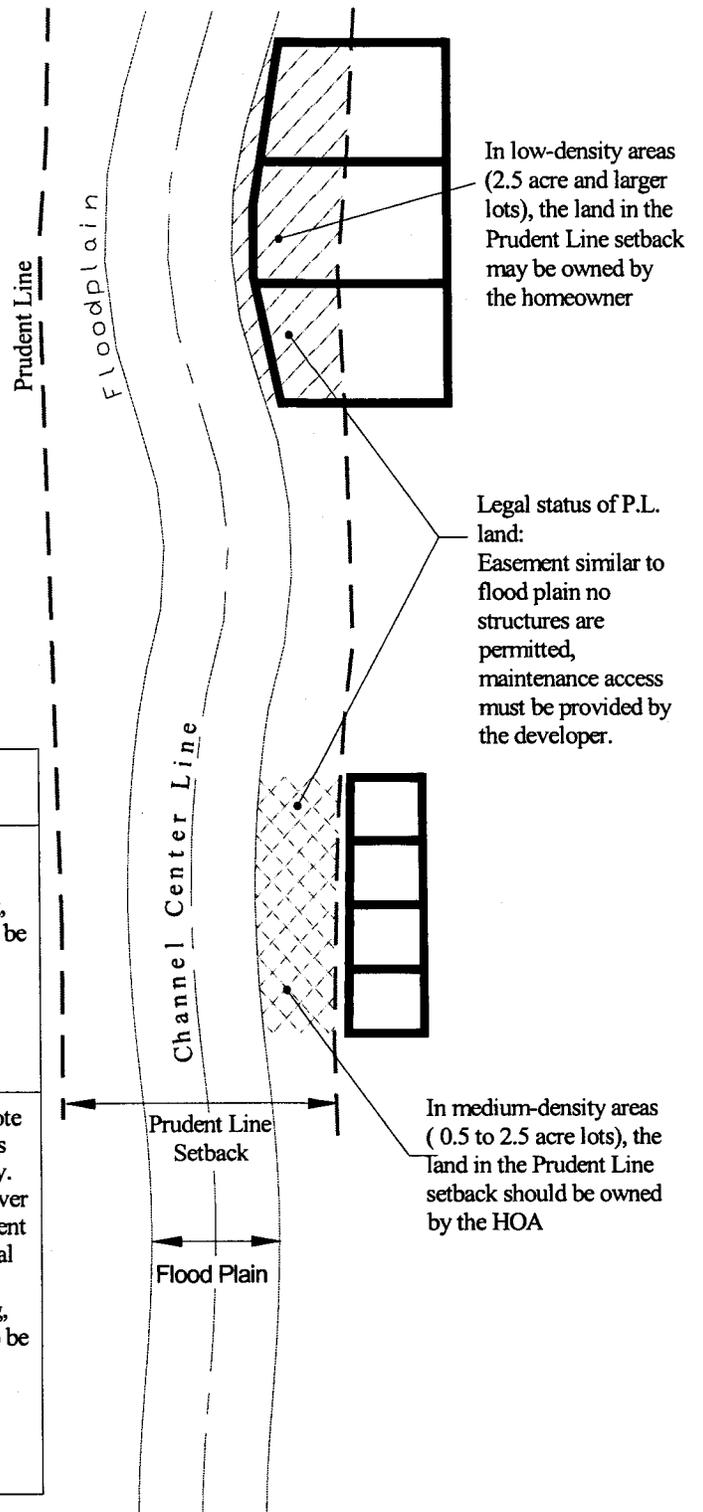
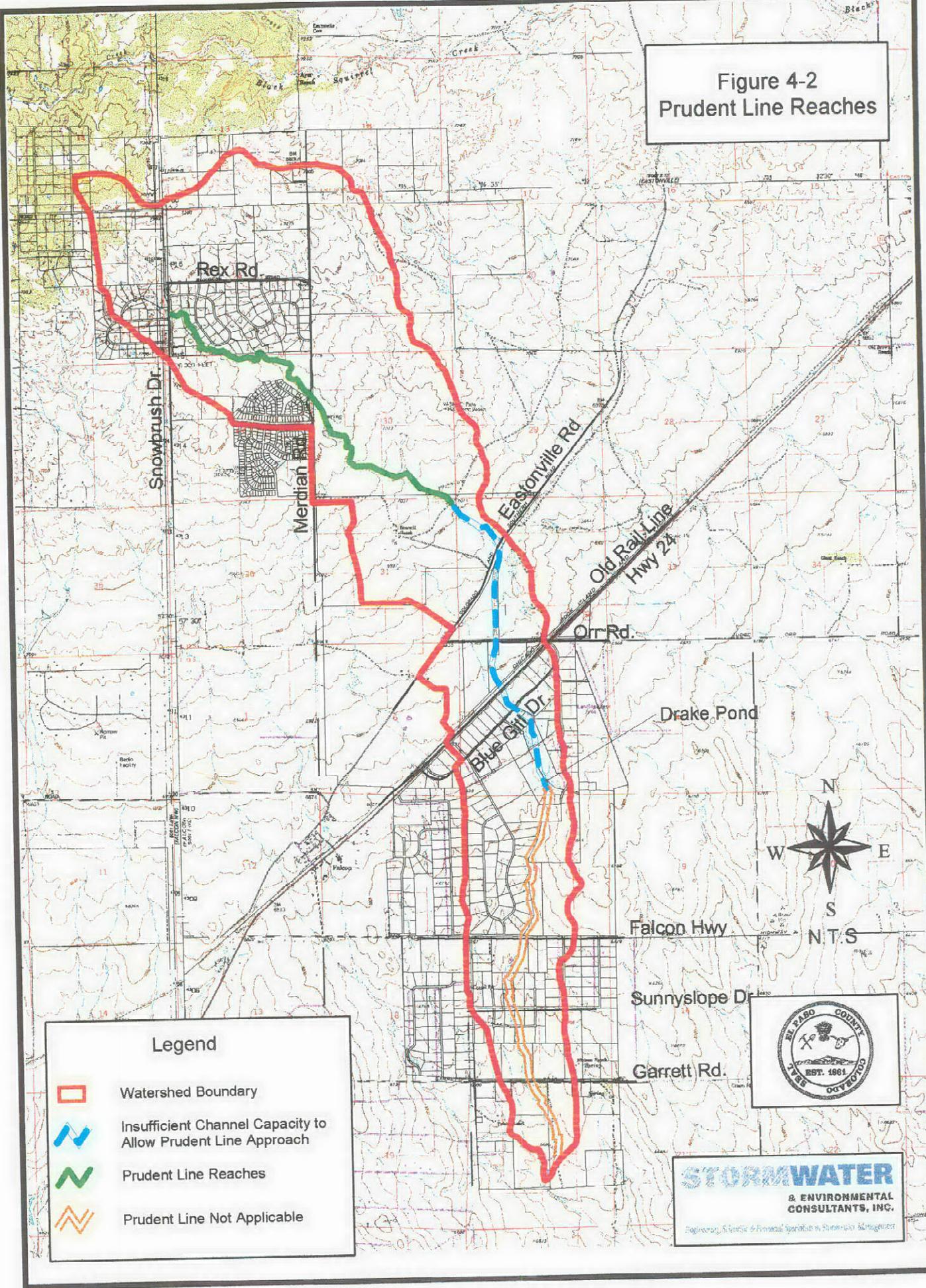


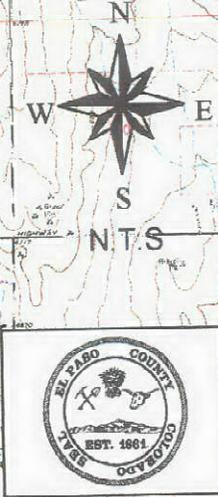
Figure 4-1 Prudent Line Reaches

Figure 4-2
Prudent Line Reaches



Legend

- Watershed Boundary
- Insufficient Channel Capacity to Allow Prudent Line Approach
- Prudent Line Reaches
- Prudent Line Not Applicable



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5. IDENTIFICATION OF DEFICIENCIES

Definition of System Deficiencies

This section defines what constitutes a deficiency for the purposes of this study. Criteria are established to define a deficiency for both hydraulic structures and open channels. Two separate sets of criteria are used to define an open channel deficiency depending on whether it is located along a Prudent Line reach or along a Traditional Improvement reach. Table 5-1 presents deficiency criteria for Prudent Line Channel Reaches. Table 5-2 presents criteria for channel segments that are not applicable for the Prudent Line approach. This set of criteria is based on the El Paso County DCM open channel design criteria. Table 5-3 presents criteria for culverts and bridges and is based on the El Paso County DCM culvert and bridge design criteria.

Table 5-1 - Criteria for Prudent Line Channel Reaches

Location	Classification	Criteria
Snowbrush Drive to Eastonville Road	Prudent Line Reaches	<p>Bank full capacity of channel must convey flows from future land use conditions 10-year event.</p> <p>All upstream culverts and bridges must not significantly alter channel hydraulics (limited backwater effects).</p> <p>Velocities caused by the future land use conditions 100-year event must not increase velocities more than 10% above existing conditions 100-year event velocities.</p>

**Table 5-2 - Criteria for Traditional-Improvement Channel Segments
(Non-Prudent Line Channels)**

Location	Classification	Criteria
Eastonville Road to Watershed Outfall	Major drainage way segment (100-year event flows > 1,500 cfs)	Refer to El Paso County DCM

Table 5-3 - Criteria for Structures

Location	Classification	Criteria
Snowbrush Drive Meridian Road	Culverts located on a collector road within a Prudent Line Reach.	Refer to El Paso County DCM
Judge Orr Road RR Bridge Hwy 24 Blue Gill Drive Falcon Hwy Sunny Slope Road Garrett Road	Structures along a major drainage way (100-year event flows > 1,500 cfs).	Refer to El Paso County DCM

Evaluated Reaches

The El Paso County DCM defines major drainage ways as open channels that convey more than 1,500 cfs under the 100-year event. Just over 40,000 feet of open channel were evaluated for deficiencies (Figure 5-1). These constitute all of the major drainage ways within the project watershed and also approximately 7,300 feet of minor drainage way located between Meridian Road and Snowbrush Drive. All culverts and bridges along these drainage ways were evaluated for system deficiencies. The remainder of this report evaluates alternatives for each of the identified deficiencies.

All other drainage ways located within the project watershed were considered minor reaches and were not evaluated under the scope of this study. Deficiencies that may exist along these minor drainage ways were not identified and corresponding alternatives were not developed or evaluated. However, estimates were created to help quantify the costs associated with improvements for minor drainage systems in the currently developed areas between Highway 24 and 1400-feet downstream of Sunnyslope Drive. It was assumed that further development would not occur in this area; therefore the County would be responsible for upgrading these minor drainage systems.

Identification of System Deficiencies

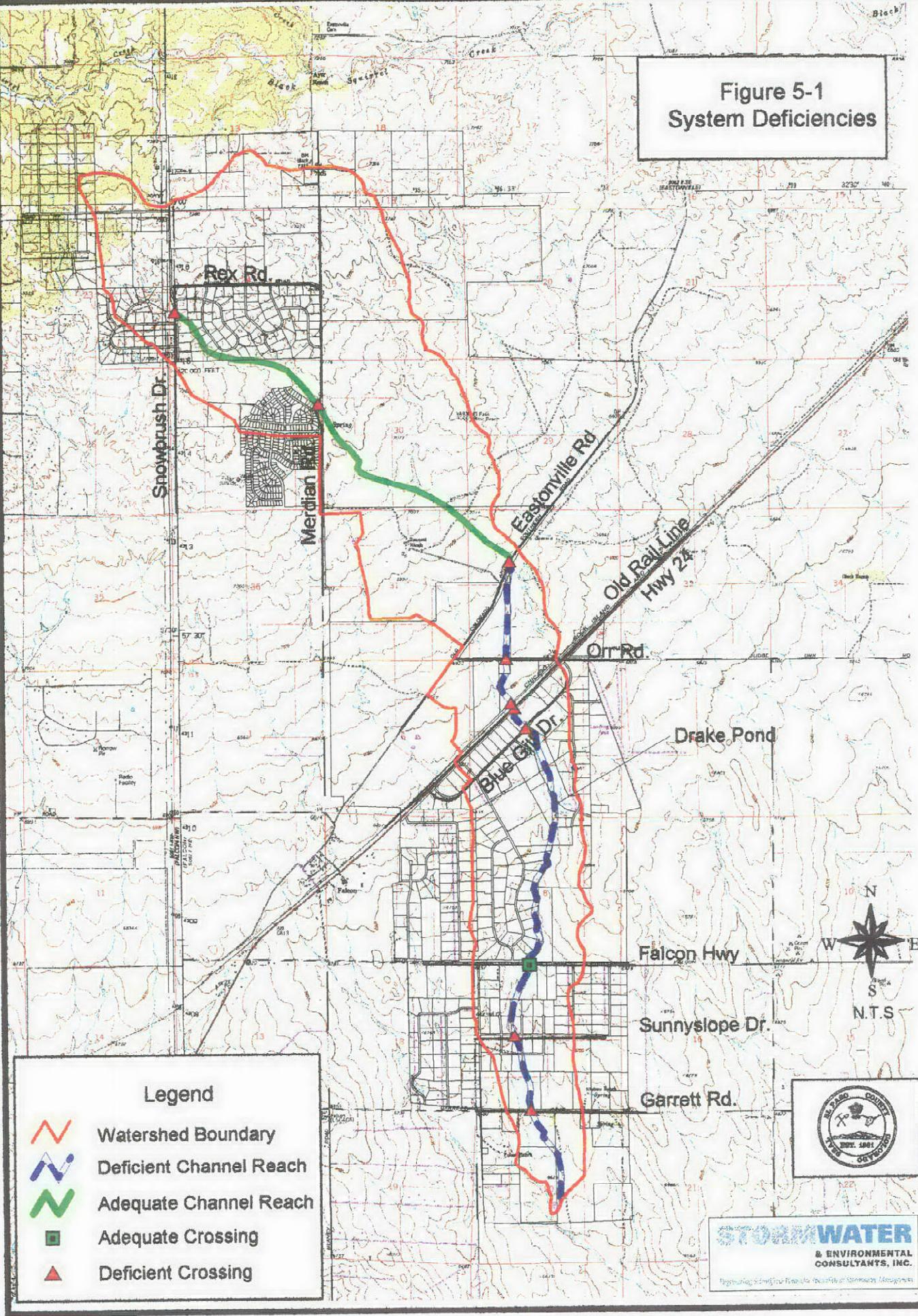
The Bennett Ranch drainage way system was evaluated to identify deficiencies by comparing estimated future-conditions, 100-year event peak flows to existing open channel, culvert, and bridge capacities. Channel segments and structures that do not meet the design criteria established in Tables 5-1 through 5-3 are considered deficient.

Peak flows used to identify deficiencies were estimated using a HEC-1 model modified by replacing existing culverts and bridges with new structures designed to meet DCM conveyance capacity criteria presented in Table 5-3. Culvert nomographs were used to estimate existing capacities of the culverts and bridges based on inlet control flow conditions. The Haested Methods computer program Flow Master was used to estimate capacities of the open channel

segments. Flow Master uses normal depth calculations to estimate flows and does not consider backwater effects.

Based on our analysis, just over one-half of the evaluated open channel reaches are deficient (25,800 feet of open channel). Table 5-4 presents results of the analysis of open channel segments located in Prudent Line reaches. Table 5-5 presents results of the analysis of open channel segments located outside Prudent Line reaches. Nine of the ten existing crossings are deficient (the Falcon Highway bridge meets design criteria). Table 5-6 presents results from the analysis of culverts and bridges. Figure 5-1 graphically presents the locations of system deficiencies within the Bennett Ranch watershed. Full documentation of the deficiency evaluation process is presented in the Technical Appendices.

