SPRING CREEK

Drainage Basin Planning Study

City of Colorado Springs and El Paso County

October, 1993

URS CONSULTANTS

SPRING CREEK
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DRAFT REPORT

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EXECUTIVE SUMMARY

The Spring Creek Drainage Basin Planning Study (DBPS) was authorized on April 10, 1990 to restudy the basin per current criteria. The last approved study for this basin was done in 1968. There have been a significant number of changes in the scope and criteria since the 1968 study. These include the following:

- o The hydrologic design storms and methods are different. Current criteria predicts much larger design flows than previously for both the initial and major storms.
- o Many of the structure inventory items or current considerations were not included in the previous study. These considerations include cost, safety, multi-use, and environment. The environmental and multi-use considerations are new to this study.
- o The current mapping used is considerably more accurate than before. Maps with a 2 foot contour interval are used versus a 10 to 20 foot contour interval previously.
- o The extent of development within the basin has increased. The basin is already 88% developed with very little new development remaining.
- o The public involvement process is considerably different than before. The previous study only involved the City Departments for the review process. Now, the study includes interested citizens, Federal, State, and County officials, as well as holding open public meetings.

The Spring Creek basin is generally bounded by Palmer Park Blvd. on the north, Hancock Expressway on the south, Union Blvd. on the west, and Murray Blvd. on the east. The total study area includes approximately 7 square miles, with 88% of it being already developed, mostly of which is within the City of Colorado Springs corporate limits. The basin generally slopes from northeast to southwest with the outfall being Fountain Creek.

Incorporated with the study is a series of Public Agency/Citizen involvement meetings. Concurrently with the City of Colorado Springs basin planning process, the U.S. Army Corps of Engineers is conducting a Letter of Permission (LOP) process to obtain an LOP for the basin. The LOP is basically a list of categories of types of construction activities that are planned for the basin and the types of mitigation and best management practices that are required as part of those activities. The LOP is meant to streamline the individual permit requests for the basin under Section 404 of the Clean Water Act. In addition to the Public Agency/Citizen meetings, public meetings have been included for the basin study and LOP.

The study incorporates a wide range of new considerations in the study and selection of alternatives. Items considered as part of the alternative selection process included economics, employment, water supply, ownership, flood hazard, public safety, erosion/deposition, land use, aesthetics, cultural values, recreation, floodplain values, conservation, water quality, wetlands, and wildlife. In order to evaluate different areas of the basin, the channel segments were separated into distinct reaches with similar characteristics. An evaluation of these 'community values' parameters was done for each channel reach and potential detention pond location and presented for comment in one of the Public Agency/Citizen meetings. Subsequently, an environmental evaluation of various alternatives was made versus the wetlands/wildlife impacts was made for each reach. The environmental community values and evaluations were performed by Dr. Erik Olgeirson, the project team ecologist. The other community values were initially rated by the appropriate project team specialist. Recommendations have been made for each reach and are included in Section V.

In accordance with current City/County policy, drainage basin capital improvement requirements and developer drainage basin fees have also been established for the basin. The first step in this process was to establish the estimated cost of each new drainage system. Then each of these systems was reviewed to determine who benefits from the construction of the new system. If the system is in a state highway, and directly benefits the highway users, then the cost was assumed to be borne by the Colorado Department of Transportation. Examples of these are the new drainage facilities being constructed as part of the U.S. 24 Bypass Project. If the system considered is an upgrade to an existing drainage system and the area upstream is fully built out, then the cost was considered to be a capital improvement project. If the area being served by the drainage system is currently undeveloped, then the cost of the system was allocated to the developer drainage fee system. In addition, there are cases where the costs were allocated at a calculated percentage between the capital improvement funds and the developer drainage basin fee. As a result of these allocations, the new developer drainage basin fee for Spring Creek is $5,832 per acre based on 548 acres of developable land remaining in the basin. In addition, there is a need for $9.9 million in public capital improvements and $1.3 million in CDOT capital improvements in the basin.

Both major and initial systems were included in the required facilities. These systems are eligible for reimbursement from the drainage basin fund to the extent outlined in this study. Also included in the drainage basin fee calculations are the current basin fund balance and land for drainage channels in excess of the 100-year floodplain widths. Bridge fees were not calculated for this basin since all of the improvement costs were included in the drainage fee calculations. Bridge improvements were generally upgrading or increasing capacity of existing bridges. Based on the relatively small amount of undeveloped land within the basin, the majority of the costs will be public and would have created a ridiculously small bridge fee. It was more practical to include these costs in the drainage fee.

Introduction

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I. INTRODUCTION

A. CONTRACT AUTHORIZATION

This study of the storm water management facilities within the Spring Creek Basin was authorized under terms of an agreement between the City of Colorado Springs and URS Consultants approved by the Colorado Springs City Council on April 10, 1990. Subconsultants of URS participating in the study include the following:

1. Geotechnical Engineering - GCI, Inc.
2. Environmental Considerations - Erik Olgeirson, Ph.D.

B. NATURE AND PURPOSE OF STUDY

The drainage basin planning study is a key part of the drainage planning process. A basin wide study provides a guide to future designs and construction of facilities and ensures consistency within the basin. The basin planning process provides the public and interested agencies an opportunity to have input into the form our drainage facilities will take in the future. The study is intended to form broad guidelines as to the type and approximate cost of facilities that are to be planned within the basin. The study is intended to delineate type of facilities but not the actual design details. Figure 1 shows the location of the Spring Creek basin.

C. SCOPE OF WORK

The specific scope of work for this project was identified to occur in the following three phases:

1. Phase 1 - Basin Concept Study
2. Phase 2 - Basin Alternative Analysis
3. Phase 3 - Final Drainage Basin Planning Study

Phase 1 of the project included all of the basic inventory items and the mapping for the basin. The existing drainage systems were identified on the 200 scale topographic maps and included in a computer data base. Additional inventory items were identified and included the following:

1. Type of Existing Protection
2. Existing and Available Channel Capacity
3. Erosion Potential
4. Type of Wetlands Present
5. Wildlife Habitats and Corridors
6. Existing and Proposed Utilities

7. Type of Current and Proposed Land Uses
8. Existing Development Limits
9. Multi-use Opportunities
10. Capital Costs
11. Maintenance Considerations
12. Safety or Flood Protection Considerations

Many of these inventory items were added to 1"=1000' scale base maps of the basin. The project deliverables for this phase of the study included an overall base map for the basin, inventory forms for the existing facilities, and maps with overlays of the inventory results. Figures 2 through 6 (attached) show the various inventory items on an overall topographic map of the basin.

Phase 2 of the project included hydrology development and analysis, hydraulic analysis, development of alternatives, and evaluation of alternatives. A hydrologic report was produced during the second phase of the project. This phase included the majority of the study group and public meetings for the project.

Phase 3 of the project included the final production of the drainage basin planning study. This final study presents the recommended alternatives for the basin as well as new facility cost estimates. Figures 7 through 16 are the 200 scale maps which show the recommendations for the basin.

Throughout the various phases of the project, there was meetings with the affected agencies and the public to keep them appraised of the status of the report and to get their input.

D. PAST STUDIES - RELATED INVESTIGATIONS

The basin has studies performed in recent years as follows:

1. DBPS approved in 1968 by Lincoln DeVore
2. Drainage study for State Highway 24 Bypass in 1989 by DMJM
3. Approved flood insurance maps by FEMA

The most significant change from these studies is in the drainage criteria and scope of the analysis. The hydrologic methods and the design storm used are different than the previous studies. The approved (1968) Lincoln DeVore study used the 50-year recurrence interval storm of one hour duration for the basin. The 1989 study by DMJM uses the Colorado Urban Hydrograph Procedure for a 100 year recurrence interval. The FEMA study uses only present development for a 100 year recurrence interval at the time of the study (1986).

We have also verified the adjacent study boundaries with those used in this study. The adjacent basin studies available are:

1. Shooks Run Basin
2. Sand Creek Basin

E. AGENCY JURISDICTIONS (GOVERNMENTAL)

The Spring Creek basin is located partly in the City of Colorado Springs and partly within El Paso County. The City of Colorado Springs Department of Planning, Development, and Finance and the El Paso County Department of Public Works have responsibility for implementation of the approved DBPS. Since the basin plan is concurrently being processed in the Corps of Engineers "Letter of Permission " process, the Corps of Engineers, Environmental Protection Agency, U.S. Fish and Wildlife and Colorado Division of Wildlife also are closely involved in the process. Also involved in an advisory role are the various City and County Departments affected by the plan such as Parks, Planning, and Utilities. The Colorado Department of Transportation has several major roadways under their jurisdiction in the Spring Creek basin. The Colorado Department of Health is involved in water quality permitting for the basin.