**Figure 5-1
System Deficiencies**



Legend

-  Watershed Boundary
-  Deficient Channel Reach
-  Adequate Channel Reach
-  Adequate Crossing
-  Deficient Crossing



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**Table 5-4 - Evaluation of Existing Channel Segments
 Prudent Line Reaches**

Location	HEC-1 SegmentID	Length (feet)	Future 10-yr Peak Flow(cfs)	Estimated Existing Channel Capacity (cfs)	Criteria: must convey 10-year event flows	Existing 100-yr velocity (ft/sec)	Future 100-yr Velocity (ft/sec)	Criteria: velocity cannot change > 10%
Snowbrush Drive to Meridian Road	1051	4305	82	1053	Meets Criteria	4.3	5.0	Meets Criteria
	5020	1765	150	860	Meets Criteria	5.0	5.3	Meets Criteria
	2080	1284	253	860	Meets Criteria	6.0	5.2	Meets Criteria
Meridian Road to Eastonville Drive	8071	5423	310	948	Meets Criteria	6.8	7.4	Meets Criteria
	7090	4468	611	948	Meets Criteria	8.8	9.7	Meets Criteria

Table 5-5 - Evaluation of Existing Channel Segments

Traditional Method Reaches

Location	HEC-1 Segment	Length (feet)	Future Peak Flow (cfs)	Flow Depth (feet)	DCM Maximum Depth	DCM Freeboard	Future 100-yr Velocity (ft/sec)	DCM Velocity	Flow Froude #	Max. DCM Froude # of 0.9
Eastonville Road to Drake Pond Drive	90131	3493	1910							
	90133	1372	1906							
	90135	140	1905							
	90137	912	1897							
	130141	612	1933							
Drake Pond to Falcon Highway	140170	3047	2244	1.4	Meets Criteria	Meets Criteria	5.2	Meets Criteria	.79	Meets Criteria
	170171	1902	2278	3.3	Meets Criteria	Meets Criteria	6.2	Exceeds	.63	Meets Criteria
	171190	4052	2437	3.6	Meets Criteria	Meets Criteria	6.2	Exceeds	.65	Meets Criteria
Falcon Highway to Sunnyslope Road	190211	2875	2534	3.4	Meets Criteria	Likely Meets Criteria	6.9	Exceeds	.73	Meets Criteria
	210221	2852	2532	3.2	Meets Criteria	Exceeds	8.1	Exceeds	.88	Meets Criteria
Garrett Road to end of watershed	220231	4555	2538	3.1	Meets Criteria	Exceeds	7.8	Exceeds	.87	Meets Criteria

These segments do not contain defined and/or continuous channels and therefore do not meet DCM criteria.

Table 5-6 - Evaluation of Existing Culverts and Bridges

Crossing Location	HEC-1 ID	Structure	Peak Flows 100-yr future (cfs)	Peak Flows 5-yr future (cfs)	Existing Capacity ¹ (cfs)	DCM Criteria Met?
Snowbrush Drive	1050	CUL-14: 54" CMP	220	50	85	No ²
Meridian Road	8070	CUL-13: triple 48" RCP	840	190	240	No ²
Eastonville Road	90130	CUL-12: twin 30" RCP	1930	420	80	No ³
Judge Orr Road	90131	CUL-11: twin - 36" CMP	1910	410	76	No ³
Old Railroad line crossing	90133	CUL-10: RCB: 13' W x 3' H	1950	420	176	No ³
Highway 24	90135	CUL-08: RCB: 23' W x 4' H	1950	420	460	No ³
Blue Gill	130140	CUL-04: twin 36" CMP	1950	420	60	No ³
Falcon Highway	190210	BDG-01: RCB: 60' W x 8' H	2551	490	3900	Yes
Sunnyslope Road	210220	CUL-02: 30" CMP	2550	490	20	No ³
Garrett Road	220230	CUL-01: 48" CMP	2540	480	70	No ³

¹ Capacity based on assumed inlet control.

² Crossing must not cause significant backwater effects because it is located within a Prudent Line reach.

³ Crossing must convey 100-year discharge because it is located along a major drainage way (flows > 1,500 cfs).

6. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

Screening of Alternatives

The Prudent Line Approach is the preferred alternative for rural basins and is recommended for all reaches within the Bennett Ranch watershed that meet the Prudent Line Approach criteria (defined in Chapter 4, Prudent Line). When land use or channel conditions preclude the use of this method, other more traditional improvements were considered including:

- Grade and erosion controls
- Upgrading culverts and bridges to increase conveyance capacity
- Upgrading existing channel reaches to increase conveyance capacity
- Constructing new channel segments where channels are currently undefined
- Providing detention storage

The following summarizes the feasible alternatives that will be considered for this project. The alternatives are presented in order from upstream to downstream. Table 6-1 presents a matrix summarizing the screening process used to identify these alternatives.

Snowbrush to Eastonville Road

This approximately two-mile long reach of the watershed meets the land use criteria for the Prudent Line Approach and is therefore the recommended alternative.

An undersized culvert, located at Snowbrush Drive, and two small ponds are located at the upstream end of this reach. The ponds do not appear to have controlled outlets and large amounts of sediment have deposited in the ponds. The Prudent Line Approach will require upgrading the existing 54 inch-diameter culvert at Snowbrush Drive (CUL-14) to a 7' x 5' box culvert and removing the pond berms to allow free passage of channel flows. The channel continues unimpeded downstream from the ponds until reaching Meridian Road.

At Meridian Road, three existing 54-inch diameter culverts (CUL-13) are restricting flows, causing sediment to deposit on the upstream side, and failing due to erosion at the downstream end. The Prudent Line Approach will require upgrading these culverts to a 30' x 7' box culvert and armoring the downstream ends to prevent erosion.

Eastonville Road to Drake Pond

This portion of the watershed does not contain a single, continuous reach of channel. In addition, existing culverts and bridges in this area are undersized and are not aligned with each other. Stormwater currently flows overland using many flow paths through this area of the watershed, resulting in flood-related problems.

The lack of defined channels and configuration of existing culverts and bridges in this area requires more traditional improvement methods including: detention storage, increasing the capacity of existing channel segments, constructing new open channel segments, upgrading

existing hydraulic structures, and constructing new structures. Check structures will be required along new channel segments to maintain stream channel grades that will prevent channel erosion and degradation.

Drake Pond to the Watershed Outfall

The downstream section of the watershed contains approximately 7,500 feet of undersized channels. These channels are not applicable for the Prudent Line approach because contributing land has greater than 20% cumulative impervious surface area, and this will require the use of traditional channel improvements. In addition, the existing culverts located at Blue Gill Drive (CUL- 04), Sunnyslope Drive (CUL-02), and Garrett Road (CUL-01) do not meet DCM capacity requirements.

Table 6-1 - Alternative Screening Matrix

Analysis Section	Deficiencies	Prudent Line/grade & erosion control	Improved Crossings	Improve Existing Channel	New Channel	Detention Storage
Snowbrush Drive to Eastonville Road	<ul style="list-style-type: none"> • Undersized culvert at Snowbrush Dr. (CUL-14) • Undersized and failing culverts at Meridian Rd. (CUL-13) 	X ¹	X			
Eastonville Road to Drake Pond	<ul style="list-style-type: none"> • Undersized culvert at Eastonville Rd. (CUL-12) • Undersized Railroad culvert (CUL-10) • Undersized culvert at Hwy 24 (CUL-08) • Undersized culvert at Blue Gill Rd. (CUL-04) • Undefined/undersized segments of channel 	X ¹	X	X	X	X
Drake Pond to watershed outfall	<ul style="list-style-type: none"> • Undersized culvert at Sunnyslope Dr. (CUL-02) • Undersized culvert at Garrett Rd. (CUL-01) • Undersized channel segments 		X	X		X

X = feasible alternative

¹ Includes removal of berms from existing ponds located downstream from Snowbrush Drive

Development of Alternatives

Two alternatives were developed for further consideration based on the alternatives screening process. Table 6-2 presents the design criteria used to develop the alternatives. The alternatives are based on the assumption that new channels can be excavated approximately six feet below existing ground elevations and still meet the watershed outfall elevation at West Squirrel Creek.

Table 6-2 - Alternative Development Design Criteria

Culverts and Bridges

- Culverts at Snowbrush Drive and Meridian Road sized to pass 100-year event without surcharging
- Bridges to provide 2 feet of freeboard for 100-year event
- Bridges and culverts upstream from Prudent Line reaches designed to have limited backwater effects

Prudent Line Setback Reaches

- Bank-full capacity of the channel must convey flows from future land use conditions 10-year event
- Velocities caused by the future land use conditions 100-year event must not increase more than 10% above existing conditions 100-year event velocities

New Open Channel Segments

- Flow depth = 5 feet
- Manning's roughness coefficient = 0.035
- Velocity = 5 ft/sec or less
- One foot (minimum) of channel bank freeboard
- Channel side slopes of 5V:1H
- Froude Number of 0.9 or less
- 3 foot (maximum) drop at each check structure

Alternative 1

Alternative 1 upgrades all reaches and hydraulic structures to meet DCM design criteria and/or Prudent Line criteria without providing regional detention storage. This alternative includes a combination of the Prudent Line setback in the upper reaches, new channel segments in the middle reaches, and improved channel segments in the downstream reaches of the project watershed. It requires upgrading nine of the ten existing culverts/bridges located along the design drainage way.

The estimated cost to implement this alternative is \$7.3 million. Table 6-3 summarizes the specific improvements associated with this alternative. Figure 6-1 presents a schematic of the alternative. Supporting engineering calculations and cost estimates are presented in the Technical Appendices.

**Table 6-3 - Alternative 1
 Summary of Improvements**

Improvement	Estimated Cost ¹ (\$1000)
Approximately 2.8 miles of Prudent Line reaches	319.0
2 new box culverts	375.6
7 new bridges	2,557.8
3.2 miles of new channel	2,994.0
65 new check structures	471.3
Misc.: Placement of erosion control riprap and removal of existing pond berms	26.8
Upgrade existing minor drainage system	522.0
Total estimated cost	\$7.3 million

¹ Includes 15% cost for engineering, 25% contingency factor, and a 5% cost for utilities

Alternative 2

Alternative 2 upgrades all reaches and hydraulic structures to meet DCM design criteria and/or Prudent Line criteria by incorporating regional detention upstream of Eastonville Road. This alternative reflects the El Paso County Board of County Commissioners requirement that both the Bennett Ranch and Meridian Subdivisions detain future conditions storm water runoff to 80 percent of existing 100-year event flows⁶.

This alternative incorporates the developer's design concept of five on-line detention ponds located upstream of Eastonville Road. Four of the ponds are to be incorporated into a golf course system and would provide a total storage volume of approximately 90 acre-feet. The developer proposes to modify the existing channels between these ponds as part of the golf course. These channel segments are applicable for Prudent Line and therefore the cost associated with improving the channels are not included in this study. A fifth pond with approximately 50 acre-feet of storage is proposed just upstream from Eastonville Road. All storm water runoff upstream from Eastonville Road would be routed through this pond.

⁶ The initial draft of the Bennett Ranch Pilot Project recommended that detention for Alternative 2 be provided in one regional pond located at Eastonville Road. The pond was sized to provide approximately 30 acre-feet of storage and limit peak flows to 1,650 cfs at HWY 24, the design capacity of the new CDOT highway culvert. El Paso County requested that the alternative be modified to reflect the current development scenario that provides over-detention (80% of existing conditions) as required by the Board of County Commissioners.

The approximately 140 acre-feet of detention will eliminate the need to replace the new CDOT culvert located on Highway 24,⁷ but still requires the upgrading of eight existing culverts and the construction of a new channel from Eastonville Road to Drake Pond. The estimated cost to implement this alternative is \$7.9 million. Figure 6-2 presents a schematic of the alternative. Table 6-4 presents the specific improvements associated with this alternative.

Supporting engineering calculations and cost estimates are presented in the Technical Appendices (separate document).

**Table 6-4 - Alternative 2
Summary of Improvements**

Improvement	Estimated Cost ¹ (\$1000)
Approximately 1.4 miles of Prudent Line reaches	159.5
8 new box culverts	2568.0
2.16 miles of new channel	1,469.3
61 new check structures	442.3
Misc.: Placement of erosion control riprap and removal of existing pond berms	26.8
Detention ponds (combined storage of 140 acre-feet)	2,708.6
Upgrade existing minor drainage system	522.0
Total estimated cost	\$7.9 million

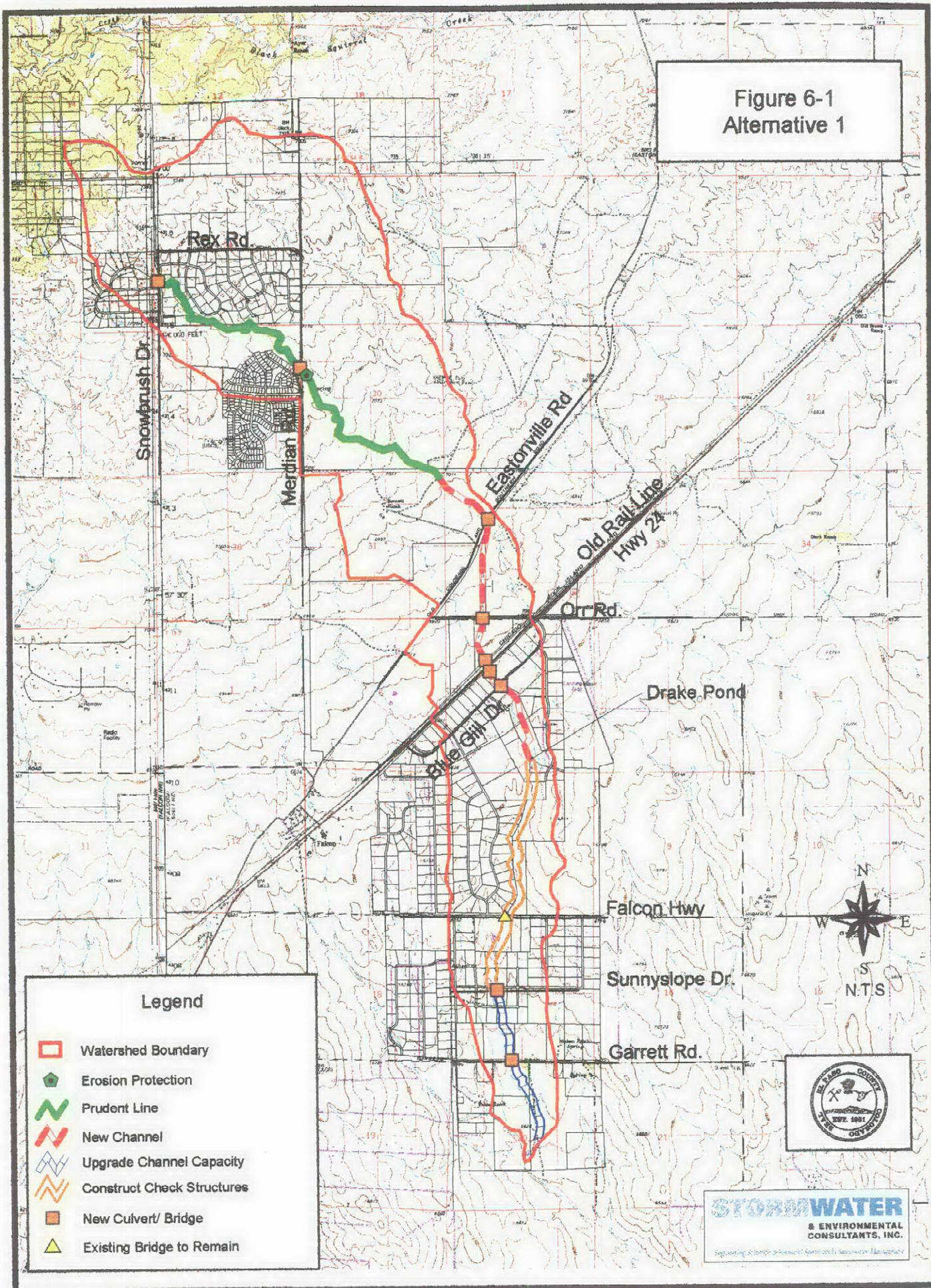
¹ Includes 15% cost for engineering, 25% contingency factor, and a 5% cost for utilities

Evaluation of Alternatives

Table 6-5 presents a comparison of the two feasible alternatives for the Bennett Ranch pilot project. The Table compares the alternatives based on total estimated project costs, Prudent Line approach applicability, permitting requirements, construction-related issues, maintenance issues, public perceptions and political issues, and easement acquisition needs.

⁷ The culvert upgrade is proposed in conjunction with the CDOT widening of Highway 24 from the town of Falcon to the town of Peyton. The new culvert is to be designed to convey 1,650 cfs and replace the existing 23' x 4' box culvert (culvert 0-8 in Figure 2-2).

Figure 6-1
Alternative 1



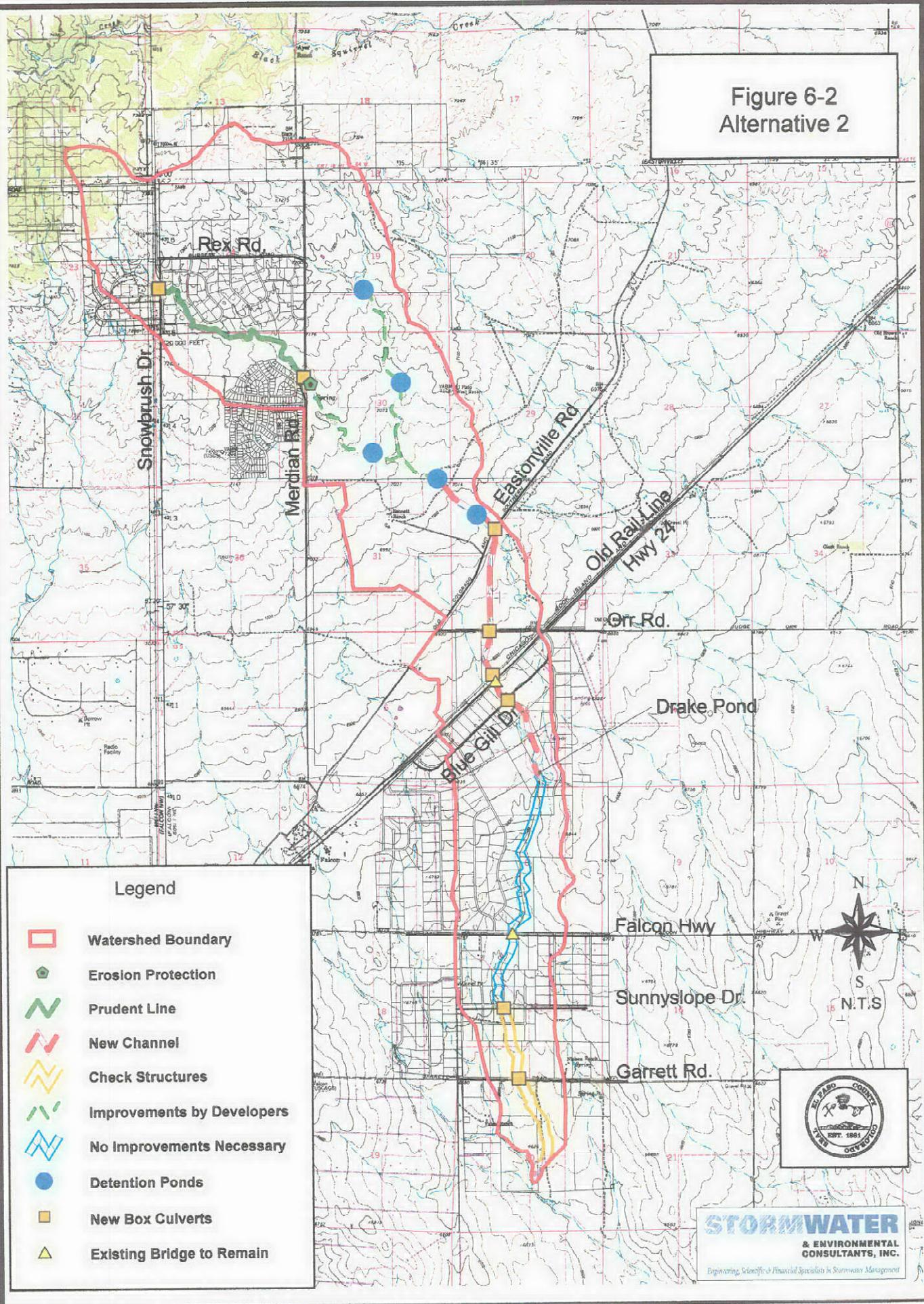
Legend

-  Watershed Boundary
-  Erosion Protection
-  Prudent Line
-  New Channel
-  Upgrade Channel Capacity
-  Construct Check Structures
-  New Culvert/ Bridge
-  Existing Bridge to Remain



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Figure 6-2
Alternative 2



Legend

-  Watershed Boundary
-  Erosion Protection
-  Prudent Line
-  New Channel
-  Check Structures
-  Improvements by Developers
-  No Improvements Necessary
-  Detention Ponds
-  New Box Culverts
-  Existing Bridge to Remain



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Table 6-5 - Comparison of Alternatives

Alternative	Total Cost	Prudent Line Applicability	Permitting Issues	Construction Issues	Maintenance Issues	Public Perceptions and Political Issues	Easement Acquisitions
Alternative 1: System upgrade without detention	\$7.3 million	Applicable in ~ 1/3 of the system reaches	Greater flows require more extensive upgrades to the system than Alternative 2 and therefore requires more in-stream and riparian-zone work and associated 404 permitting	Greater flows require more extensive construction to upgrade the system than Alternative 2, particularly in the lower 1/3 of the watershed	Likely would require much less maintenance than Alternative 2 because there are more Prudent Line reaches and no detention ponds	Public may prefer the concept of regional detention ponds to mitigate development impacts	Requires securing a total of approximately 44 acres of Prudent Line easements at an estimated cost of \$319,000
Alternative 2: System upgrade with regional detention	\$7.9 million	Applicable in only ~ 1/6 of the system reaches	Detention greatly reduces the need to construct within the lower 1/3 of the basin.	Detention reduces the number and size of new bridges, reduces the cross-sectional area of new channel segments, and reduces the number of channel check structures from Alternative 1	Detention ponds will require maintenance (sediment transport into the ponds) per El Paso County DCM criteria	Public may perceive detention in a positive light as mitigating development impacts within the watershed	Requires securing a total of approximately 22 acres of Prudent Line easements at an estimated cost of \$159,500 and approximately 25 acres of land for detention at an estimated cost of \$300,000.

7. RECOMMENDED ALTERNATIVE

Alternative 2 is recommended for the Bennett Ranch watershed. This alternative is recommended over Alternative 1 because it reflects the detention scenario required by the Board of County Commissioners⁸, requires smaller upgraded structures, smaller cross-sectional area of new channel segments, and construction of fewer channel check structures. This alternative will also help protect the existing downstream developments from major event flooding by implementing the BOCC detention scenario. In addition, this alternative will require less in-stream and riparian-zone construction and associated 404 permitting in the well-established, healthy riparian channels located in the lower 1/3 of the watershed (Photograph 2-2).

The cost of the recommended alternative is estimated at \$7.9 million and includes Prudent Line in the upper-most reaches of the watershed, detention ponds upstream from Eastonville Road, and new channel between Eastonville Road and Drake Pond. It also replaces all nine of the undersized culverts located throughout the length of the drainage way and check structures along channel reaches located between Sunnyslope Drive and the project outfall to maintain a stable channel slope. This alternative allows the existing bridge located at the Falcon Highway and a proposed new CDOT bridge crossing at Highway 24 to remain unchanged.

Table 7-2 lists the specific improvements associated with Alternative 2. Figure 7-1 graphically presents the recommended improvements as they are located along the drainage way.

Recommended Alternative Hydrology

BOCC requirements indicate that the Bennett Ranch and Meridian Subdivisions must attenuate developed condition flows to 80% of historic condition flows for the 5-year and 100-year events. The developer of these subdivisions has designed detention facilities in accordance with these requirements. The developer's detention scenario as of January 2001 was incorporated into the SEC OA alternative #2 HEC-1 model. Results of this model indicated that peak flows at Eastonville Road and Garrett Road were 810 cfs and 950 cfs respectively. The developer requested that SEC OA use a flow of 996 cfs (80% of developer calculated historic flow at Eastonville Road) to size drainage improvements downstream of Eastonville Road. Refer to Figure 3-4 for the alternative #2 discharge profile.

Drainage Basin and Bridge Fees

Drainage basin and bridge fees presented in this study were calculated by dividing the respective improvement costs by the acreage of impervious land that will be added to the basin when undeveloped areas are constructed. Criteria for determining what improvement costs should be included in the fee calculation are presented in Table 7-1. The approximately seven square mile Bennett Ranch basin currently contains 225 acres of impervious land. An additional 709 acres of

⁸ Our initial recommendation for detention in this alternative provided one regional pond located at Eastonville Road. The pond was sized to provide approximately 30 acre-feet of storage and limit peak flows to 1,650 cfs at HWY 24, the design capacity of the new CDOT highway culvert. El Paso County requested that the alternative be modified to reflect the current development scenario that provides over detention (80% of existing conditions) required by the Board of County Commissioners.

impervious land will be added to the basin when the undeveloped areas are constructed. Refer to Table 7-2 for a breakdown of existing and added future development impervious areas; and Table 7-3 for cost estimates, basin fees, bridge fees, and public costs.

Table 7-1 – Improvement Cost Inclusion in Fee Calculations

Drainage way Improvements (including Prudent Line)	
<p><i>Included if:</i></p> <ul style="list-style-type: none"> • the improvements lie within currently undeveloped land AND are for major drainage ways as identified in a DBPS or a County accepted addendum to a DBPS • the improvements lie within currently developed land or public land downstream of future development that does not attenuate developed peak flows to historic peak flows AND are for major drainage ways as identified in a DBPS or a County accepted addendum to a DBPS 	<p><i>Not included if:</i></p> <ul style="list-style-type: none"> • the improvements lie within currently developed land or public land downstream of future development that attenuates developed peak flows to historic peak flows • the improvements are on drainage ways that are not identified as major drainage ways in a DBPS or a County accepted addendum to a DBPS
Culvert Improvements	
<p><i>Included if:</i></p> <ul style="list-style-type: none"> • the selected alternative flow at the culvert is greater than the existing condition flow at the culvert AND the culvert is along a major drainage way as identified in a DBPS or a County accepted addendum to a DBPS 	<p><i>Not included if:</i></p> <ul style="list-style-type: none"> • the selected alternative flow at the culvert is less than or equal to the existing condition flow at the culvert • the culvert is not along a major drainage way as identified in a DBPS or a County accepted addendum to a DBPS • the improvement is to be constructed by the Colorado Department of Transportation
Detention Facilities	
<p><i>Included if:</i></p> <ul style="list-style-type: none"> • the detention facility is required in a Drainage Basin Planning Study or a County accepted addendum to a DBPS 	<p><i>Not included if:</i></p> <ul style="list-style-type: none"> • the detention facility is not required in a Drainage Basin Planning Study or a County accepted addendum to a DBPS

Table 7-2 – Existing and Added Future Developed Impervious Area

Existing Impervious Area in Bennett Ranch Basin			
Area (acres)	Landuse	Percent Impervious	Impervious Area (acres)
102	RR3	7%	7
87	RR3	7%	6
402	RR2	11%	44
217	R	25%	54
29	R1	53%	15
7	RR3	7%	1
3	R	25%	1
1	RR3	7%	0
52	RR1	25%	13
880	RR3	7%	62
5	R2	65%	3
145	RR2	11%	16
3	RR3	7%	0
39	A1	7%	3
Sum = 1973			Sum = 225
Impervious Area to be Added in Bennett Ranch Basin by Future Development			
492	RR3	7%	34
52	A35	2%	1
181	RR2	11%	20
21	1AC Lots	20%	4
210	2DU/AC	25%	52
22	2DU/AC	25%	6
57	3DU/AC	30%	17
25	SCHOOL	50%	13
26	4DU/AC	40%	11
35	4DU/AC	40%	14
36	6DU/AC	48%	17
35	4DU/AC	40%	14
3	SCHOOL	50%	2
30	4DU/AC	40%	12
24	2DU/AC	25%	6
12	Open/Park	7%	1
38	Commercial	95%	36
10	RR1	25%	2
10	4DU/AC	40%	4
10	SCHOOL	50%	5
51	Open/Park	7%	4
85	RR1	25%	21
16	4DU/AC	40%	6
13	RR1	25%	3
2	RR3	7%	0
2	RR1	25%	0
151	4DU/AC	40%	60
138	Open/Park	7%	10
66	6DU/AC	48%	32
56	Commercial	95%	53
28	M	72%	20

71	GC	7%	5
62	6DU/AC	48%	30
119	6DU/AC	48%	57
56	Open/Park	7%	4
117	4DU/AC	40%	47
107	M	72%	77
116	RR3	7%	8
Sum = 2586			Sum = 709

Recommended Phasing of Improvements

The developer of Bennett Ranch and Meridian Subdivisions is currently planning to construct the golf course channel segments, the four high priority golf course detention ponds, and the high priority regional pond at Eastonville Road within the next two years. The new channel segment between Stapleton Drive and Eastonville Road needs to be constructed coincident with the aforementioned improvements to provide a well-defined drainage way to route flows into the pond at Eastonville Road. All of these improvements need to be constructed before or during the initial over lot grading process and be fully operational before any impervious surfacing is constructed.

The new channel segments located between Eastonville Road and Drake Pond are also considered high priority improvements because the current drainage way is discontinuous and not well defined. If this channel system is not constructed before the upstream detention scenario required by the Board of County Commissioners, future development condition major event flow depth impacts to the downstream system would be reduced because the upstream detention system reduces future peak flows below existing peak flows. However, the increased volume of runoff produced under developed conditions will result in increased flow durations in the downstream system for the major and minor events. The frequency of flows less than the minor event will also increase because runoff will be produced under developed conditions for rainfall events that did not produce runoff under historic conditions. Increased flow durations and increased frequency of flow may adversely affect the existing downstream drainage system. If the channel improvements between Eastonville Road and Drake Pond are not constructed prior to the upstream developments, the existing downstream drainage system and adjacent property may experience damage.

The new culverts at Judge Orr Road, the railroad embankment, and Blue Gill Road should be constructed concurrently with the channel improvements between Eastonville Road and Blue Gill Road. Construction of these structures along with the new channel segments in this area will provide a well-defined and continuous drainage way from Eastonville Road to Drake Pond.

Replacing the failing culverts located at Meridian Road should also be a high priority (Photograph 2-3). These culverts are failing at the downstream end and will soon compromise the road subgrade.

Of secondary importance is the upgrading of culvert crossings located at Sunnyslope Drive and Garrett Road. Replacing these culverts would help provide a continuous, adequate conveyance system from the new regional pond at Eastonville Road to the project outfall. Again, similar to the new channel segment between Eastonville and Drake Pond, replacing these structures is not

critical because the detention system alone would decrease future conditions major event flows below existing conditions. In addition, there are no reported flood-related problems adjacent to these crossings.