F. DRAINAGE CRITERIA

The current City/County Drainage Criteria Manual was used for analyzing the different areas of this study. This criteria manual has resulted in changes to the way things were done versus the previous studies mentioned. A significant change, as stated previously, is the hydrologic methods used. In addition, more alternatives were considered and environmental and multi-use opportunities were given more consideration than in the previous study. An inventory of existing drainage facilities has been compiled for the basin and the channel alternatives cover a wide range of lining types and channel treatments.

Along with the changes to the main channel flows due to new criteria, the channel hydraulic design criteria has undergone some changes. While this has a minor effect on the channels themselves, the most significant changes occur at box culverts or bridge crossings. There is a current trend to use more natural type of linings for channels versus the concrete lining used in the past. This resulted in significantly longer bridge structures in some cases.

Another change due to current versus old criteria is the increase in the size of the initial storm sewer system. The change from the 5-year 6-hour SCS method to the 10-year Rational Method results in larger proposed systems and poses a question on how much the existing system will have to be upgraded. Another, often neglected part of the initial system design in the old subdivision drainage reports is the routing for the 100-year overflow. The 10-year storm was generally used for sizing the initial system. It became necessary to upsize at the point where 100-year street capacity is exceeded. This is discussed in more detail in the Recommended Plan section of the report. It was not a written criteria in the past and was not studied very closely in some of the subdivision studies. Specific initial system upgrades are included in this study under the recommendations. The areas were identified through a list of specific flooding complaints received by the City as well as specific discussions with City staff.

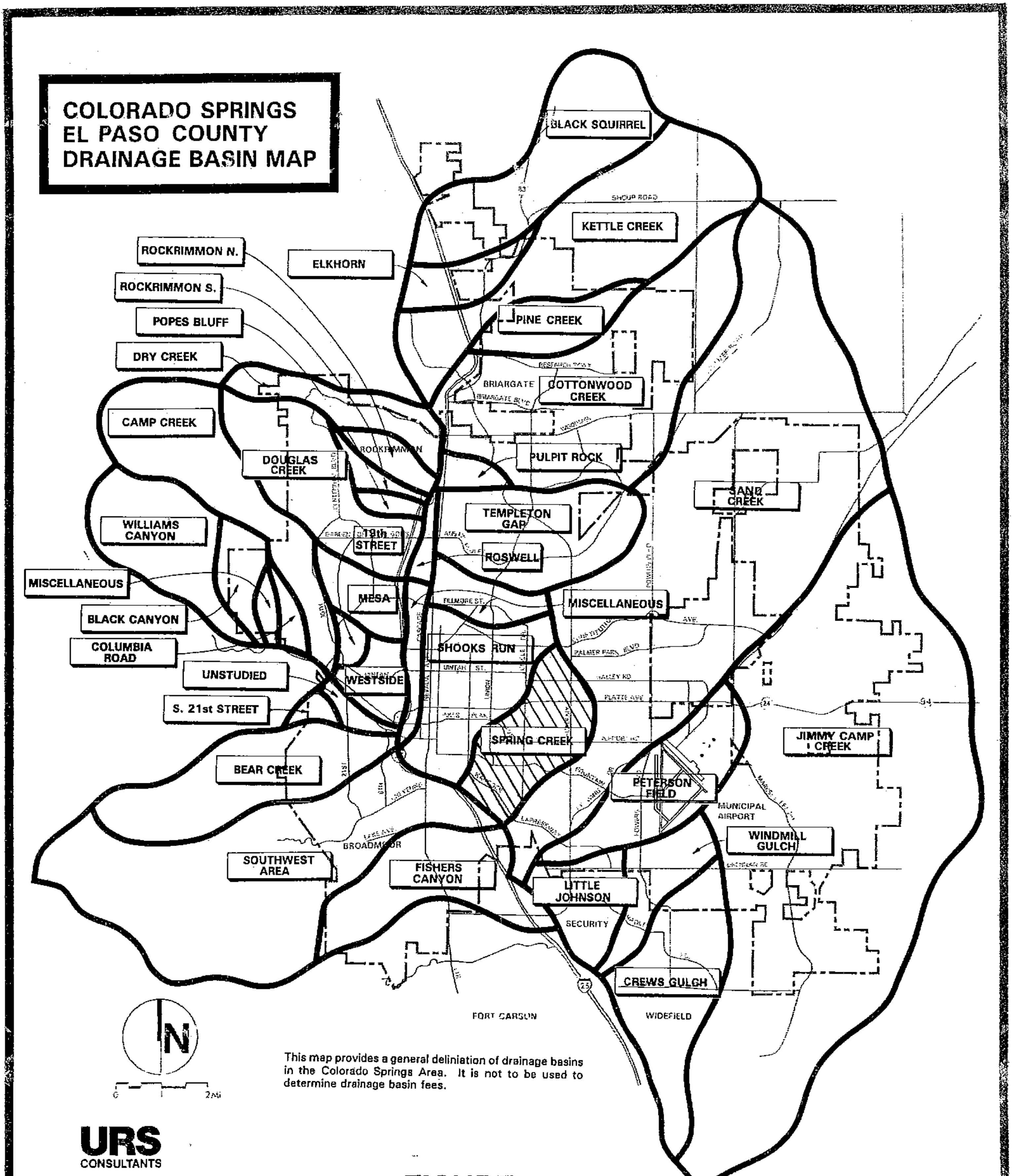
COLORADO SPRINGS
EL PASO COUNTY
DRAINAGE BASIN MAP
BLACK SQUIRREL
KETTLE CREEK
ROCKRIMMON N.
ELKHORN
ROCKRIMMON S.
POPES BLUFF
PINE CREEK
DRY CREEK
BRIARGATE
COTTONWOOD CREEK
CAMP CREEK
ROCKRIMMON
DOUGLAS CREEK
PULPIT ROCK
SAND CREEK
TEMPLETON GAP
WILLIAMS CANYON
19th STREET
ROSWELL
MISCELLANEOUS
MESA
MISCELLANEOUS
BLACK CANYON
COLUMBIA ROAD
SHOOKS RUN
UNSTUDIED
WESTSIDE
S. 21st STREET
SPRING CREEK
JIMMY CAMP CREEK
BEAR CREEK
PETERSON FIELD
MUNICIPAL AIRPORT
WINDMILL GULCH
BROADMOOR
SOUTHWEST AREA
FISHERS CANYON
LITTLE JOHNSON
SECURITY
CREWS GULCH
FORT CARSON
WIDEFIELD
N
This map provides a general deliniation of drainage basins in the Colorado Springs Area. It is not to be used to determine drainage basin fees.
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FIGURE 1

Project Description, Location and Drainage

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II. PROJECT DESCRIPTION, LOCATION, AND DRAINAGE

A. BASIN DESCRIPTION AND LOCATION

1. General Basin Location

The basin is surrounded by the following adjacent basins:

a. Shooks Run on the west
b. Sand Creek on the north and east
c. The outfall is Fountain Creek on the southwest

The basin can generally described as being bounded by Palmer Park Blvd. on the north, Hancock Expressway on the south, Union Blvd. on the west, and Murray Blvd. on the east. The remaining major roads in the basin include parts of Academy Blvd., Circle Drive, Galley Road, Platte Ave., Pikes Peak Ave., Airport Road, Fountain Blvd., and the new U.S. 24 Bypass.

The total study area is approximately 7.0 square miles, of which approximately 6.9 square miles are in the City of Colorado Springs and the remaining 0.1 square miles are in El Paso County.

2. Key Features and Characteristics

The basin generally slopes from northeast to southwest with the outfall being Fountain Creek. The existing channel slopes range from 0.5% to 4.0% with the majority of slopes being near 1.0%. The side slopes away from the channels range in slopes of from 5% to near vertical in areas of heavy erosion. The majority of the natural channel side slopes are very steep due to the incised nature of the channels.

The majority of the basin consists of hydrologic soil types A and B soils with some C and D in the valleys and areas of shallow bedrock. The soil type is mostly variations of sandy soils that are well drained and are susceptible to both wind and water erosion in disturbed areas. The soil is generally poor for both channel and dam construction materials due to its high seepage rates and erodibility. The primary concern for vegetative lining is to keep the velocities down and to maintain enough water in the soil to allow vegetation to maintain its protection in dry periods (i.e.- some irrigation may be required). There are existing Pierre Shale outcrops in parts of the basin.

The existing landscape for the basin can be generally described as follows. The western 20% of the drainage basin near Fountain Creek is hilly with rangeland type vegetation away from the channels and grasses, trees, and shrubs along the main channels. As we proceed upstream (east and north), the land tends to flatten somewhat with more rolling terrain and this area is mostly built out with commercial or residential type development and higher density uses on or near the major streets.

B. AERIAL MAPPING

Aerial mapping was obtained from the City of Colorado Springs FIMS program. It was flown in spring of 1990 and final maps were obtained in November. The mapping was prepared on 200 scale maps with a two foot contour interval and digitized streets and buildings. The contour base was then reduced to a 1000 scale base map and tributary subbasins, ultimate land uses, geologic inventory, environmental inventory and hydrologic soil groups were added to reproducible copies of the base map. Copies of photographs of the basin, flown for the FIMS maps, were obtained for aid in the environmental inventory. The geologic inventory used 1947 air photos to depict predevelopment conditions.

Use of this aerial mapping for the basin is with the following proviso from the Colorado Springs Department of Utilities:

> "The maps and photographs included in this report were developed for purposes of the Colorado Springs Department of Utilities and are for internal use only. The Colorado Springs Department of Utilities makes no warranty, expressed or implied, as to the completeness, accuracy, or content of such products or any reproductions thereof. Any other use is not recommended and occurs at the risk of the user; such user is solely responsible and/or liable for the use of such products.
>
> Original maps and photographs are the property of the Colorado Springs Department of Utilities. All rights are reserved. These maps and photographs or any associated record may not, wholly or in part, be reproduced, stored, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise, without the express prior written permission of the Colorado Springs Department of Utilities.
>
> Regardless of the existence of purported copies of these official maps and photographs which may from time to time be made or published, there is only one set of official maps and photographs, which are those kept and maintained by the Colorado Springs Department of Utilities."

C. MAJOR DRAINAGEWAYS AND DETENTION FACILITIES

The existing types of channels and condition can be split into several distinctive areas. The natural channels between the outfall at Fountain Creek and just downstream of Union Blvd. are highly eroded channels that are filled with grass and shrub depressions with cottonwoods and willows above the channel. The majority of the channel between Union

Blvd. and Circle Drive is now contained in a buried concrete box culvert. This construction was recently accomplished as part of the U.S. 24 Bypass Project. Most of the channels between Circle Drive and north of Airport Road are improved channels with concrete or riprap lining. The channels between north of Airport Road and Bijou Street are highly eroded channels that are heavily vegetated. Upstream of Bijou Street is a concrete lined channel which changes to an underground box/pipe system near Platte Ave. A more detailed description of each channel reach can be found in the alternative section of this study. Figure 2 (attached) shows the drainage subbasins and design points.

We considered four detention pond locations for the basin. Detention is recommended because much of the existing system lacks capacity to handle undetained flows. All of the detention ponds are of the regional or subregional size per current criteria. Current criteria does not allow the use of onsite detention ponds for permanent, public facilities. Based on our look at the existing reach capacities, we concluded that we had a desire to reduce the flows above the following reaches. The four locations identified are as follows:

- o Upstream of the crossing of Pike Peak Ave. in Wagner Park
- o The downstream end of the Red Wing Bird Sanctuary
- o Using existing Valley Hi Lake
- o The mitigation site on the U.S. 24 Bypass (CDOT project) upstream of Union Blvd.

D. EXISTING AND PROPOSED LAND USE

Over 88 percent of the basin is already developed. The proposed land uses were obtained from current zoning maps and master plans for the basin. Figure 3 (attached) shows the existing and proposed land uses for the basin.

Approximately 52% of the basin is residential land uses, 31% is commercial/business, 9% is parks/open space, 6% is industrial and 2% is school/church uses. Specific land use locations within the basin are as follows:

1. Master Planned Areas

Printers Park is a 177 acre mixed use development located between Pikes Peak and Airport on Printer's Parkway. Approximately half of the land is platted.

Spring Creek Development is located northwest of Hancock and Circle and extends north almost to Fountain Boulevard. A small portion of the 473 acre property is developed. Only part of this land is in Spring Creek Basin. Spring Creek and the alignment of the

U.S. 24 Bypass pass along the north edge of the land. The estimated developable land in the basin is shown on Figure 3 (attached).

Most of Western Sun's 83 acres are developed. Two parcels remain, plus an undeveloped park site. The land is located on Fountain Boulevard between Academy and Chelton.

Only a small percentage of Gateway Park is located in Spring Creek Basin. Gateway Park is located northeast of Academy and Airport and encompasses over 2200 acres. Approximately 3 different parcels from this development remain unplatted in the basin.

2. Vacant Parcels

Southwest of Hancock Expressway undeveloped land remains both in the County and in the City. These parcels are bisected by the US 24 bypass, railroad right-of way and Spring Creek.

On Pikes Peak, west of Academy, a parcel of land has been graded but remains vacant and unplatted. Another parcel is unplatted on the east side of Chelton just south of Fountain Blvd. This is currently being used as a park with baseball fields on it. A short distance east of Murray on the south side of Pikes Peak is a small parcel. The back lot of a garden shop on Circle Drive and San Miguel is underdeveloped and unplatted.

Several other small parcels remain candidates for higher density developments. These include the drive-in theater west of Chelton between Platte and Bijou and the driving range plus vacant residential property located northwest of Spring Creek and Airport Road.

3. Parks and Open Space

Wagner Park (3637 East Bijou) fronts on Spring Creek and totals greater than 5 acres when adjacent City property is included. Valley Hi Golf Course has 120 acres and is located along Spring Creek from Airport south to just east of Circle Drive. Prospect Lake is part of Memorial Park and is west of Union Boulevard across from the intersection of Airport Road. The remainder of Memorial Park is outside the basin. Evergreen Cemetery is located southeast of Fountain Boulevard and Hancock. Only the easterly half of the cemetery's 220 acres is in the basin. Other parks are summarized below:

Franklin Park	2951 E. Dale	3.8 acres
Prairie Grass	710 Chapman Drive	5.0 acres (undeveloped)
Roosevelt Park	219 Byron Drive	5.8 acres
Twain Park	3320 E. San Miguel	4.6 acres

Van Diest	1520 S. Chelton Road	16.0 acres

Within the basin there are numerous parcels which are built out but do not have a plat name shown on the base information that we had. Examples include the Circle East Mall (Circle and Galley), the K-Mart (Airport and Circle) and the Rustic Hills Mall (Academy and Palmer Park). Red Wing Sanctuary is located south of Pikes Peak and west of Academy. This land is owned by the Aiken Audubon Society and will most likely remain unplatted. The City also owns several acres on Bijou on the east side of Spring Creek. This land has the Fire Department's training facility on it with the remainder being Parks and Recreation property as part of Wagner Park. It is assumed that these properties will probably not be platted and drainage fees will not collected from these properties.

E. EXISTING IRRIGATION FACILITIES

There is an existing irrigation canal owned by the Fountain Mutual Irrigation Company on the southwest side of the basin adjacent to the railroad. This facility crosses the main channel of Spring Creek in a siphon pipe.

F. EXISTING SURFACE WATER IMPOUNDMENTS

There are two surface water impoundments within the basin. The first one is Prospect Lake. This is included in the study limits but does not contribute runoff to the main channel of Spring Creek. The second surface water impoundment is the Valley Hi Lake on the golf course. There is only one small detention facility near Murray Blvd. and Chapman Drive. This was not included in the overall hydrology for the basin due to its small size. The Valley Hi Lake was included in the hydrology model to see what effect it had on the overall results and to reduce peak flows in the lower reaches.

A request was sent to the Colorado State Engineer's Office regarding the location of all jurisdictional dams within the basin. Their response indicates that there is only one dam of record within the Spring Creek Basin. That is for the dam and water impoundment at Prospect Lake. It was listed as priority No. 76A on the correspondence received.

G. EXISTING/PROPOSED UTILITIES

The majority of the major utility corridors are along the major roads or the main channel of Spring Creek. Since the exact locations of future utility lines are subject to change, each individual drainage facility design should contact all of the appropriate utilities early in the design process. Each of the City utility departments have overall planning maps and detailed maps showing the location of existing utilities. The existing facilities were mapped as part of the recent FIMS study by the City. The majority of the drainage facility/utility conflicts should be crossings where the major roads cross the drainage channels and pipes.

H. SOILS/EROSION POTENTIAL - GEOLOGIC INVENTORY

1. Introduction

This section of the report contains the results of a geologic study conducted in the Spring Creek Drainage Basin. The purpose of this study was to provide geologic information to aid in the planning study and in selecting facilities alternatives. The geologic information has been plotted on a 1" = 1000' scale topographic base map (Figure 4).

Over the past 40 years or so, the Spring Creek Drainage Basin has been an area of intense construction and development. At this point in time, the drainage basin is almost entirely developed with the exception of a few larger parcels and other small undeveloped parcels. Due to this development, natural geologic features have been altered by the acts of man and natural geologic features have been obscured by the present developed areas. Some topographic changes have occurred due to infilling of drainageways and cutting in ridge areas. Older aerial photographs and published regional geologic were therefore utilized for the geologic mapping on this project. The 1947 aerial photographs (which basically depict undeveloped conditions), along with GCI's knowledge of specific sites within the basin and published geologic mapping were all utilized in preparing the photogeologic map provided in this report. It should be noted that mass grading operations and development within the basin have changed the topography in some areas, and soil conditions may be somewhat different than depicted on the photogeologic map.