The Snowbrush Drive culvert upgrade and demolition of the existing berms, located at the ponds just downstream from Snowbrush Drive, and purchasing of Prudent Line easement from Snowbrush Drive to Meridian Road, could be constructed last. Similarly, construction of the check structures along the existing channel located between Sunnyslope Drive and the project outfall can be delayed until monitoring of the channel conditions indicate the erosion is occurring or likely to occur.

Figure 7-2 presents the recommended phasing of improvements and associated costs.

Easements and Maintenance

All culvert improvements (including the erosion protection at Meridian Road) identified in this DBPS are located within current El Paso County right-of-way. The County will be responsible for the construction and maintenance of these structures.

The Prudent Line channel located between Snowbrush Drive and Eastonville Road shall follow the maintenance and easement guidelines set forth in Section 4 of this DBPS.

Channel improvements between Stapleton Drive and Highway 24 shall follow the maintenance and easement guidelines set forth in Section 2.9 of the El Paso County Drainage Criteria Manual. Channel improvements between the basin outfall and approximately 1400-feet downstream of Sunnyslope Drive shall also follow these guidelines.

The County shall obtain maintenance and construction easements for the channel improvements between Highway 24 and approximately 1400-feet south of Sunnyslope Drive. The County will be responsible for the construction and the long-term maintenance of these improvements.

The Woodmen Hills Metropolitan District (WHMD) shall maintain the detention facilities proposed in this DBPS. However, a maintenance easement shall be given to the County in the event that WHMD defaults on its maintenance responsibilities.

Miscellaneous Items

Prudent Line was determined as the recommended improvement for the channel reach between Snowbrush Drive and Meridian Road. If future zoning, re-plats, or other planning changes dictate that the Prudent Line is no longer applicable to this channel segment based on the criteria presented in Table 4-1, an alternate improvement will need to be designed and the DBPS will need to be amended.

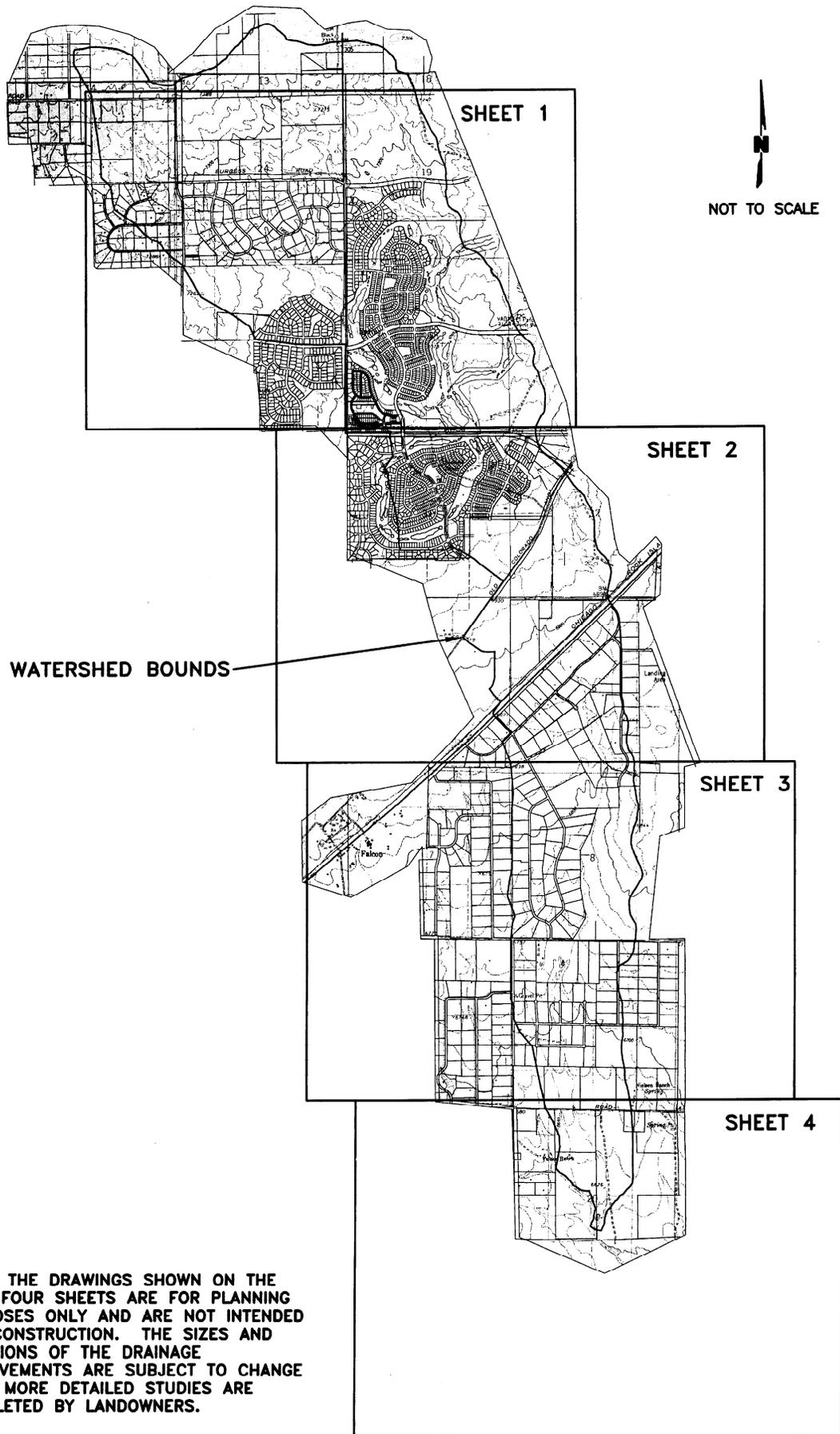
Cost estimates for replacement of culverts were calculated based on a planimetric square footage for the new structure. New culvert widths were determined by hydraulic analysis while new culvert lengths were determined by field measurements of the existing culverts and existing embankments. Future widening of roadways was not considered in determining length of the new structures.

Cost estimates were included for upgrading minor drainage systems for approximately 900 acres of currently developed land between Highway 24 and 1400-foot downstream of Sunnyslope Drive. These improvements were considered public cost improvements constructed by the County. However, developers will be responsible for construction of minor drainage systems within any re-development or new development in this area.

Table 7-3 - Recommended Alternative Improvements

Location	Improvement	Priority	Estimated Cost	Contingencies at 25%	Engineering at 15%	Utilities at 5%	Total Estimated Cost	Basin Fee Eligible Cost	Bridge Fee Eligible Cost	Public Cost
Snowbrush Drive to Meridian Road	• Purchase easements to secure approximately 7,350 ft of Prudent Line setback of 130 ft from channel centerline.	Low	110000	27500	16500	5900	159500	159500	0	0
	• Remove berms at ponds located downstream from Snowbrush Drive.	Low	2200	550	330	110	3190	3190	0	0
	• Replace existing 54 inch-diameter CMP at Snowbrush with 7' (W) x 5' (H) x 50' (L) box culvert.	Low	49000	12250	7350	2450	71050	71050	0	0
Meridian Road to Highway 24	• Replace existing triple 48 inch-diameter RCP at Meridian Road with a 30' (W) x 7' (H) x 50' (L) box culvert.	High	210000	52500	31500	10500	304500	0	304500	0
	• Place erosion protection at the downstream end of the new box culvert.	High	16280	4070	2442	814	23606	23606	0	0
Meridian Road to Highway 24	• Construct 7,200 feet of new channel with 31 check structures.	High	795000	198750	119250	39750	1152750	1152750	0	0
	• Construct four ponds with combined detention storage of ~90 ac-ft and one pond with ~50 ac-ft of storage.	High	1868000	467000	280200	93400	2708600	2708600	0	0
	• Construct a new 30' (W) x 7' (H) x 60' (L) box culvert and associated road grade at Eastonville Road.	High	252000	63000	37800	12600	365400	0	365400	0
	• Replace the existing twin 36 inch-diameter CMP at Orr Road with a 30' (W) x 7' (H) x 60' (L) box culvert and associated road grade.	High	252000	63000	37800	12600	365400	0	365400	0
Highway 24 to 1400 ft downstream of Sunny Slope Drive	• Replace existing 13' (W) x 3' (H) box culvert at old trail line with a 30' (W) x 7' (H) x 60' (L) box culvert.	High	252000	63000	37800	12600	365400	0	365400	0
	• Construct 4,200 feet of new channel with 15 check structures.	High	448330	112083	67250	22417	650079	0	650079	0
1400 ft downstream of Sunny Slope Drive to project outfall	• Replace existing 36" CMP at Blue Gill Drive with a 30' (W) x 7' (H) x 60' (L) box culvert.	High	252000	63000	37800	12600	365400	0	365400	0
	• Replace 30" cmp at Sunnyslope Drive with 30' (W) x 7' (H) x 60' (L) box culvert.	Medium	252000	63000	37800	12600	365400	0	365400	0
	• Construct approximately 3 check structures downstream of Sunny Slope Drive to maintain a maximum channel slope of 0.7%.	Low	15000	3750	2250	750	21750	0	21750	0
1400 ft downstream of Sunny Slope Drive to project outfall	• Upgrade existing minor drainage systems (roadside swales) to route flows to the major drainage system.	Low	360000	90000	54000	18000	522000	0	522000	0
	• Replace existing 48" cmp at Garrett Road with a 30' (W) x 7' (H) x 60' (L) box culvert.	Medium	252000	63000	37800	12600	365400	0	365400	0
	• Construct approximately 12 check structures to maintain a maximum channel slope of 0.7%.	Low	60000	15000	9000	3000	87000	87000	0	0
Subtotal Cost =							7896425	4205696	304500	3386229
Study Cost =							107194	107194	0	0
Basin Fee =									6083	
Bridge Fee =										429

Note: The drainage basin and bridge fees were calculated by dividing the respective improvement costs by the acreage of impervious land that will be added to the basin when undeveloped areas are constructed. The approximately seven square mile Bennett Ranch basin currently contains 225 acres of impervious land. An additional 709 acres of impervious land will be added to the basin when the undeveloped areas are constructed. Therefore, the respective improvement costs were divided by 709 acres to determine the drainage basin and bridge fees in dollars per impervious acre.



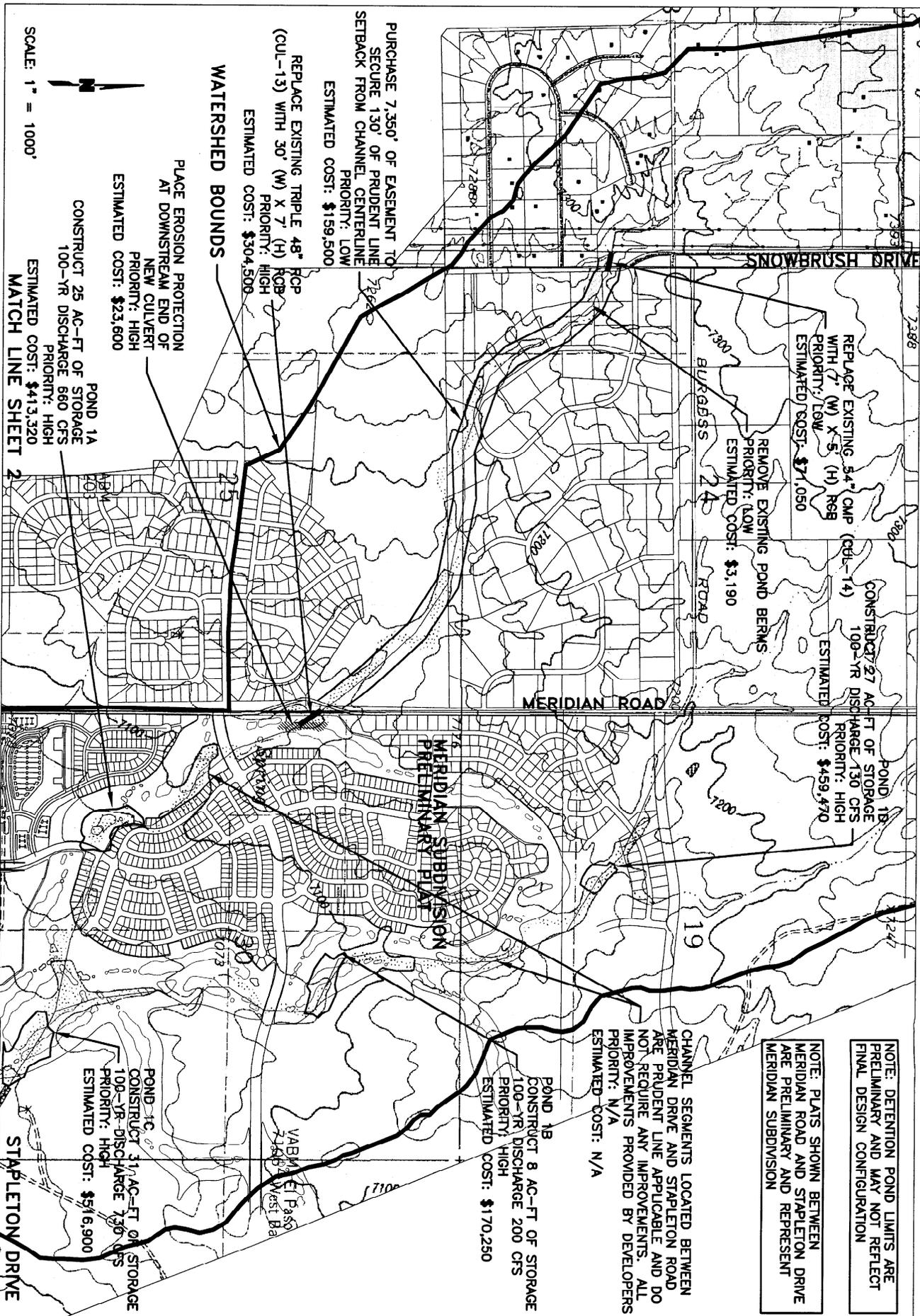
NOTE: THE DRAWINGS SHOWN ON THE NEXT FOUR SHEETS ARE FOR PLANNING PURPOSES ONLY AND ARE NOT INTENDED FOR CONSTRUCTION. THE SIZES AND LOCATIONS OF THE DRAINAGE IMPROVEMENTS ARE SUBJECT TO CHANGE ONCE MORE DETAILED STUDIES ARE COMPLETED BY LANDOWNERS.