2. Geologic Mapping Units

The entire Spring Creek Basin is underlain by bedrock consisting of the Pierre Shale. This bedrock has been eroded, weathered, and covered by various younger surficial deposits. Each of the mapped geologic units is described below:

a. Pierre Shale (kp)

The Pierre Shale is the bedrock which underlies the Spring Creek Basin area. The majority of the formation consists of a dark grey clay shale material with scattered innerbeds of sandstone, limestone, and bentonite. The shale is typically very hard when in a formational state and weathers to a low to high plastic clay material. When exposed to weathering, the Pierre Shale is prone to raveling and spalling on exposed slopes. This weathered surface is then easily eroded by running water.

b. Alluvium and Colluvium (Qac)

Alluvium and Colluvium, mapped within the drainage basin area, consist of water, wind, and gravity deposited soils in the low, broad area in the northeast portion of the basin area. This material typically consists of a mixture of sand, silt, and clay. These soils are unconsolidated and prone to erosion by both wind and water.

c. Recent Alluvium (Qal)

Recent Alluvium deposited by stream action has been mapped in the drainageways and swales within the basin area. This material is located in the drainageways, most of which have since been altered, channelized, or filled-in by grading and development operations. This material typically consists of a silty sand and clay mixture, is normally found in low density condition, and is generally characterized by a high groundwater table.

d. Older Alluvial Terrace (Qt)

Some Older Alluvial Stream Terraces have been mapped in the western portion of the basin. These represent deposits of sand, silt, and clay which were deposited in the past by Fountain Creek, Spring Creek, and their tributaries when they flowed at higher energies and at higher levels. These materials typically consist of fine to coarse grained, silty to clayey sand material. They are normally encountered in a relatively low density condition and may be characterized by a perched water table.

e. Eolian Sand (Qes)

Eolian (wind blown) Sand covers the majority of the north portion of the drainage basin and an area in the southeast part of the basin. This material generally consists of a tan, fine to coarse grained, silty to slightly silty sand deposited by the actions of wind in the past. It is typically encountered in a low density condition and is prone to erosion by both wind and water. This deposit is commonly characterized by a perched water table where it directly overlies the shale.

f. Active Seepage Areas (AS)

Several areas of active seepage are known or suspected to exist within this basin (hence the name Spring Creek). These are generally characterized by shallow groundwater conditions and/or seeps and springs which discharge upon the ground surface. Known or suspected active seepage areas are mapped based on GCI's present knowledge of sites within the basin along with interpretation of old (1947) and newer (1989) aerial photographs.

It should be noted that there are likely to be other areas of shallow groundwater, active seepage, and springs within the basin area that were not recognizable on aerial photographs. Surface reconnaissance of the basin and drainageways would likely discover these additional areas.

I. ENVIRONMENTAL INVENTORY

1. Introduction

Additional issues such as the environment, aesthetics, open space, and trails are being considered in the alternative selection. Using the aerial photography for the basin and field visits, a reconnaissance level inventory was conducted along Spring Creek and its tributaries to identify riparian and wetland vegetation (see Figure No. 5). The purpose of this study was to determine alternative streambank treatments needed to control erosion resulting from increased storm water flows and flood velocities as well as any other environmentally sensitive features in the basin affected by storm water drainage.

2. Corps of Engineers 404 Permit

A field meeting was held with agencies involved in the Section 404 permitting procedures. The intent of the meeting was to get agency involvement in the basin planning process in order to go through the Corps of Engineers "Letter of Permission" procedures for the basin. Wetlands and riparian habitat are considered jurisdictional by the U.S. Army Corps of Engineers, the Environmental Protection Agency, the U.S. Fish and Wildlife Survey and the Colorado Division of Wildlife. Streambank improvements affecting these vegetation types require permitting under Section 404 of the Clean Water Act. The Corps of Engineers has devised a process of granting a Letter of Permission (LOP) to expedite the permitting process. The basic information obtained from this field inventory is important to the structure of the LOP because it provides a baseline understanding of the ecological value in a stream reach studied. The LOP requirements are discussed in more detail in the Recommendation Section of this report.

3. Environmental Inventory and Mapping

Vegetation was mapped at a scale of 1"=1000'. Riparian habitat, wetlands, and unvegetated channel areas were mapped using the following map units:

- Structural Floodway
- Open Water
- Mature Riparian Forest
- Riparian Grassland
- Herbaceous Wetland
- Emergent Wetland

The following are descriptions of the each of the mapping units:

a. 1) Structural Floodway

Several reaches of Spring Creek have been modified as concrete or riprap lined banks with an alluvial bottom. Common plant species along these channels are introduced grasses and forbs including smooth brome, Canada thistle, tansy aster and knapweed. Some channel sections in the upper reaches are fully concrete lined.

b. 2) Open Water

Several ponds and a reservoir occur in the Spring Creek drainage basin. The small ponds in the Valley Hi Golf Course are not associated with the stream channel. A detention pond adjacent to the golf course occurs along Spring Creek. This pond contains well-developed emergent wetlands dominated by broadleaf cattail, spike rush, softstem bulrush, hairy sedge, Baltic rush and three square. This area supports abundant wildlife. Most significant is the approximate 100 species of water fowl and song birds that have been observed in this area.

c. 3) Mature Riparian Forest

Cottonwood forest occurs in areas where the natural channel of Spring Creek has not been altered significantly. Forested areas are located along the stream channel in all of these places, but are most well developed along reaches where the floodplain is more expanded. These areas are important wildlife habitat for raptors and medium-sized mammals. This vegetation type is dominated by plains cottonwood, peachleaf willow, Siberian elm and sandbar willow. Snowberry and woodrose also occur in the shrub understory. The herb layer is variable, but commonly dominated by smooth brome, hairy sedge, ticklegrass, tall fescue and reed canarygrass.

d. 4) Riparian Grassland

Wetlands dominated by grasses and interspersed with shrubs occur on broad areas of the floodplain where previous floods apparently scoured woody vegetation or where the floodplain is elevated sufficiently to prohibit the germination of plains cottonwood and willows. Dominant species include reed canarygrass, hairy sedge, ticklegrass, weeping alkaligrass, western wheatgrass and carpet bentgrass.

e. 5) Herbaceous Wetland

Seasonal wetlands occur along small intermittent tributaries to Spring Creek. These wetlands are dominated by facultative grasses and weedy forbs. Dominant species are foxtail barley, western wheatgrass, switchgrass, wild licorice and Canada thistle. These areas provide wildlife corridors for small and medium-sized mammals and provide food for song birds.

f. 6) Emergent Wetlands

True emergent wetlands are relatively infrequent in the Spring Creek drainage. The major occurrence of these wetlands is along the detention pond in the Valley Hi Golf Course.

Wetlands surrounding the detention pond in the Valley Hi Golf Course are well-developed, as discussed above, and are valuable as a wildlife resource. They allow for the filtering of urban runoff percolating to the groundwater table. They slow the water down as it goes through the vegetation allowing deposition of sediment. However, too much sediment deposition is not desirable. These areas still need to carry the required design flow safely and too much sediment could completely fill in the wetlands and change their character significantly. The amount of sediment reaching the wetlands must be controlled upstream to maintain the existing wetlands in this area. These marshes are dominated by broadleaf cattail, softstem bulrush, alkali bulrush, spike sedge, Torrey rush, hairy sedge and Nebraska sedge, and support song birds, waterfowl and raptors.

Sedimentation from upstream erosion at the Red Wing Sanctuary, Wagner Park, and other sources is causing the emergent wetlands along the detention pond to gradually increase. Sedimentation will allow the emergent wetland species and the habitat they provide to expand. The area of open water in the detention pond will subsequently decrease.

Wetlands in the Redwing Sanctuary are dominated by sandbar willow, Baltic rush, three square and hairy sedge. These wetlands may have been classified as emergent wetlands in the past,but have been altered significantly by increased erosion, particularly erosion caused by several large floods. Flooding has incised the stream channel to a major degree. Spring runoff and stormwater flooding no longer inundate the emergent wetlands, as a result. Groundwater levels have also been decreased by the apparent removal of a previously occurring clay lens that has been eroded. The overall result is a slow decline in wetland extent and function. This has changed the classification of the area into a riparian grassland instead of an emergent wetland.

J. INVENTORY OF CULTURAL RESOURCES

The Colorado Historical Society was contacted to determine if any locations within the basin were considered to be of historical or archeological significance. Their response to our request listed a total of 40 sites within the Sections, Township and Range we requested. In addition, their information lists these sites by quarter section. We have compared the list to the basin boundary map and found that most of the sites are actually outside of the Spring Creek Basin instead of being in the basin. To the best of our knowledge, from the information supplied to us, there appear to be only three sites within the basin. These sites are as follows:

- Evergreen Cemetery
- Fountain Mutual Irrigation Ditch
- Babcock Hog Farm

The Colorado Historical Society indicated that there is still the possibility that additional sites could exist within the basin. The information provided is the best available information at this time. Indications are that there should be very little impact on these historical sites since they are not located in the drainageways.