**DRAFT BENNETT
RANCH PILOT PROJECT**

drawn by: FAP, WCB
 designed by: KKB
 checked by: KKB
 project no.: 2000-0818
 drawing no.:
 date: MAR 01
 revisions:



FIGURE 7-1
INDEX SHEET



NOTE: DETENTION POND LIMITS ARE PRELIMINARY AND MAY NOT REFLECT FINAL DESIGN CONFIGURATION

NOTE: PLATS SHOWN BETWEEN MERIDIAN ROAD AND STAPLETON DRIVE ARE PRELIMINARY AND REPRESENT MERIDIAN SUBDIVISION

CHANNEL SEGMENTS LOCATED BETWEEN MERIDIAN DRIVE AND STAPLETON ROAD ARE PRUDENT LINE APPLICABLE AND DO NOT REQUIRE ANY IMPROVEMENTS. ALL IMPROVEMENTS PROVIDED BY DEVELOPERS
PRIORITY: N/A
ESTIMATED COST: N/A

SCALE: 1" = 1000'



WATERSHED BOUNDS

PLACE EROSION PROTECTION AT DOWNSTREAM END OF NEW CULVERT
PRIORITY: HIGH
ESTIMATED COST: \$23,600

CONSTRUCT 25 AC-FT OF STORAGE
100-YR DISCHARGE 660 CFS
PRIORITY: HIGH
ESTIMATED COST: \$413,520

MATCH LINE SHEET 2

PURCHASE 7,350' OF EASEMENT TO SECURE 130' OF PRUDENT LINE SETBACK FROM CHANNEL CENTERLINE
PRIORITY: LOW
ESTIMATED COST: \$159,500

REPLACE EXISTING TRIPLE 48" RCP (CUL-13) WITH 30" (W) X 7" (H) RCP
PRIORITY: HIGH
ESTIMATED COST: \$304,500

MERIDIAN SUBDIVISION
PRELIMINARY PLAT

CONSTRUCT 31 AC-FT OF STORAGE
100-YR DISCHARGE 730 CFS
PRIORITY: HIGH
ESTIMATED COST: \$516,900

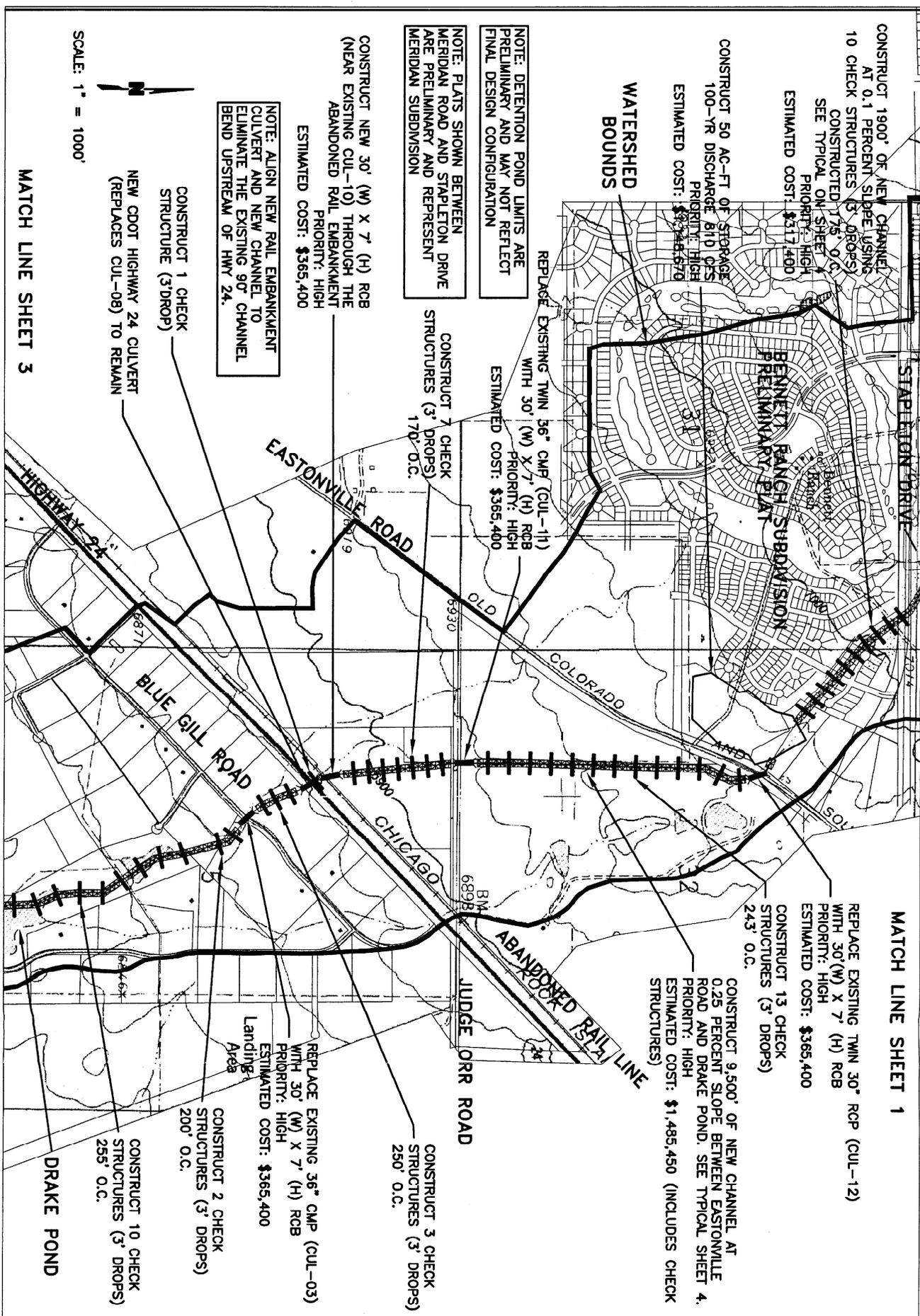
STAPLETON DRIVE

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checked by: KKB
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FIGURE 7-1
SHEET 1



CONSTRUCT 1900' OF NEW CHANNEL AT 0.1 PERCENT SLOPE USING 10 CHECK STRUCTURES (3' DROPS) CONSTRUCTED AT 175' O.C. SEE TYPICAL ON SHEET 1 PRIORITY: HIGH ESTIMATED COST: \$317,400

CONSTRUCT 50 AC-FT OF STORAGE 100-YR DISCHARGE BLD CFS PRIORITY: HIGH ESTIMATED COST: \$324,670

NOTE: DETENTION POND LIMITS ARE PRELIMINARY AND MAY NOT REFLECT FINAL DESIGN CONFIGURATION

NOTE: PLATS SHOWN BETWEEN MERIDAN ROAD AND STAPLETON DRIVE ARE PRELIMINARY AND REPRESENT MERIDAN SUBDIVISION

CONSTRUCT NEW 30' (W) X 7' (H) RCB (NEAR EXISTING CUL-10) THROUGH THE ABANDONED RAIL EMBANKMENT PRIORITY: HIGH ESTIMATED COST: \$365,400

NOTE: ALIGN NEW RAIL EMBANKMENT CULVERT AND NEW CHANNEL TO ELIMINATE THE EXISTING 90° CHANNEL BEND UPSTREAM OF HWY 24.

CONSTRUCT 1 CHECK STRUCTURE (3' DROP) NEW CDOT HIGHWAY 24 CULVERT (REPLACES CUL-08) TO REMAIN

SCALE: 1" = 1000'

MATCH LINE SHEET 3

MATCH LINE SHEET 1

REPLACE EXISTING TWIN 30" RCP (CUL-12) WITH 30" (W) X 7' (H) RCB PRIORITY: HIGH ESTIMATED COST: \$365,400

CONSTRUCT 13 CHECK STRUCTURES (3' DROPS) 243' O.C.

CONSTRUCT 9,500' OF NEW CHANNEL AT 0.25 PERCENT SLOPE BETWEEN EASTONVILLE ROAD AND DRAKE POND. SEE TYPICAL SHEET 4. PRIORITY: HIGH ESTIMATED COST: \$1,485,450 (INCLUDES CHECK STRUCTURES)

REPLACE EXISTING 36" CMP (CUL-03) WITH 30" (W) X 7' (H) RCB PRIORITY: HIGH ESTIMATED COST: \$365,400

CONSTRUCT 2 CHECK STRUCTURES (3' DROPS) 200' O.C.

CONSTRUCT 10 CHECK STRUCTURES (3' DROPS) 255' O.C.

CONSTRUCT 3 CHECK STRUCTURES (3' DROPS) 250' O.C.

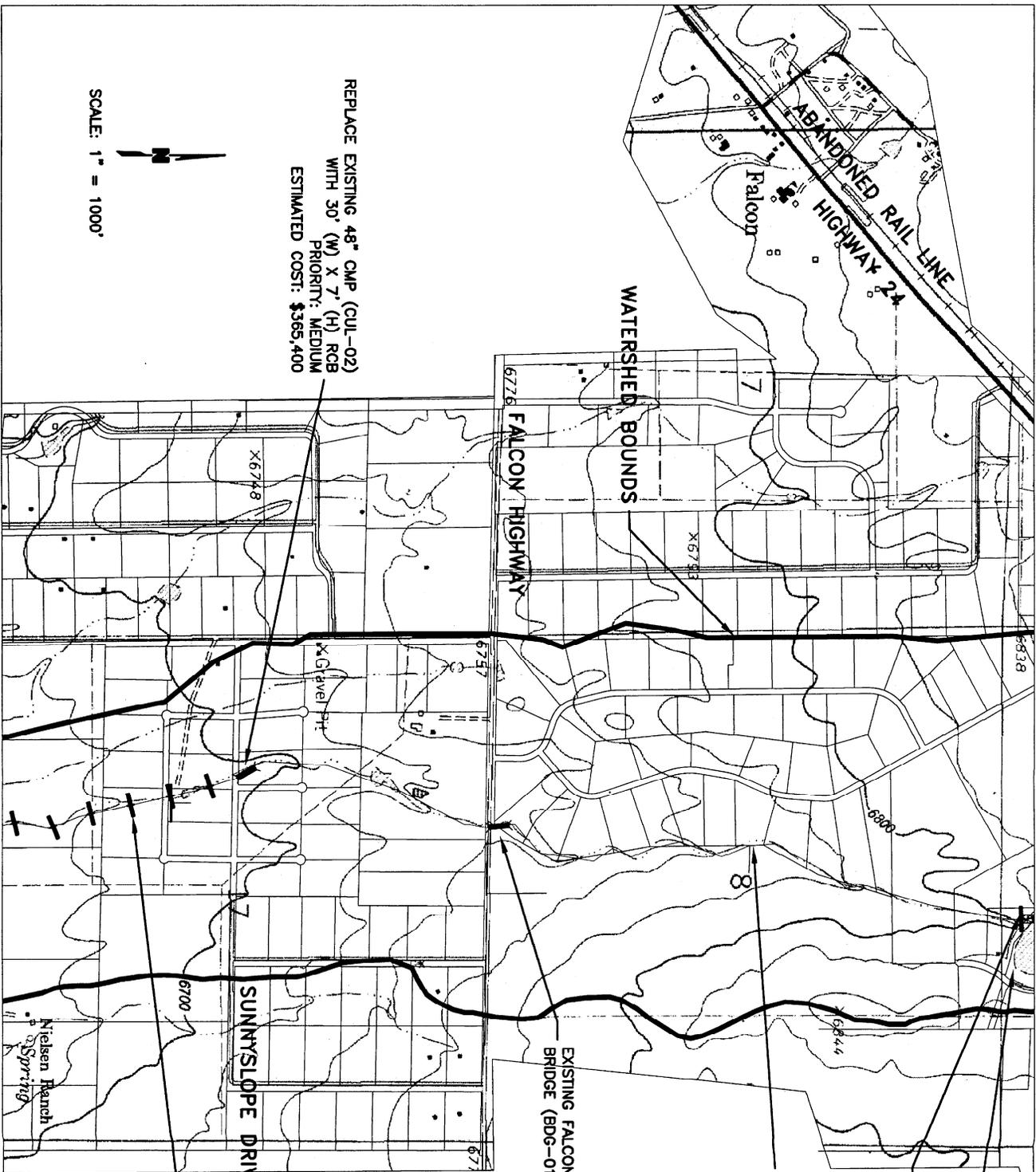
CONSTRUCT 3 CHECK STRUCTURES (3' DROPS) 200' O.C.

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FIGURE 7-1 SHEET 2



SCALE: 1" = 1000'



REPLACE EXISTING 48" CMP (CUL-02)
WITH 30" (W) X 7' (H) RCB
PRIORITY: MEDIUM
ESTIMATED COST: \$365,400

WATERSHED BOUNDS

FALCON HIGHWAY

EXISTING FALCON HIGHWAY
BRIDGE (BDG-01) TO REMAIN

SUNNYSLOPE DRIVE

MATCH LINE SHEET 2
DRAKE POND

APPROXIMATE END OF NEW CHANNEL
SEE SHEET 2

NO IMPROVEMENTS NECESSARY
BETWEEN DRAKE POND AND
SUNNYSLOPE DRIVE

CONSTRUCT 6 CHECK
STRUCTURES (3' DROPS) 425' O.C.
TO MAINTAIN MAXIMUM CHANNEL
SLOPE OF 0.7 PERCENT
PRIORITY: LOW
ESTIMATED COST: \$43,500

MATCH LINE SHEET 4

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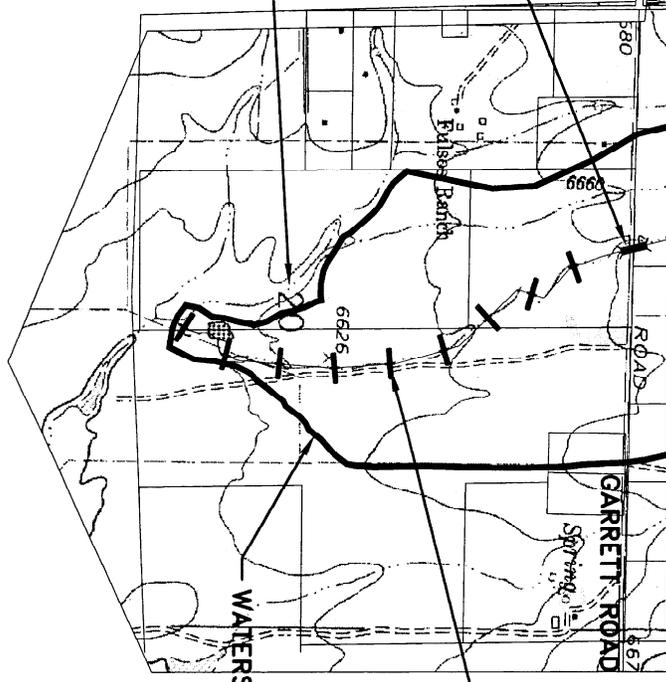


FIGURE 7-1
SHEET 3

SCALE: 1" = 1000'

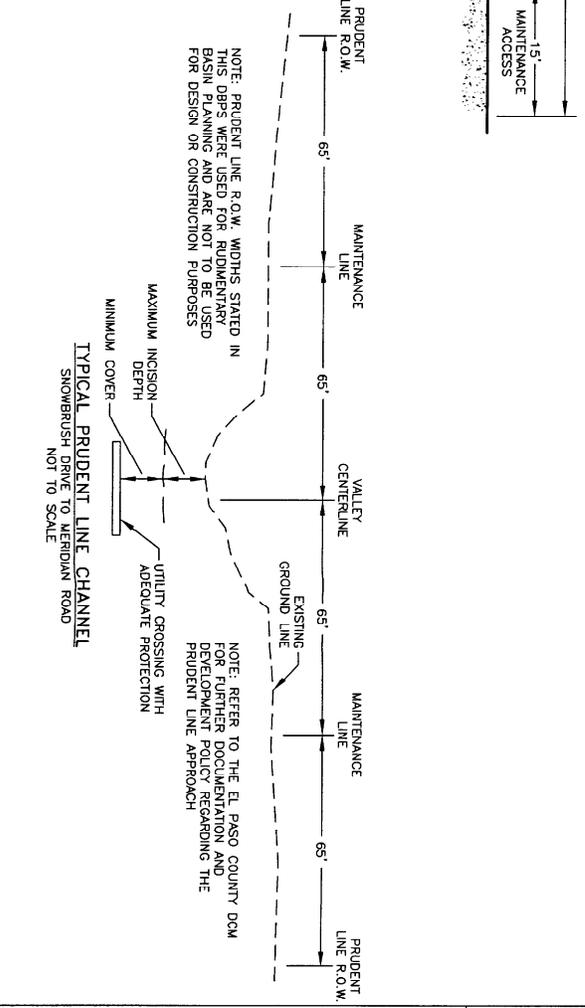
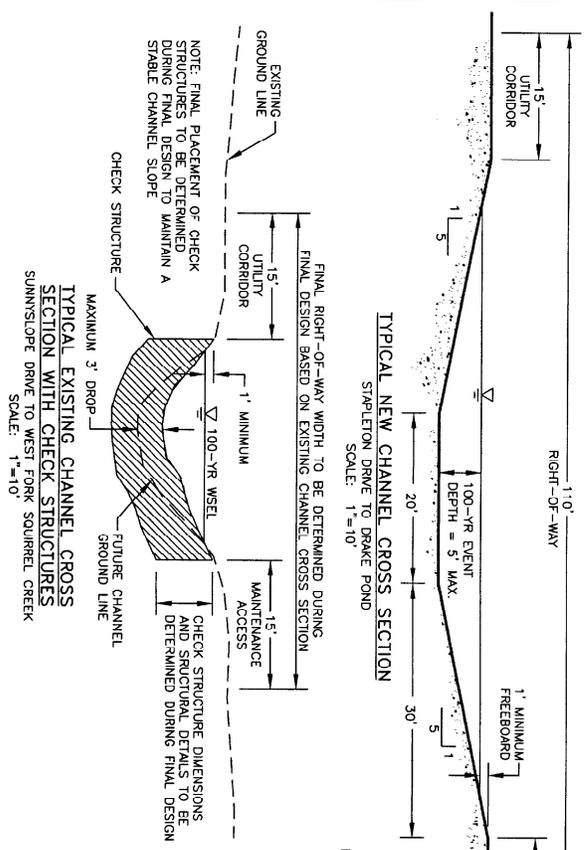