Hydrologic and Hydraulic Design Evaluation

URS CONSULTANTS

III. HYDROLOGIC AND HYDRAULIC DESIGN EVALUATION

A. BASIN HYDROLOGY

1. Assumptions and Model Used

The basins were modelled using the U.S. Army Corps of Engineers HEC-1 computer program with the SCS method of determining runoff for the subbasins. The results are for the 10-year and 100-year 24-hour storms using AMC-2. The drainage basin boundaries were determined from 200 scale contour maps at a two foot interval, provided by the City. The basin curve numbers were determined from existing and projected land uses that were developed from current zoning and master planning. The SCS hydrologic soil types were obtained from the SCS soil survey of El Paso County. A rainfall depth of 4.4 inches was used for the basin based on isopluvials for the basin area. There are two different models used for determining the major system basins. The first model is for the main channel flows and consisted of basins from 200 acres to 800 acres in size. Tributaries were then analyzed with HEC-1 based on a basin size of approximately 100 acres. Individual subbasins were also analyzed with the Rational Method as outlined in the City/County "Drainage Criteria Manual" and compared to the results from HEC-1. The precipitation distribution for each 15 minute increment of cumulative precipitation is shown on Table 1.

The following is a list of the basic assumptions used in the model:

a. 100-year 24-hour Type IIA storm was used.
b. Antecedent Moisture Condition 2 was used.
c. Areas where SCS hydrologic soil type A was encountered were analyzed as type B soils due to regrading of the sites with development.
d. Average densities were assumed for the projected land use type.
e. A five minute interval was used for hydrographs.
f. Table 2 presents the sub-basin SCS hydrologic data used in the models. Table 3 presents the sub-basin Rational Method hydrologic data.
g. Time of concentration calculations were done with combination of overland flow and street and/or storm sewer system travel times. Table 4 presents the subbasin time of concentration calculations.
h. The Valley Hi Lake was input using the elevation, volume, discharge curves derived from the topographic map and information provided by the City.
i. A total rainfall depth of 4.4 inches was used.
j. The basin was analyzed for full development conditions.
k. Residential land use densities shown on Tables 2 & 3 are in terms of actual lot size in acres instead of the planners typical convention of number of lots per acre.

2. Overall Results

The results of the model indicates a significant increase in flow over the previous studies done for the basin. These results were compared with two previous studies, namely the approved 1968 Drainage Basin Planning Study (DBPS) performed for the City by Lincoln Devore and a 1989 study for CDOT by DMJM as part of the U.S. 24 Bypass project.

The 1968 DBPS used the 50-year one hour design storm so there is not a realistic point of comparison with this study. The previous study did not recommend any detention ponds for the basin. It also proposed greenbelts for the channels with concrete or riprap bank lining. This is somewhat misleading since approximately 1/2 of the channels were proposed as being fully lined in the study. The sections built are actually narrower than proposed in the study. The expected velocities shown in their study were also between 9 and sixteen feet per second which is fairly high. Off the main channel concrete lined ditches or storm sewer pipes were proposed.

A more realistic comparison is possible with the 1989 study. The one common point and method (at Valley Hi Lake) with the 1989 study indicates that 1/2 of the increase in flow is due to the increase in curve number and 1/2 of the increase is due to the size of the subbasins used. The curve numbers are higher in our case since they used Type A soil curve numbers which is not allowed per current City criteria. The larger the subbasin size, the lower the resulting peak discharge for the model used. They also used a different method (the Colorado Urban Hydrograph Procedure) for the remainder of the basin design points. This method was developed and calibrated for the Denver metropolitan area and has not been calibrated for Colorado Springs. The remaining sections of this report provide the detailed information that was used to evaluate the alternatives.

Table 5 presents the fully developed peak flows modelled with the aid of the HEC-1 model at each design point. This is for the model with the recommended detention ponds at Union Blvd., Valley Hi Lake, Red Wing Bird Sanctuary, and Wagner Park. The individual subbasin peak flows are also presented for the Rational Method in Table 6. Figures 17 through 20 are the hydrographs at each detention pond location showing both the inflow and release for each pond in the recommended plan.

3. Sensitivity of the Results

The hydrologic model was tested at various points in this study to determine the sensitivity of the results to changes in basic assumptions. The results of the sensitivity analysis for each of the basic assumptions are as follows:

a. The previous studies used different design storms than the current study. The approved 1968 study used the 50-year one hour storm for runoff calculations. Therefore, there was no viable basis to compare the model with the previous work.

b. Based upon past experience, the model is very sensitive to changes in the antecedent moisture condition. Antecedent Moisture Condition II was used per current City drainage criteria.

c. The change in hydrologic soil type from A to B results in a higher curve number. Since the model was run with various values for curve number in the basin, we estimate that this assumption resulted in an increase of 20% in the basin flows.

d. A standard time interval for hydrograph steps of 5 minutes was used to maintain consistency with the majority of the studies done in recent years. Comparing these results with longer and shorter time intervals tells us that this can vary +/- 10% depending on the time interval selected.

e. The model was run with the entire basin upstream of Valley Hi Lake to compare to the 100 acre subbasins used. The model with the entire basin as one subbasin was still higher than the DMJM flows. This pointed out the differences in curve number for type A soils. Using the DMJM curve number, one subbasin upstream of this point, and comparing the results with the DMJM report, resulted in our model giving lower flows than their report. It appears that their SCS method calculation was derived from an SCS dimensionless hydrograph instead of using the computer model.

g. The model was run with changes in the time of concentrations to determine the sensitivity in this area. The results were within 3% with the type of adjustments that could reasonably be made. Since the calculations were done using standard methods and actual drainage systems and patterns, no changes were made in this area.

4. FEMA Coordination

Part of this study included coordination of the design flows and methods used with the Federal Emergency Management Agency (FEMA). A meeting was held with Dr. John Liou of FEMA to discuss the hydrology for the basin. It was discovered that FEMA was considering using the regression analysis by the Corps of Engineers based on the gaging station on Fountain Creek near Pueblo. Since this was not completed yet, there was only an indication that the predicted flows would be lower than the flows FEMA used in the past. FEMA is required to use existing flow conditions only and our study uses flows for a completely developed basin. Therefore, we do not have a common point of comparison. This report has been submitted to FEMA for review and any comments they have will be included in a correspondence supplement to the report. The current Flood Insurance Study shows 2,340 CFS for Spring Creek at the confluence with Fountain Creek. This is considerably lower than being predicted in this study (5,726 CFS including the proposed detention ponds). It may not be possible to resolve all of the potential conflicts on the flows to be used. In any case, since our study recommends the facilities be designed for a flow higher than FEMA uses, the facilities should have ample capacity to handle the FEMA flows.

B. MAJOR DRAINAGEWAY HYDRAULICS

The hydraulics of the existing drainage channels and crossings were analyzed to determine the adequacy of existing systems to carry the 100-year design flow with detention. In addition, the analysis included what type of alternatives were feasible from a hydraulics standpoint. Various assumptions were used in this analysis and include the following:

1. Channel Assumptions

   a. Channel flows were based on the recommended detention scheme
   b. Existing drainage facilities were taken from an office inventory of the existing plans available from the City and County
   c. Existing topographic conditions were taken from aerial photography for the basin (City of Colorado Springs FIMS Project)
   d. Width of ROW proposed included access road/trail
   e. Existing improved channels were analyzed by reach based on the type of existing channel improvement and existing capacities both with and without freeboard
   f. Freeboard was based on the equation in the Drainage Criteria Manual
   g. Bridge hydraulics was based on inlet control nomographs or comparison of velocities in the channel and bridge
   h. Existing natural channels allowed a full range of alternatives to be considered. Grade control or drop structures were used to limit the channel velocities to acceptable ranges.
   i. Side slopes were taken as what it is now in the field or flatter when bank reshaping was being considered as an alternative

2. Storm Sewer/Street Combination Assumptions

   a. Mannings n=0.013 (assumes concrete pipe)
   b. Pipe slope was taken at the slope of the existing ground along the pipe route
   c. Full pipe flow capacities were used without pressurizing the pipe

3. Results of Analysis

The existing channel and crossing capacities are presented Table 7 and 8, respectively. A summary of the recommended plan hydraulics is presented in Section V of this report. In addition, a water surface profile model was developed for the recommended treatments for the basin. This was done with the aid of the Corps of Engineers' HEC-2 model. The profiles generated are attached and the full HEC-2 printouts are included in Appendix B.