REPLACE EXISTING 48" CMP (CUL-01)
WITH 30" (W) X 7' (H) RCB
PRIORITY: MEDIUM
ESTIMATED COST: \$365,400



CONSTRUCT 9 CHECK
STRUCTURES (3' DROPS)
450' O.C. TO MAINTAIN A
MAXIMUM CHANNEL SLOPE OF
0.7 PERCENT
PRIORITY: LOW
ESTIMATED COST: \$65,250

MATCH LINE SHEET 3



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FIGURE 7-1
SHEET 4

APPENDIX A

Agency Coordination

January 18, 2001

US Army Corps of Engineers
ATTN: Anita Culp
720 N. Main, Rm 205
Pueblo, CO 80103-3046

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Ms. Anita Culp:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

On behalf of Andre' Brackin, El Paso County Project Manager, we invite you to attend a project agency coordination meeting on January 30, 2001 at 2:00 p.m. The meeting will be held in the El Paso County Planning Department's 5th floor conference room located at 27 East Vermijo, Colorado Springs. Attached is a meeting agenda and information package for your review.

Please contact Andre' Brackin via email at Andre_Brackin@co.el-paso.co.us to let us know if you are able to attend. If you have any questions prior to the meeting, please call me at (303) 694-3800 or Andre' Brackin at (719) 520-6845. We look forward to meeting with you on January 30th.

Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

US Fish and Wildlife
ATTN: Bob McCue
PO Box 25486
Denver, CO 80225-0486

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. Bob McCue:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

On behalf of Andre' Brackin, El Paso County Project Manager, we invite you to attend a project agency coordination meeting on January 30, 2001 at 2:00 p.m. The meeting will be held in the El Paso County Planning Department's 5th floor conference room located at 27 East Vermijo, Colorado Springs. Attached is a meeting agenda and information package for your review.

Please contact Andre' Brackin via email at Andre_Brackin@co.el-paso.co.us to let us know if you are able to attend. If you have any questions prior to the meeting, please call me at (303) 694-3800 or Andre' Brackin at (719) 520-6845. We look forward to meeting with you on January 30th.

Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

Colorado Division of Wildlife
ATTN: Gary Dowller
2126 N. Weber
Colorado Springs, CO 80907

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. Gary Dowller:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

Federal Emergency Management Agency
ATTN: John Liou
Denver Federal Center
Bldg 710, Box 25267
Denver, CO 80225-0267

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. John Liou:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

Colorado Water Conservation Board
ATTN: Larry Lang
1313 Sherman, Rm 721
Denver, CO 80203

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. Larry Lang:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

City of Colorado Springs
ATTN: Bruce Thorson
101 W. Costilla St.
Colorado Springs, CO 80901

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. Bruce Thorson:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

El Paso County -
Regional Building Department
ATTN: Floodplain Administrator
101 W. Costilla St.
Colorado Springs, CO 80901

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Sir or Madam:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

National Resources Conservation Service
ATTN: John Valentine
1826 E. Platte Ave., Suite 114
Colorado Springs, CO 80909

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. John Valentine:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

Colorado Department of Transportation
ATTN: Paul Reinswa
16 E. Arvada St.
Colorado Springs, CO 80906

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. Paul Reinswa:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

El Paso County Planning
ATTN: Mark Gebhardt
27 E. Vermijo
Colorado Springs, CO 80903

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Mr. Mark Gebhardt:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Sincerely,

Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

January 18, 2001

Colorado Geological Survey
ATTN: Celia Greenman
1313 Sherman, Rm 715
Denver, CO 80902

Subject: Bennett Ranch Pilot Project Agency Coordination Meeting

Dear Ms. Celia Greenman:

El Paso County is experiencing rapid growth in areas that lack drainage basin plans. In an effort to produce basin drainage plans in a timely manner, El Paso County contracted with Stormwater and Environmental Consultants (SEC) to conduct a Pilot Project that establishes an accelerated planning process for rural basins. A rural basin is defined as any basin likely to have less than a cumulative 15% to 20% imperviousness within the entire basin under future land use conditions. El Paso County selected the Bennett Ranch drainage basin for the Pilot Project to define work efforts and formats for future rural drainage basin planning studies.

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Kurt Bauer, P.E.
Project Manager

Jon Sorensen, P.E.
Project Principal

Bennett Ranch Pilot Project Basin Planning Study Summary

Background

The Bennett Ranch watershed is located approximately 20 miles northeast of downtown Colorado Springs (Figure 2-1 Project Location). The western boundary is located just two miles east of the town of Falcon. The approximately seven square-mile watershed is long, narrow, and aligned north to south. Major roads within the watershed include Highway 24, Meridian Road, Eastonville Road, and Falcon Highway.

The majority of the developed land is currently used for large-lot (greater than 2.5 acres) single family homes with large portions of land within the watershed still undeveloped and used as pasturelands for grazing. Three large subdivisions are proposed within the watershed. It is anticipated that with the development of the three subdivisions, future conditions land use will change to higher density land uses.

Stormwater runoff within the watershed is conveyed north to south through a series of open channel reaches, culverts, and bridges. Existing channels are largely adequate to convey stormwater through the northern portion of the watershed and there are no reported flooding-related problems within this area of the watershed. Flood related problems occur in the middle of the watershed near Highway 24. Drainageways located in this area are poorly defined and existing culverts are undersized. Existing culverts and numerous channel segments within the lower portions of the watershed are undersized but no flood related problems are reported.

Prudent Line Approach

The Bennett Ranch Pilot Project includes a channel setback approach to be considered in rural basins. This approach, named the Prudent Line approach, is an alternative to the way the County has traditionally designed channel improvements. The approach allows a creek to adjust to increased flows from lower density development by constructing a limited number of grade control structures and providing a strip of land adjacent to the creek, defined by a "Prudent Line", within which erosion can occur. Limited bank stabilization would also be implemented in places where erosion may occur such as on the outside of bends. If future erosion threatened land beyond the Prudent Line, the County would have the responsibility to stabilize the erosion.

The Prudent Line setback is protected with an easement, similar to a floodplain easement, where structures are not allowed and maintenance access is provided. The land in the Prudent Line setback can be owned by individual homeowners, by a Homeowners' Association, or can be land dedicated to the County. It is only applicable in areas within the watershed that contain lower land use densities (cumulative upstream land use must contain less than 20 percent impervious cover). With the Prudent Line approach, fewer channel stabilization measures are used than in drainages with conventional channel improvements, and, in most cases, the Prudent Line approach is less costly than the conventional approach.

Project Status

Peak flows within the watershed have been developed and are shown on Figure 3-3 Peak Flows. Based on our deficiency analysis, just over one-half of the evaluated open channel reaches are deficient (23,800 feet of open channel). All nine of the evaluated culverts are deficient. One existing bridge, the Falcon Highway bridge, meets design criteria. Figure 5-1 System Deficiencies presents deficient open channel segments and existing culverts or bridges within the watershed.

Alternatives

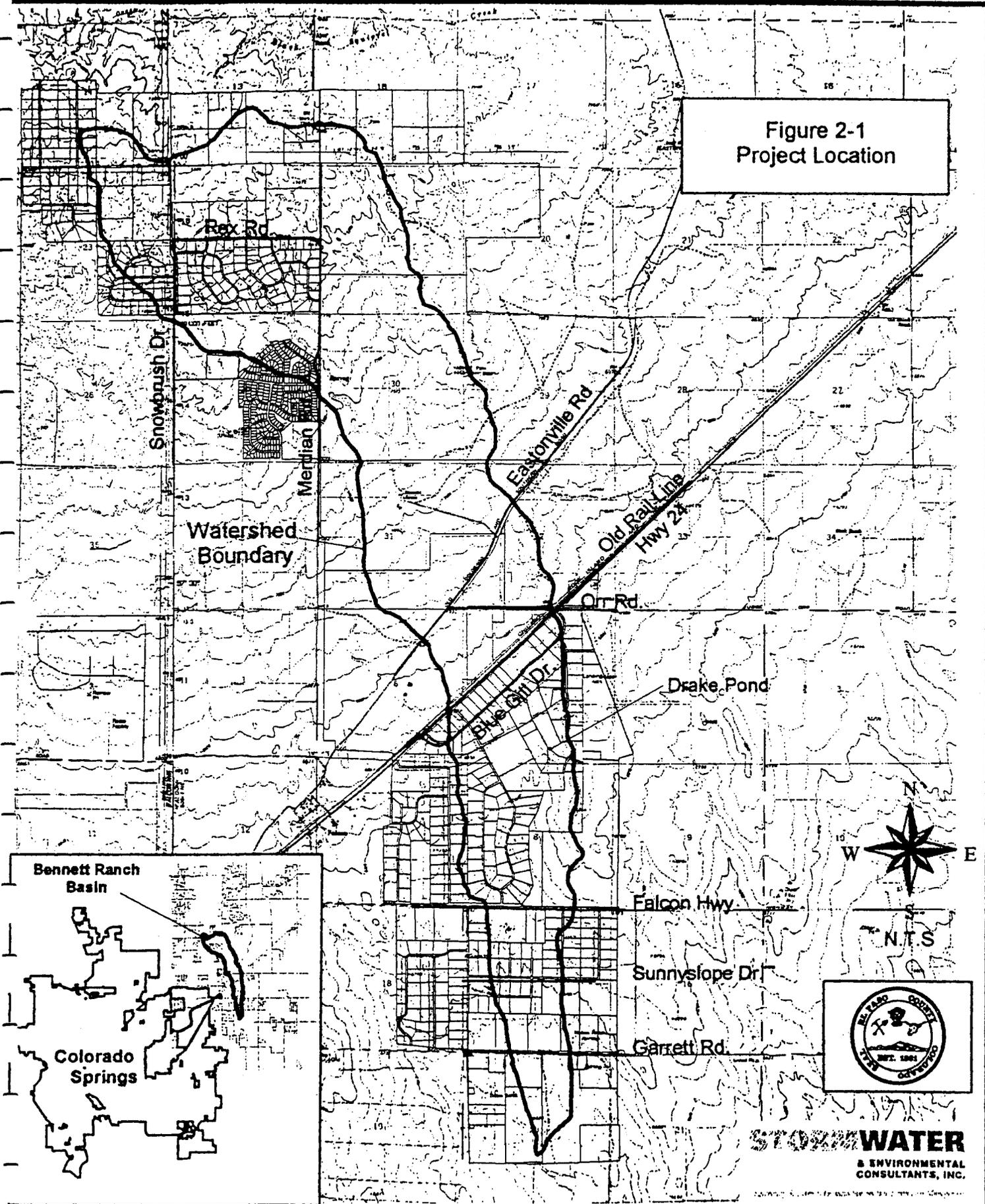
Two feasible alternatives have been developed. The first alternative, presented in Figure 6-1 Alternative 1, upgrades the entire conveyance system without any detention storage. It includes:

- Approximately 2.8 miles of Prudent Line reaches
- 2 new box culverts
- 7 new bridges
- 3.2 miles of new channel
- 69 new check structures
- Misc.: Placement of erosion control riprap and removal of existing pond berms
- Monitor approximately 1.7 miles of channel to determine future channel improvements

The second alternative, presented in Figure 6-2 Alternative 2, upgrades the entire conveyance system but includes a regional detention pond located in the middle of the watershed. This alternative includes:

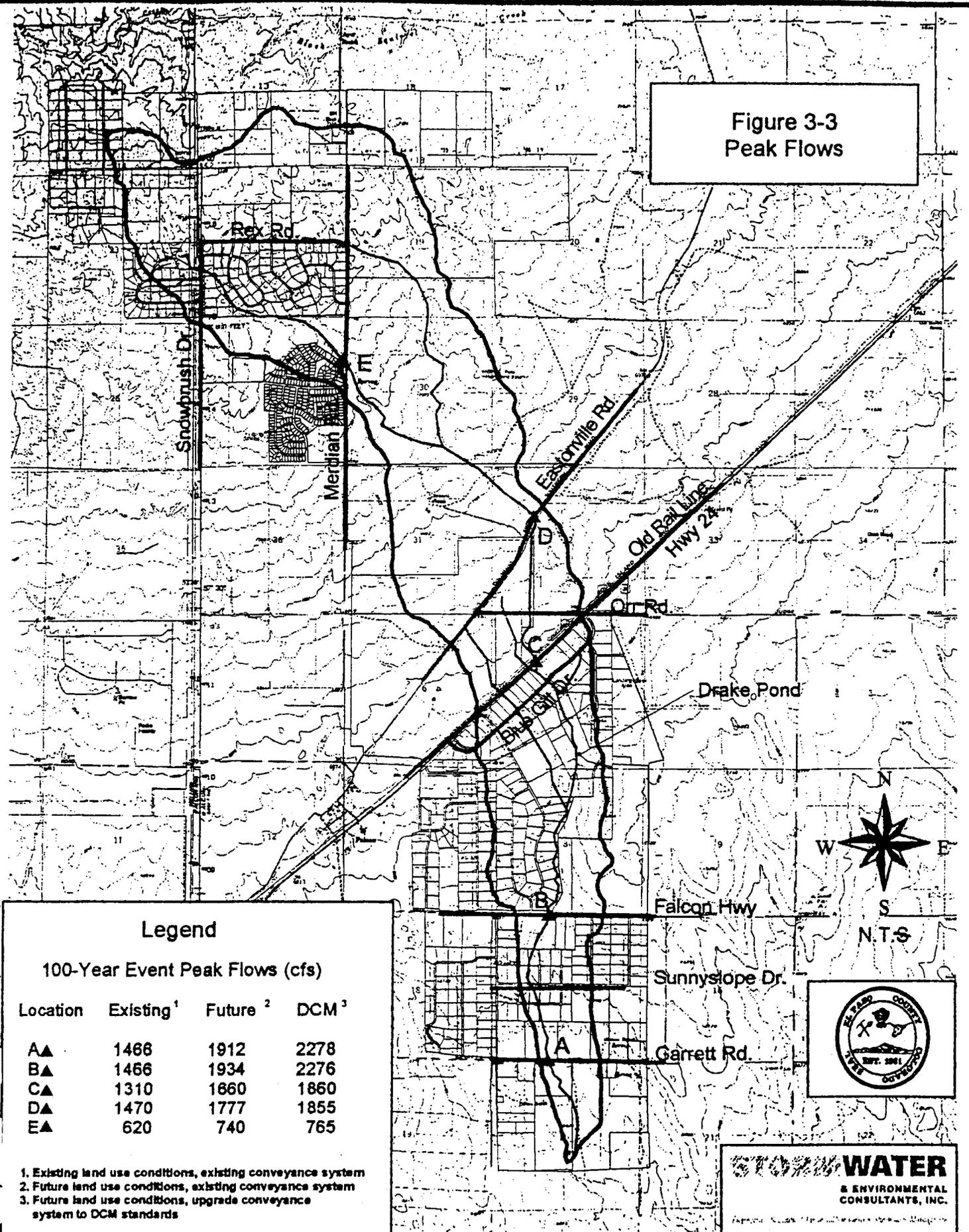
- Approximately 5.9 miles of Prudent Line reaches
- 2 new box culverts
- 6 new bridges
- 1.8 miles of new channel
- 53 new check structures
- Misc.: Placement of erosion control riprap and removal of existing pond berms
- Regional detention pond (21 acre-feet storage)

Figure 2-1
Project Location



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Figure 3-3
Peak Flows



Legend

100-Year Event Peak Flows (cfs)

Location	Existing ¹	Future ²	DCM ³
A▲	1466	1912	2278
B▲	1466	1934	2276
C▲	1310	1860	1860
D▲	1470	1777	1855
E▲	620	740	765

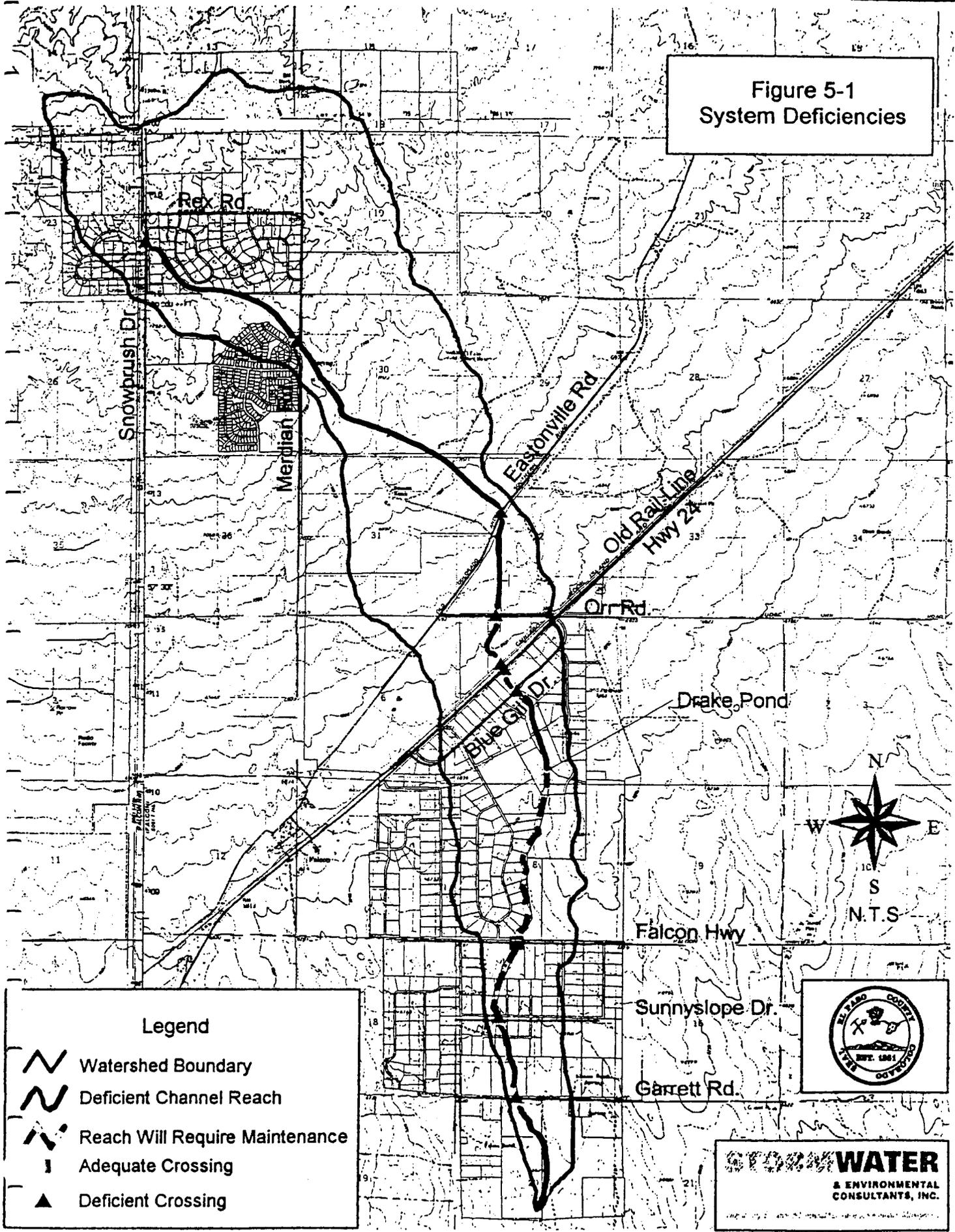
- 1. Existing land use conditions, existing conveyance system
- 2. Future land use conditions, existing conveyance system
- 3. Future land use conditions, upgrade conveyance system to DCM standards



WATER
& ENVIRONMENTAL
CONSULTANTS, INC.

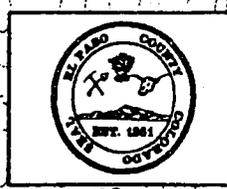
Specialty Services for Municipalities and Agencies

Figure 5-1
System Deficiencies



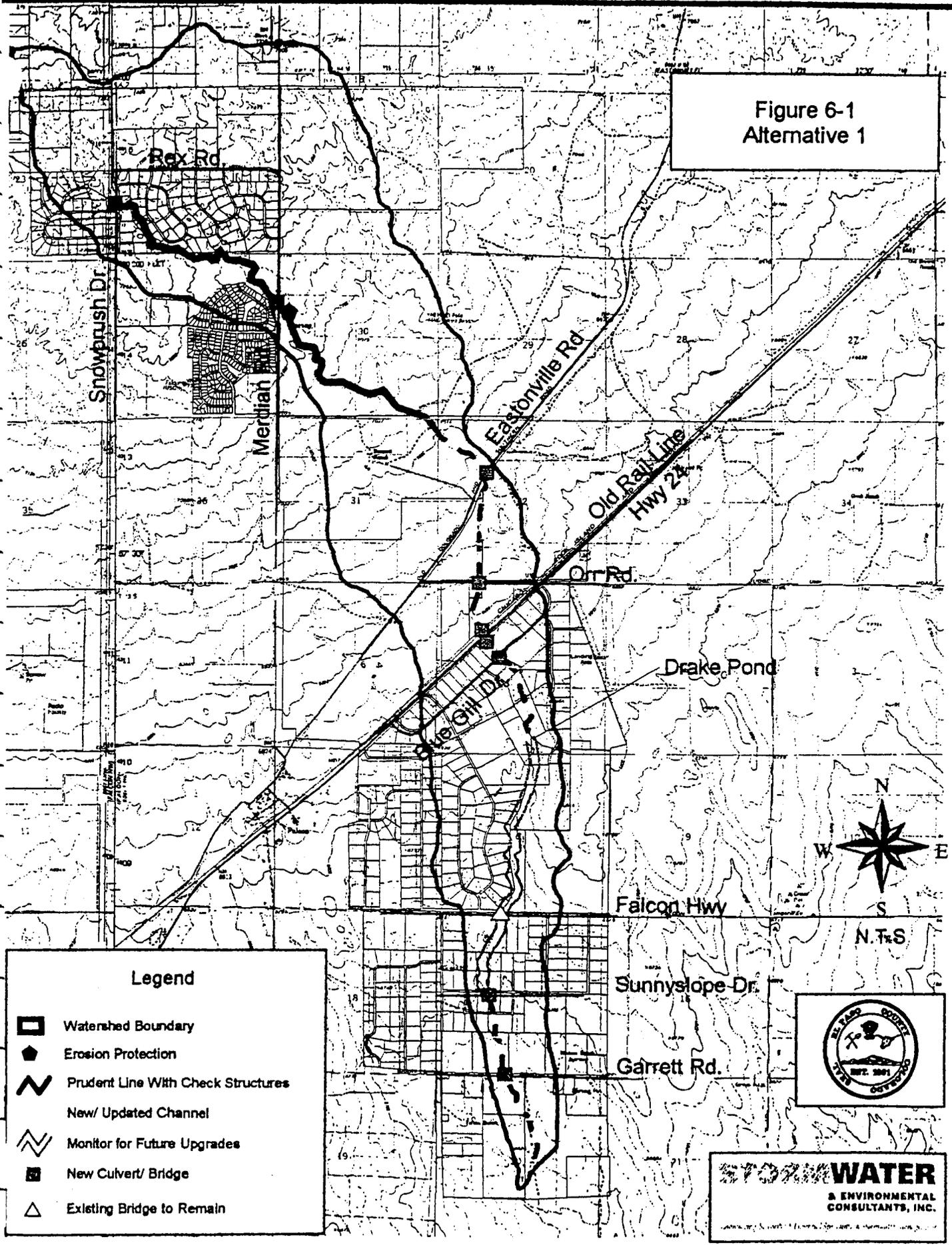
Legend

-  Watershed Boundary
-  Deficient Channel Reach
-  Reach Will Require Maintenance
-  Adequate Crossing
-  Deficient Crossing



WATER
& ENVIRONMENTAL
CONSULTANTS, INC.

Figure 6-1
Alternative 1



Legend

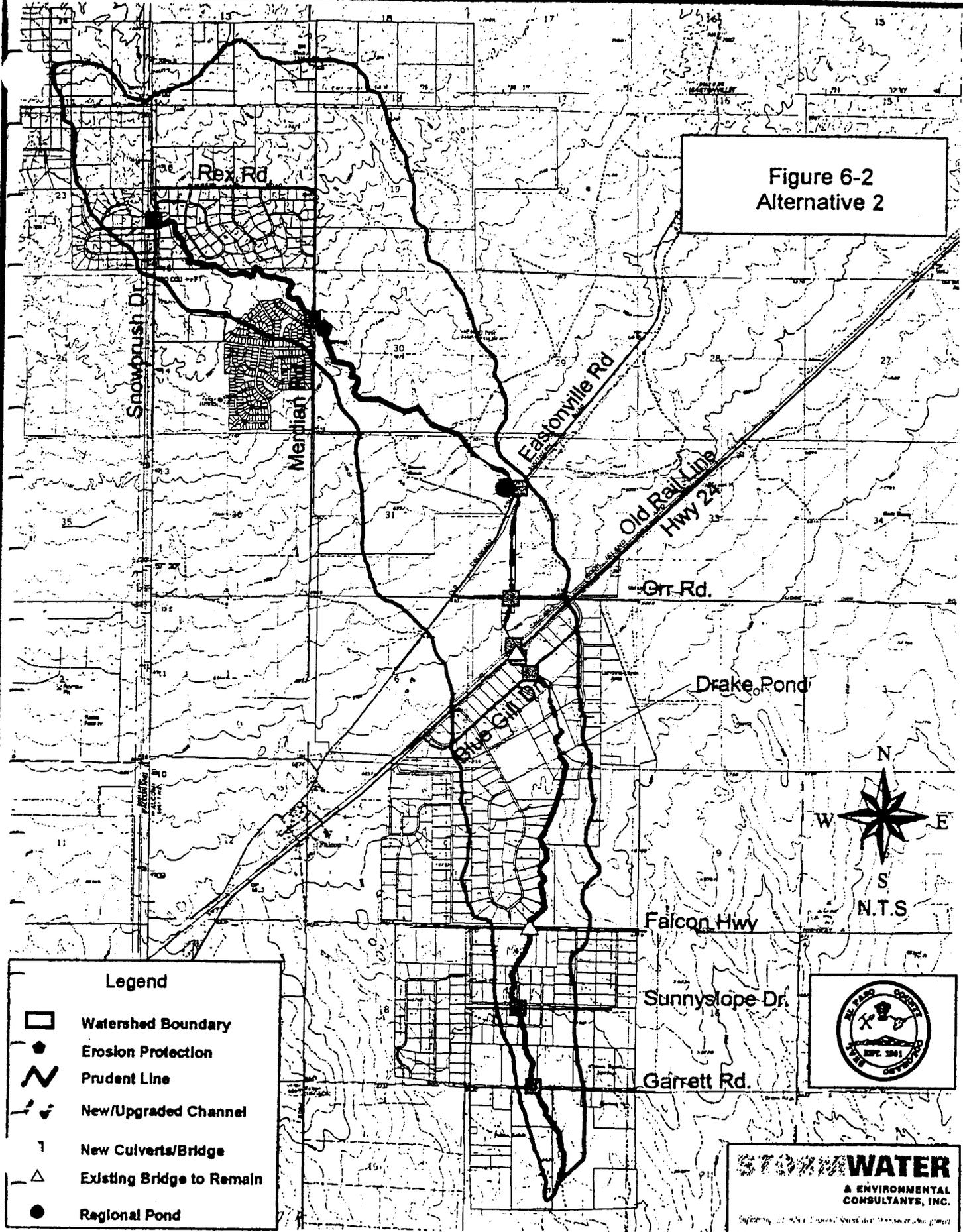
-  Watershed Boundary
-  Erosion Protection
-  Prudent Line With Check Structures
-  New/ Updated Channel
-  Monitor for Future Upgrades
-  New Culvert/ Bridge
-  Existing Bridge to Remain



STORMWATER
 & ENVIRONMENTAL
 CONSULTANTS, INC.

www.stormwater.com • 303.440.1111 • 10000 E. Hampden Ave., Suite 100, Denver, CO 80231

Figure 6-2
Alternative 2



Legend

-  Watershed Boundary
-  Erosion Protection
-  Prudent Line
-  New/Upgraded Channel
-  New Culverts/Bridge
-  Existing Bridge to Remain
-  Regional Pond



STORMWATER
& ENVIRONMENTAL
CONSULTANTS, INC.