SPRING CREEK DBPS - TABLE 1
SHEET 1 OF 2

100-YEAR STORM RAINFALL DISTRIBUTION

P= 4.400 INCHES IN 24 HOURS

		0 MIN	15 MIN	30 MIN	45 MIN
0	HOURS	0.000	0.002	0.007	0.013
1	HOURS	0.020	0.026	0.035	0.044
2	HOURS	0.053	0.063	0.073	0.083
3	HOURS	0.092	0.103	0.112	0.122
4	HOURS	0.141	0.172	0.202	0.233
5	HOURS	0.264	0.330	0.440	1.760
6	HOURS	3.080	3.190	3.300	3.366
7	HOURS	3.432	3.476	3.520	3.564
8	HOURS	3.608	3.630	3.652	3.674
9	HOURS	3.696	3.718	3.740	3.762
10	HOURS	3.784	3.801	3.817	3.834
11	HOURS	3.850	3.867	3.883	3.900
12	HOURS	3.916	3.933	3.949	3.966
13	HOURS	3.982	3.997	4.011	4.025
14	HOURS	4.039	4.052	4.066	4.079
15	HOURS	4.092	4.103	4.114	4.125
16	HOURS	4.136	4.147	4.158	4.169
17	HOURS	4.180	4.191	4.202	4.213
18	HOURS	4.224	4.235	4.246	4.257
19	HOURS	4.268	4.279	4.290	4.301
20	HOURS	4.312	4.318	4.323	4.329
21	HOURS	4.334	4.340	4.345	4.351
22	HOURS	4.356	4.362	4.367	4.373
23	HOURS	4.378	4.384	4.389	4.395
24	HOURS	4.400			

SPRING CREEK DBPS – TABLE 1
SHEET 2 OF 2

10-YEAR STORM RAINFALL DISTRIBUTION

P= 3.000 INCHES IN 24 HOURS

		0 MIN	15 MIN	30 MIN	45 MIN
0	HOURS	0.000	0.002	0.005	0.009
1	HOURS	0.014	0.018	0.024	0.030
2	HOURS	0.036	0.043	0.050	0.056
3	HOURS	0.063	0.070	0.077	0.083
4	HOURS	0.096	0.117	0.138	0.159
5	HOURS	0.180	0.225	0.300	1.200
6	HOURS	2.100	2.175	2.250	2.295
7	HOURS	2.340	2.370	2.400	2.430
8	HOURS	2.460	2.475	2.490	2.505
9	HOURS	2.520	2.535	2.550	2.565
10	HOURS	2.580	2.591	2.603	2.614
11	HOURS	2.625	2.636	2.648	2.659
12	HOURS	2.670	2.681	2.693	2.704
13	HOURS	2.715	2.725	2.734	2.744
14	HOURS	2.754	2.763	2.772	2.781
15	HOURS	2.790	2.798	2.805	2.812
16	HOURS	2.820	2.828	2.835	2.843
17	HOURS	2.850	2.858	2.865	2.872
18	HOURS	2.880	2.888	2.895	2.903
19	HOURS	2.910	2.918	2.925	2.932
20	HOURS	2.940	2.944	2.948	2.951
21	HOURS	2.955	2.959	2.963	2.966
22	HOURS	2.970	2.974	2.978	2.981
23	HOURS	2.985	2.989	2.992	2.996
24	HOURS	3.000			

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – SCS CURVE NUMBERS
TABLE 2 – SHEET 1 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	BASIN AREA ACRES	SUB-BASIN CN	OVERALL BASIN A
A1	B		13.6		1.5	73.5			88.6	81.9	88.6	81.9	CN x A
	C								0.0	0.0			73149.7
	D								0.0	0.0			AREA
A2	B		43.5		25.0	12.5			81.0	88.0	81.0	88.0	850
	C								0.0	0.0			CN
	D								0.0	0.0			86.1
B1	B		40.2			73.2		5.7	119.1	84.4	119.1	84.4	
	C								0.0	0.0			
	D								0.0	0.0			
B2	B		18.3		31.5	70.6		2.5	122.9	83.2	122.9	83.2	
	C								0.0	0.0			
	D								0.0	0.0			
B3	B					61.2		3.6	64.8	80.4	64.8	80.4	
	C								0.0	0.0			
	D								0.0	0.0			
B4	B		38.0		19.8	17.0			74.8	87.4	74.8	87.4	
	C								0.0	0.0			
	D								0.0	0.0			
B5	B					27.6			27.6	80.0	27.6	80.0	
	C								0.0	0.0			
	D								0.0	0.0			
C1	B		65.9		26.5	9.7		13.1	115.2	88.9	115.2	88.9	
	C								0.0	0.0			
	D								0.0	0.0			
C2	B		145.0		11.0				156.0	91.5	156.0	91.5	
	C								0.0	0.0			
	D								0.0	0.0			

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – SCS CURVE NUMBERS
TABLE 2 – SHEET 2 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	BASIN AREA ACRES	SUB-BASIN CN	OVERALL BASIN B
D1	B		73.7	7.8	2.3	5.6			89.4	90.7	89.4	90.7	CN x A
	C								0.0	0.0			21593
	D								0.0	0.0			AREA
D2	B		58.2	1.6					59.8	91.9	59.8	91.9	245.3
	C								0.0	0.0			CN
	D								0.0	0.0			88.0
E1	B	6.3	39.3						45.6	87.7	50.7	87.5	
	C								0.0	0.0			
	D	3.1	2.0						5.1	85.9			
F6	B	6.7			1.4	32.1		1.8	42.0	77.5	45.4	78.2	
	C								0.0	0.0			OVERALL
	D	1.4	0.5		0.7	0.8			3.4	86.9			BASIN D
G1	B				9.7	36.3			46.0	81.1	80.1	86.9	CN x A
	C								0.0	0.0			38082.45
	D		32.1		0.1	1.9			34.1	94.7			AREA
G2	B				24.6				24.6	85.0	127.0	84.1	443.2
	C	39.0			61.4				100.4	83.8			CN
	D				2.0				2.0	92.0			85.9
G3	B		17.3		6.4				23.7	90.1	40.8	91.4	
	C		3.4		5.7				9.1	91.5			
	D		8.0						8.0	95.0			
F5	B				1.9	68.1			70.0	80.1	195.3	85.6	
	C				29.9	59.6			89.5	87.7			
	D				20.0	15.8			35.8	90.9			

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – SCS CURVE NUMBERS
TABLE 2 – SHEET 3 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	BASIN AREA ACRES	SUB-BASIN CN	OVERALL BASIN C
F1	B		46.6	2.1	2.3	24.7			75.7	87.8	76.7	87.8	CN x A
	C			1.0					1.0	91.0			43339.85
	D								0.0	0.0			AREA
F2	B		77.3	14.9	32.1	3.5		20.0	147.8	89.3	148.8	89.3	500
	C			1.0					1.0	91.0			CN
	D								0.0	0.0			86.7
F3	B				71.2	21.0		12.1	104.3	84.3	121.9	85.5	
	C					5.7			5.7	86.5			
	D		11.9						11.9	95.0			
F4	B		22.3		7.6				29.9	90.2	29.9	90.2	
	C								0.0	0.0			
	D								0.0	0.0			
F7	B		28.0			61.8			89.8	83.7	89.8	83.7	
	C								0.0	0.0			
	D								0.0	0.0			
F8	B	7.1	10.3						17.4	79.4	32.9	81.6	
	C		4.6						4.6	94.0			OVERALL
	D	10.9							10.9	80.0			BASIN E
H1	B				1.0				1.0	85.0	138.6	91.9	CN x A
	C		52.2		21.2				73.4	92.8			16723.6
	D	11.0	22.2		31.0				64.2	91.0			AREA
I2	B								0.0	0.0	45.3	87.9	183.9
	C	6.0	0.3		22.5				28.8	86.7			CN
	D	2.7			13.8				16.5	90.0			90.9

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – SCS CURVE NUMBERS

TABLE 2 – SHEET 4 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	AREA ACRES	SUB-BASIN CN	OVERALL BASIN F
I1	B				14.5		16.0		30.5	76.6	74.0	78.8	CN x A
	C								0.0	0.0			27142.5
	D	41.2			0.9		1.4		43.5	80.4			AREA
J1	B		8.8	14.0	7.9	128.6		3.2	162.5	81.7	162.5	81.7	340.9
	C								0.0	0.0			CN
	D								0.0	0.0			79.6
J2	B	8.5			5.1	50.0	17.8		81.4	75.9	104.4	76.9	
	C								0.0	0.0			
	D	22.5			0.5				23.0	80.3			BASIN G
J3	B								0.0	0.0	54.0	89.9	CN x A
	C				28.1				28.1	90.0			49061.35
	D	5.3	1.4		19.2				25.9	89.7			AREA
K1	B		82.4	15.9	54.5	1.1			153.9	89.0	153.9	89.0	580.4
	C								0.0	0.0			CN
	D								0.0	0.0			84.5
K2	B		11.5		14.5	137.4		10.6	174.0	81.7	174.0	81.7	
	C								0.0	0.0			
	D								0.0	0.0			
K3	B	21.2	9.1				29.3		59.6	69.7	78.7	72.7	
	C								0.0	0.0			
	D	16.2	2.4		0.5				19.1	82.2			
I3	B	4.2				8.9			13.1	73.9	119.8	88.2	
	C		21.8		40.3	32.1			94.2	89.7			
	D				12.5				12.5	92.0			