Engineering, Planning, Construction Management, and Construction

**Bennett Ranch Pilot Project Drainage Basin Planning Study
El Paso County, Colorado
Agency Coordination Meeting**

**January 30, 2001 2:00 p.m.
5th Floor Conference Room, Planning Department
27 East Vermijo, Colorado Springs**

1. Rural Basin vs Traditional Basin Planning

A. Rural Planning Goals

- 1) Prepare rural basin plans for ~50% the current cost of drainage basin studies
- 2) Prepare rural basin plans in less time (~ 5-6 months)

B. Rural Planning Methods

- 1) Existing mapping, generally USGS quadrangle maps (electronic)
- 2) Hydrology with HEC-1 and input parameters generated electronically using AutoCAD Map and ArcView for easier updates/modifications
- 3) No floodplain delineation (hydrology complete for crossings and channels. Developers can use peak flows to develop floodplains)
- 4) Concept level design and budgetary opinions of cost
- 5) Prudent Line as preferred alternative using new El Paso County Rural
- 6) Basin Methodology developed by Ayres for DCM
- 7) SIMS will be explored
- 8) Environmental issues/wetlands

C. Drainage Basin Fees

- 1) Impervious-based fees

2. Bennett Ranch Pilot Project

A. Status

- 1) Summary of current schedule and project status
- 2) Copy of current Bennett Ranch Draft Report

B. Summary

- 1) Project Location, major features, and land uses
 - a. CDOT HWY 24 project
 - b. Summary of new subdivision developments
- 2) Summary of peak flow estimates
- 3) Prudent Line Applicability
- 4) System deficiencies/problem areas/public input
- 5) Presentation of DRAFT Alternatives

3. Agency Comment Period

A. Solicitation of agency questions, concerns, input

B. Future communications and key project milestones

**Bennett Ranch Pilot Project
DRAFT Agency Contact List
Modified December 13, 2000**

Agency	Contact	Address	Phone Number	Fax Number
US Army Corps of Engineers (USCOE)	Anita Culp	720 N. Main Rm 205 Pueblo, CO 801003-3046	719-543-6914	719-543-9475
Ecological Service US Fish and Wildlife Service (USFWS)	Bob McCue	PO Box 25486 Denver, CO 80225-0486	303-236-7400	
Colorado Division of Wildlife	Gary Dowler Dave Levell	2126 N. Weber Colorado Springs, CO 80907	719-227-5224	719-227-5297
Federal Emergency Management Agency (FEMA)	John Liou	Denver Federal Center Bldg 710 Box 25267 Denver, CO 80225-0267	303-235-4800	303-235-4849
Colorado Water Conservation Board	Larry Lang Bill Green	1313 Sherman Rm 721 Denver, CO 80203	303-866-3441 x320	
City of Colorado Springs	Bruce Thorson	101 W. Costilla St. Suite 113 Colorado Springs, CO 80901	719-385-5054	719-578-6161
Regional Floodplain Coordinator	Dan Bunting	El Paso County Engineering Department of Transportation 3460 Marksheffel Road Colorado Springs, CO 80922	719-578-6230	719-578-6806
National Resources Conservation Service (NRCS)	John Valentine	1826 E. Platte Ave. Suite 114 Colorado Springs, CO 80909	719-632-9598	719-473-7104
Colorado Department of Transportation (CDOT)	Paul Reinswa	16 E. Arvada St. Colorado Springs, CO 80906	719-634-2303	719-632-2172
El Paso County Planning	Mark Gebhardt	27 East Vermijo Colorado Springs, CO 80903	719-520-6300	
Colorado Geological Survey	Celia Greenman	1313 Sherman Street Room 715 Denver, CO 80203	303-866-2611 x3811	303-866-2461

Bennett Ranch Pilot Project
 Drainage Basin Planning Study
 Agency Coordination Meeting

January 30, 2001 2:00 p.m.
 5th Floor Conference Room, Planning Department
 27 East Vermijo, Colorado Springs

List of Attendees

Name	Organization	Contact Number
ANDRÉ BRACKIN	EPCDOT	719-520-6845 andre_brackin@co.el-paso.co.us
John Valentine	NRCS	719-473-7104 EXT 3 John.Valentine@co.usda.gov
Celia Greenman	Co. Geo Surv.	Celia.Greenman@state.co.us
JOE GORNEY	EL PASO COUNTY PLANNING DEPT.	719-520-6304 joegorney@elpasoco.com
ROBERT FLESE	PPRBD	327-2906 RLPLESE@PPRBD.ORG
Garth Englund	URS	303-796-4631 Garth_Englund@urscorp.com
Paul REINSMAN	CDOT	719-331-5384 CELL 719-634-2323
Bruce Thorson	City Engineering	385-5054
TIM MITROS	" "	385-5061
Jon Sorenson	SEC/OA	303-694-3800
Kurt Bauer	SEC/OA	303-694-3800

Criteria for Prudent Line Channel Reaches

Location	Classification	Criteria
Snowbrush Drive to Eastonville Road	Prudent Line Reaches	<ul style="list-style-type: none"> • Bank full capacity of channel must convey flows from future land use conditions 10-year event • All upstream culverts and bridges must not significantly alter channel hydraulics (limited backwater effects) • Velocities caused by the future land use conditions 100-year event must not increase velocities more than 10% above existing conditions 100-year event velocities.

Criteria for Traditional-Improvement Channel Segments (Non-Prudent Line Channels)

Location	Classification	Criteria
Eastonville Road to Watershed Outfall	Major drainageway segment (100-year event flows > 1,500 cfs)	<ul style="list-style-type: none"> • Maximum channel Froude # of 0.9 (unlined channels) for 100-year event • Maximum mean channel velocity of 5 ft/sec (unlined channels with coarse sand or fine gravel or vegetated bottoms) for 100-year event • Minimum one foot of bank freeboard for 100-year event

Criteria for Structures

Location	Classification	Criteria
<ul style="list-style-type: none"> • Snowbrush Drive • Meridian Road 	Culverts located on a collector Road within a Prudent Line Reach	Minimal backwater effects
<ul style="list-style-type: none"> • Judge Orr Road • RR Bridge • Hwy 24 • Blue Gill Drive • Falcon Hwy • Sunny Slope Road • Garrett Road 	Structures along a major drainageway (100-year event flows > 1,500 cfs)	Minimum two feet of freeboard for the 100-year event

**El Paso County DCM
Prudent Line Applicability Criteria**

DCM Prudent Line approach is applicable and recommended for:

Open channel segments located downstream from land having less than or equal to a cumulative 15% impervious surface cover under future conditions and the main channel can adequately convey future conditions 10-year event flows.

DCM Prudent Line approach may apply to:

Open channel segments located downstream from land having between a cumulative 15% and 20% impervious surface cover under future conditions and the main channel can adequately convey future conditions 10-year, flows. These reaches require justification for recommending the prudent line approach.

DCM Prudent Line approach is not recommended for:

Open channel segments located downstream from land having greater than a cumulative 20% impervious surface cover under future conditions or main channel lacks adequate conveyance capacity for the future conditions 10-year flows. However, the Prudent Line may still be considered if a detailed analysis of the Prudent Line is conducted using more advanced analytical techniques. The detailed approach must be completed by a firm experienced in conducting this advanced Prudent Line analysis.

Comments/Notes from Agency Coord. Mtg

Andre - should we require the developer to develop flood plain in the planning study / how it relates to the prudent line

- consider not simulating A soil groups because a saturated conditions

- water conservation board
Larry Long - some mapping? w/ the basin

* need to state in the study who is to maintain the pond

- stipulate how the pond be constructed
do we
or is that covered in the
we need to ID the cost of importing materials to construct the pond is. reflect the cost/maint of pond in cost estimates

* • keep in the report the no-detention
alt.

→ we need to comment @ least on the
use of soil type A & for anticipated
moisture conditions.

→ put Robert Lee Pless Floodplain
administrator (719) 327-2906
on the DCM President like review
criteria

look @ County geotech logs & also

WM Curtis Wells & Co. 1977 GW map.

get Rich Cooper @ water resources
form

MEMORANDUM

To: Andre Brackin, Project Manager, El Paso DOT
From: Celia Greenman
Date: February 1, 2001

Re: Bennett Basin Planning Study

I have both general and specific comments to make on the report.

General:

Criteria for the planning study. The Drainage Criteria Manual for Colorado Springs, El Paso County, states in the outline, p. 4-3, that the report should include "drainage criteria and special requirements unique to the basin" and include "subsurface investigations". While I understand that the planning study for a rural basin may omit some of the detail or methodology that is required for an urban area, I believe that conditions in the Bennett Basin necessitate that the effects of groundwater and near-surface geology be studied. These factors play a prominent role in the drainage of the basin, and to ignore them will produce an inadequate picture of how drainage operates and how improvements will perform. There is significant interaction between the bedrock and alluvial aquifers that contributes to the generally high water table, which in turn impedes surface drainage.

Response:

All criteria and/or design considerations unique to the basin are included in the report, specifically in the Recommended Alternative section. The issue of consideration of groundwater in basin planning studies should be discussed with El Paso County because this is a DCM issue.

I agree with John Valentine, NRCS, on the importance of accurate soil classification. The comment in the draft report that "the watershed contains predominantly low-runoff potential soils" should be examined in light of how grading operations will transform the soil profile in the upstream part of the basin.

Response:

It is our understanding from the agency coordination meeting that this was really an issue of saturated ground conditions. We have addressed this by decreasing the initial infiltration rate from the HEC-1 default values to 0.5 inches for subcatchments located near Highway 24. All reported flows in the revised draft Bennett Ranch basin study reflect the decreased infiltration rates.

Specific:

Detention and channelization will change a portion of the flows from sheet to concentrated. Has SEC studied how the stream banks may be affected?

Response:

The Prudent Line approach allows the stream to naturally meander without adversely affecting private or public property. Ayres Associates developed Prudent Line setbacks for this project. All setbacks consider stream meandering and associated effects on stream banks.

All "traditional channel improvements" ie non Prudent Line segments, are designed based on current DCM criteria. The DCM criteria limits velocities in the channel. The velocity limits are based on erosion control. It is recommended in this study to reduce velocities (when they are anticipated to exceed DCM criteria) by constructing check structures. Site-specific erosion problems at Meridian Road are addressed in the study.

In studying the communication between surface water and the alluvial and bedrock aquifers, the contribution of the future wastewater treatment plant at Stapleton Road should not be overlooked. While flows would not be considered the equivalent of storm volumes, they will be consistent, and at buildout are projected at 1.3 mgpd. This is not an insignificant amount of water that will be added to the hydrologic system.

The capacity of detention ponds may be compromised by the buildup of sediment and the inflow of groundwater, particularly if there are prolonged periods of precipitation that cause groundwater to rise.

Response:

1.3 MGD = 2 cfs. The 100-year peak flow under future conditions at the downstream end of the project is estimated at 2,544 cfs. The plant would contribute 0.08% of this flow. The estimated future 5-year peak flow is 484 cfs. The plant would contribute 0.4% of this flow. This flow of 2 cfs is well below the accuracy of any HEC-1 model flow estimates. The potential groundwater effects caused by the 2 cfs increase to base flow could be considered in an Environmental Assessment conducted separate from this study.

Flows and soil loss should be calculated for construction periods (overlot grading, bare ground), and temporary detention and sedimentation ponds should be designed accordingly. This is an issue that should be addressed specifically by the Bennett Ranch and Meridian Ranch developments, but the impact of inadequately designed temporary structures will be manifested downstream.

Response:

Construction-related practices are addressed in development drainage plans.

The Colorado Water Conservation Board should be contacted to see if they can provide assistance in characterization of the floodplain in the area



Olsson Associates

Engineers - Planners - Scientists - Surveyors
143 South Union Blvd., Suite 700
Lakewood, CO 80228
(720) 962-6072
Fax: 962-6195

COMMUNICATION MEMO

PROJECT Bennett Ranch Pilot Project

Job No. 2000-0818

Date 10/24/01

Sheet 1 of 1

NAME(S)	REPRESENTING
Gary Dowler	Colorado Division of Wildlife

TIME

- MEETING
- RECEIVED CALL 3:00 p.m.
- COMPLETED CALL
- LEFT MESSAGE

SUBJECT: Contacting all agencies involved to determine if any outstanding issues exist

NOTES: Gary returned my call from 10/19/01 and 10/24/01 and said that he needs to review the Feb. 2001
Draft DBPS before he can say that he has no issues. He asked if we had selected the alternative
that included the over-detention scenario required by the BOCC, and I said yes.
Gary indicated that he would also have the habitat dept. review the report, and if I don't hear back
from him by 10/26/01, the Colorado Division of Wildlife doesn't have any issues.

CC: _____ BY: Matt Bachman



Olsson Associates

Engineers - Planners - Scientists - Surveyors
143 South Union Blvd., Suite 700
Lakewood, CO 80228
(720) 962-6072
Fax: 962-6195

COMMUNICATION MEMO

PROJECT Bennett Ranch Pilot Project

Job No. 2000-0818

Date 11/15/01

Sheet 1 of 1

<u>NAME(S)</u>	<u>REPRESENTING</u>
<u>John Liou</u>	<u>FEMA</u>
<u> </u>	<u> </u>

TIME

- MEETING
- RECEIVED CALL
- COMPLETED CALL 3:30 p.m.
- LEFT MESSAGE

SUBJECT: Contacting all agencies involved to determine if any outstanding issues exist

NOTES: John informed me that he would need to review the report and our hydrology modeling data and compare the information to a study that FEMA and ACOE is going to do in the Black Squirrel Creek Basin. FEMA and ACOE are planning to do a detailed hydrology and floodplain study of this basin, but are not currently under contract at this time. John indicated that it would be at least 2 or 3 months before FEMA and ACOE were even under contract for the project.

John said that whether or not FEMA approves the study would depend on if our hydrology results for the Bennett Ranch Basin match the results FEMA and ACOE get from their study.

CC:

BY: Matt Bachman

FACSIMILE TRANSMITTAL HEADER SHEET

For use of the form, see AR 25-11; the procedure agency is ODSCA

COMMAND/ OFFICE		NAME/ OFFICE SYMBOL	OFFICE TELEPHONE NO. (AUTOVON/Comm.)			FAX NO. (AUTOVON/Comm.)
FROM: CORPS OF ENGINEERS		ANITA CULP	719-543-6914			719-543-9475
TO: OLSSON ASSOC		MATT BACHMAN	720-962-6072			720-962-6195
CLASSIFICATION	PRECEDENCE	NO. PAGES (Including this Header)	DATE-TIME	MONTH	YEAR	RELEASER'S SIGNATURE
		3	10-24-01			

REMARKS

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DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
SOUTHERN COLORADO REGULATORY OFFICE
720 NORTH MAIN STREET, SUITE 205
PUEBLO, COLORADO 81003-3046
FAX (719) 543-8475

October 24, 2001

REPLY TO
ATTENTION OF:

Operations Division
Regulatory Branch

Mr. Matt Bachman
Olsson Associates
143 South Union Boulevard, Suite 700
Lakewood, CO 80228

Dear Mr. Bachman:

This replies to your October 22, 2001 transmittal requesting a review of the Bennett Ranch Pilot Project Basin Planning Study Summary for the Bennett Ranch watershed near Falcon, El Paso County, Colorado. We have assigned Action No. 2001 00718 to this request.

We have studied the project description, other records, and documents available to us. It appears that the drainage basin contains the following water(s) of the United States: numerous unnamed tributaries of West Fork Black Squirrel Creek, adjacent wetlands, ponds created by impounding waterways, and tributary wetlands. It does not appear that there are any isolated waters within the basin. A site visit was not made and other waters of the United States may be located within the basin.

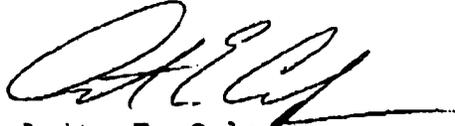
Waters of the United States are regulated under provisions of Section 404 of the Clean Water Act and a Department of the Army permit may be required for the discharge of dredged or fill material into these waters. Most of the actions included in either alternative may involve a regulated discharge into waters. The exception is the Prudent Line reaches where sections of waterways may have no action.

For Prudent Line reaches, we recommend that trails which parallel streams be located outside the prudent line. Locating trails within the line places them at risk from erosion. The typical response to an erosion threat is to hard line the stream bank, thus defeating the purpose of the prudent line concept.

Please be informed that the Black Squirrel Creek basin in El Paso County may contain habitat or populations of the Federally-listed threatened species, Preble's meadow jumping mouse. Potential areas of habitat are streams, wetlands, and riparian and upland areas within 300 feet of streams, wetlands, or flood plains. Before any Section 404 permit can be used for study-recommended activities, the Corps of Engineers must obtain endangered species clearance for the Section 404 activities. Developers are separately responsible for complying with the Endangered Species Act for the portions of developments that are not within the Corps of Engineer's purview.

These comments are provided as a review response only. If you have any questions, please feel free to contact me at (719) 543-6914 or by email at anita.e.culp@usace.army.mil.

Sincerely,



Anita E. Culp
Senior Project Manager