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – SCS CURVE NUMBERS
TABLE 2 – SHEET 5 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	BASIN AREA ACRES	SUB-BASIN CN	OVERALL BASIN H
K4	B	41.3			6.2				47.5	64.1	81.5	73.6	CN x A
	C								0.0	0.0			39850.4
	D	17.7	12.4		3.9				34.0	86.8			AREA
K5	B								0.0	0.0	42.7	90.7	473.7
	C		13.2		5.2	13.2			31.6	90.2			CN
	D		5.2			5.9			11.1	92.1			84.1
L1	B					8.5		7.5	16.0	83.8	89.3	86.7	
	C		1.9		3.5	59.6		8.3	73.3	87.4			
	D								0.0	0.0			
L2	B		1.0			27.0		0.1	28.1	80.5	142.6	85.7	
	C		1.0		7.0	101.6		4.9	114.5	87.0			
	D								0.0	0.0			
L3	B		1.2		1.8	3.0			6.0	83.9	38.4	89.3	
	C		7.4		5.2	13.8			26.4	89.3			
	D		6.0						6.0	95.0			
L4	B		18.6	0.7	1.5	57.4			78.2	83.0	79.2	83.1	
	C								0.0	0.0			
	D		0.5			0.5			1.0	92.3			

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – SCS CURVE NUMBERS
TABLE 2 – SHEET 6 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	BASIN AREA ACRES	SUB-BASIN CN	OVERALL BASIN I
M3	B		25.9		17.1	68.6		9.5	121.1	83.9	126.1	84.3	CN x A
	C								0.0	0.0			36743.4
	D		4.5		0.5				5.0	94.7			AREA
M4	B	0.9	4.6	22.9	17.5	52.3		2.1	100.3	83.2	100.3	83.2	418
	C								0.0	0.0			CN
	D								0.0	0.0			87.9
M5	B		14.4		7.0				21.4	89.7	47.9	92.0	
	C		12.9		2.4				15.3	93.4			
	D		9.6		1.6				11.2	94.6			
N1	B		33.6						33.6	92.0	97.8	93.3	
	C		56.9	0.9	0.5				58.3	93.9			
	D		5.7		0.2				5.9	94.9			
N2	B		44.9						44.9	92.0	45.9	92.1	
	C								0.0	0.0			
	D		1.0						1.0	95.0			

SPRING CREEK DBPS - HYDROLOGIC DATA SHEET - SCS CURVE NUMBERS
TABLE 2 - SHEET 7 OF 7

		LAND USE TYPE AND AREA IN ACRES											
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	CN	BASIN AREA ACRES	SUB-BASIN CN	OVERALL BASIN J
M2	B	0.9	33.8		10.3	23.5			68.5	86.4	73.5	86.4	CN x A
	C								0.0	0.0			38873.75
	D	2.3			1.6	1.1			5.0	85.9			AREA
N3	B								0.0	0.0	21.4	93.6	466.6
	C		18.4	3.0					21.4	93.6			CN
	D								0.0	0.0			83.3
N4	B	43.2	9.3						52.5	66.5	66.9	69.4	
	C	10.0	4.4						14.4	80.1			
	D								0.0	0.0			
O1	B		3.2	2.1					5.3	90.4	60.9	93.2	
	C		46.0	9.6					55.6	93.5			
	D								0.0	0.0			
O2	B	23.0	1.0						24.0	62.3	94.4	77.4	
	C	35.5	2.6	32.3					70.4	82.5			
	D								0.0	0.0			
P1	B			16.3					16.3	88.0	19.8	88.5	
	C			3.5					3.5	91.0			
	D								0.0	0.0			
P2	B	2.3		85.7					88.0	87.3	129.7	85.9	
	C	19.7		22.0					41.7	83.0			
	D								0.0	0.0			
TOTAL		410.1	1413.2	257.3	775.6	1476.3	64.5	105.0	4502.0		4502.0	85.4	

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – RATIONAL METHOD

TABLE 3 – SHEET 1 OF 4

		LAND USE TYPE AND AREA IN ACRES										
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	C	BASIN AREA ACRES	SUB-BASIN C
A1	A & B		13.6		1.5	73.5			88.6	0.67	88.6	0.67
	C & D								0.0	0.00		
A2	A & B		43.5		25.0	12.5			81.0	0.78	81.0	0.78
	C & D								0.0	0.00		
B1	A & B		40.2			73.2		5.7	119.1	0.73	119.1	0.73
	C & D								0.0	0.00		
B2	A & B		18.3		31.5	70.6		2.5	122.9	0.68	122.9	0.68
	C & D								0.0	0.00		
B3	A & B					61.2		3.6	64.8	0.63	64.8	0.63
	C & D								0.0	0.00		
B4	A & B		38.0		19.8	17.0			74.8	0.77	74.8	0.77
	C & D								0.0	0.00		
B5	A & B					27.6			27.6	0.63	27.6	0.63
	C & D								0.0	0.00		
C1	A & B		65.9		26.5	9.7		13.1	115.2	0.81	115.2	0.81
	C & D								0.0	0.00		
C2	A & B		145.0		11.0				156.0	0.88	156.0	0.88
	C & D								0.0	0.00		
D1	A & B		73.7	7.8	2.3	5.6			89.4	0.87	89.4	0.87
	C & D								0.0	0.00		
D2	A & B		58.2	1.6					59.8	0.90	59.8	0.90
	C & D								0.0	0.00		
E1	A & B	6.3	39.3						45.6	0.85	50.7	0.84
	C & D	3.1	2.0						5.1	0.72		
F1	A & B		46.6	2.1	2.3	24.7			75.7	0.80	76.7	0.80
	C & D			1.0					1.0	0.80		
F2-1	A & B		11.4	14.9	32.1	3.5		20.0	81.9	0.75	82.9	0.75
	C & D			1.0					1.0	0.80		
F2-2	A & B		65.9						65.9	0.90	65.9	0.90
	C & D								0.0	0.00		

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – RATIONAL METHOD
TABLE 3 – SHEET 2 OF 4

		LAND USE TYPE AND AREA IN ACRES										
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	C	BASIN AREA ACRES	SUB-BASIN C
F3	A & B				71.2	21.0		12.1	104.3	0.66	121.9	0.69
	C & D		11.9			5.7			17.6	0.84		
F4	A & B		22.3		7.6				29.9	0.84	29.9	0.84
	C & D								0.0	0.00		
F5	A & B				1.9	68.1			70.0	0.63	195.3	0.70
	C & D				49.9	75.4			125.3	0.73		
F6	A & B	6.7			1.4	32.1		1.8	42.0	0.62	45.4	0.63
	C & D	1.4	0.5		0.7	0.8			3.4	0.70		
F7	A & B		28.0			61.8			89.8	0.71	89.8	0.71
	C & D								0.0	0.00		
F8	A & B	7.1	10.3						17.4	0.76	32.9	0.73
	C & D	10.9	4.6						15.5	0.69		
G1	A & B				9.7	36.3			46.0	0.63	80.1	0.74
	C & D		32.1		0.1	1.9			34.1	0.89		
G2-1	A & B								0.0	0.00	69.5	0.67
	C & D	37.8			31.7				69.5	0.67		
G2-2	A & B				24.6				24.6	0.65	57.5	0.70
	C & D	1.2			31.7				32.9	0.74		
G3	A & B		17.3		6.4				23.7	0.83	40.8	0.84
	C & D		11.4		5.7				17.1	0.85		
H1	A & B				1.0				1.0	0.65	138.6	0.82
	C & D	11.0	74.4		52.2				137.6	0.82		
I1	A & B				14.5		16.0		30.5	0.53	74.0	0.57
	C & D	41.2			0.9		1.4		43.5	0.60		
I2	A & B								0.0	0.00	45.3	0.72
	C & D	8.7	0.3		36.3				45.3	0.72		
I3	A & B	4.2				8.9			13.1	0.60	119.8	0.75
	C & D		21.8		52.8	32.1			106.7	0.77		
J1-1	A & B		8.8	14.0	6.2	53.3			82.3	0.69	82.3	0.69
	C & D								0.0	0.00		

SPRING CREEK DBPS - HYDROLOGIC DATA SHEET - RATIONAL METHOD
TABLE 3 - SHEET 3 OF 4

		LAND USE TYPE AND AREA IN ACRES										
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	C	AREA ACRES	SUB-BASIN C
J1-2	A & B				1.7	75.3		3.2	80.2	0.63	80.2	0.63
	C & D								0.0	0.00		
J2	A & B	8.5			5.1	50.0	17.8		81.4	0.58	104.4	0.58
	C & D	22.5			0.5				23.0	0.60		
J3	A & B								0.0	0.00	54.0	0.74
	C & D	5.3	1.4		47.3				54.0	0.74		
K1	A & B		82.4	15.9	54.5	1.1			153.9	0.80	153.9	0.80
	C & D								0.0	0.00		
K2-1	A & B		7.4		5.0	111.9		10.6	134.9	0.65	134.9	0.65
	C & D								0.0	0.00		
K2-2	A & B		4.1		9.5	25.5			39.1	0.66	39.1	0.66
	C & D								0.0	0.00		
K3-1	A & B	2.8	5.4				25.3		33.5	0.51	33.5	0.51
	C & D								0.0	0.00		
K3-2	A & B	18.4	3.7				4.0		26.1	0.58	45.2	0.61
	C & D	16.2	2.4		0.5				19.1	0.64		
K4	A & B	41.3			6.2				47.5	0.56	81.5	0.63
	C & D	17.7	12.4		3.9				34.0	0.73		
K5	A & B								0.0	0.00	42.7	0.80
	C & D		18.4		5.2	19.1			42.7	0.80		
L1	A & B					8.5		7.5	16.0	0.71	89.3	0.73
	C & D		1.9		3.5	59.6		8.3	73.3	0.74		
L2	A & B		1.0			27.0		0.1	28.1	0.64	142.6	0.71
	C & D		1.0		7.0	101.6		4.9	114.5	0.73		
L3	A & B		1.2		1.8	3.0			6.0	0.69	38.4	0.78
	C & D		13.4		5.2	13.8			32.4	0.80		
L4	A & B		18.6	0.7	1.5	57.4			78.2	0.69	79.2	0.69
	C & D		0.5			0.5			1.0	0.81		
M2	A & B	0.9	33.8		10.3	23.5			68.5	0.76	73.5	0.76
	C & D	2.3			1.6	1.1			5.0	0.68		

SPRING CREEK DBPS – HYDROLOGIC DATA SHEET – RATIONAL METHOD
TABLE 3 – SHEET 4 OF 4

		LAND USE TYPE AND AREA IN ACRES										
BASIN	HYDROLOGIC SOIL TYPE	PARKS	COMMERCIAL OR BUSINESS	INDUSTRIAL	RESIDENT 1/8 AC OR <	RESIDENT 1/6 AC	RESIDENT 3/4 AC	SCHOOL OR CHURCH	AREA (ACRES)	C	BASIN AREA ACRES	SUB-BASIN C
M3	A & B		25.9		17.1	68.6		9.5	121.1	0.70	126.1	0.71
	C & D		4.5		0.5				5.0	0.89		
M4	A & B	0.9	4.6	22.9	17.5	52.3		2.1	100.3	0.68	100.3	0.68
	C & D								0.0	0.00		
M5	A & B		14.4		7.0				21.4	0.82	47.9	0.85
	C & D		22.5		4.0				26.5	0.88		
N1	A & B		33.6						33.6	0.90	97.8	0.90
	C & D		62.6	0.9	0.7				64.2	0.90		
N2	A & B		44.9						44.9	0.90	45.9	0.90
	C & D		1.0						1.0	0.90		
N3	A & B								0.0	0.00	21.4	0.89
	C & D		18.4	3.0					21.4	0.89		
N4	A & B	43.2	9.3						52.5	0.61	66.9	0.63
	C & D	10.0	4.4						14.4	0.69		
O1	A & B		3.2	2.1					5.3	0.86	60.9	0.88
	C & D		46.0	9.6					55.6	0.88		
O2	A & B	23.0	1.0						24.0	0.56	94.4	0.67
	C & D	35.5	2.6	32.3					70.4	0.70		
P1	A & B			16.3					16.3	0.80	19.8	0.80
	C & D			3.5					3.5	0.80		
P2	B	2.3		85.7					88.0	0.79	129.7	0.77
	C	19.7		22.0					41.7	0.71		
TOTAL		410.1	1413.2	257.3	775.6	1476.3	64.5	105.0	4502.0		4502.0	0.74

SPRING CREEK DBPS-HYDROLOGIC DATA SHEET - TIME OF CONCENTRATION
TABLE 4 - SHEET 1 OF 3

		USING CITY CRITERIA FOR RATIONAL													*USING OVERALL Tc*			*USE LONGER*	
		OVERLAND			STREET			PIPE			CHANNEL			TOTAL	DIST	EL DIFF	TOTAL	FOR USE	LAG
BASIN	"C"	S(%)	L(FT)	t(MIN)	L(FT)	V(FPS)	t(MIN)	L(FT)	V(FPS)	t(MIN)	L(FT)	V(FPS)	t(MIN)	T(MIN)	(MI)	(FT)	T(MIN)	T(MIN)	L(HR)
A1	0.58	4.0	200	10.0	2000	10.0	3.3	550	10.0	0.9		10.0	0.0	14.3	0.52	111	12.0	14.3	0.14
A2	0.73	5.0	100	10.0	1850	10.0	3.1	700	10.0	1.2		10.0	0.0	14.3	0.50	74	13.4	14.3	0.14
B1	0.66	8.0	200	10.0	3400	10.0	5.7	450	10.0	0.8		10.0	0.0	16.4	0.77	146	16.8	16.8	0.17
B2	0.59	2.5	200	10.0	2850	10.0	4.8	2750	10.0	4.6		10.0	0.0	19.3	1.10	147	25.4	25.4	0.25
B3	0.53	2.5	200	11.1	3800	10.0	6.3	1350	10.0	2.3		10.0	0.0	19.7	1.01	179	21.5	21.5	0.21
B4	0.72	4.0	100	10.0	2200	10.0	3.7	250	10.0	0.4		10.0	0.0	14.1	0.48	60	13.9	14.1	0.14
B5	0.53	1.0	200	15.1	1400	10.0	2.3	200	10.0	0.3		10.0	0.0	17.7	0.34	35	11.4	17.7	0.18
C1	0.77	2.5	400	10.0	3100	10.0	5.2	1350	10.0	2.3		10.0	0.0	17.4	0.92	61	29.0	29.0	0.29
C2	0.88	2.0	700	10.0		10.0	0.0	3000	10.0	5.0		10.0	0.0	15.0	0.70	109	17.0	17.0	0.17
D1	0.85	1.0	100	10.0	3250	10.0	5.4	1000	10.0	1.7		10.0	0.0	17.1	0.82	105	20.8	20.8	0.21
D2	0.89	2.0	500	10.0	1650	10.0	2.8	240	10.0	0.4		10.0	0.0	13.2	0.45	131	9.6	13.2	0.13
E1	0.79	3.0	600	10.0		10.0	0.0	1500	10.0	2.5		10.0	0.0	12.5	0.40	108	8.9	12.5	0.13
F1	0.76	2.0	100	10.0		10.0	0.0	4100	10.0	6.8		10.0	0.0	16.8	0.80	72	23.0	23.0	0.23
F2	0.77	2.0	100	10.0	1700	10.0	2.8	2400	10.0	4.0		10.0	0.0	16.8	0.80	106	19.8	19.8	0.20
F3	0.60	2.0	100	10.0	4800	10.0	8.0		10.0	0.0		10.0	0.0	18.0	0.93	115	23.0	23.0	0.23
F4	0.81	2.5	250	10.0	2200	10.0	3.7	600	10.0	1.0	1000	10.0	1.7	16.3	0.77	140	17.1	17.1	0.17
F5	0.60	4.5	200	10.0	4450	10.0	7.4	1200	10.0	2.0		10.0	0.0	19.4	1.11	176	23.9	23.9	0.24
F6	0.50	3.5	200	10.5	1850	10.0	3.1		10.0	0.0		10.0	0.0	13.6	0.39	124	8.2	13.6	0.14
F7	0.64	2.0	100	10.0	2500	10.0	4.2	2300	10.0	3.8		10.0	0.0	18.0	0.93	44	33.3	33.3	0.33
F8	0.59			10.0		10.0	0.0		10.0	0.0		10.0	0.0	10.0	0.24	30	8.1	10.0	0.10
G1	0.68	6.5	150	10.0	2200	10.0	3.7	700	10.0	1.2		10.0	0.0	14.8	0.58	108	13.6	14.8	0.15
G2	0.54	5.0	240	10.0	1070	10.0	1.8	4000	10.0	6.7		10.0	0.0	18.5	1.01	121	24.7	24.7	0.25
G3	0.81	3.0	250	10.0	4130	10.0	6.9		10.0	0.0		10.0	0.0	16.9	0.83	147	18.4	18.4	0.18
H1	0.76	9.0	100	10.0	900	10.0	1.5	3100	10.0	5.2		10.0	0.0	16.7	0.78	114	18.7	18.7	0.19
I1	0.39	10.0	200	10.0	1300	10.0	2.2	900	10.0	1.5		10.0	0.0	13.7	0.45	73	12.0	13.7	0.14
I2	0.59	6.0	100	10.0	1900	10.0	3.2	800	10.0	1.3		10.0	0.0	14.5	0.53	85	13.5	14.5	0.15

SPRING CREEK DBPS-HYDROLOGIC DATA SHEET - TIME OF CONCENTRATION
TABLE 4 - SHEET 2 OF 3

		USING CITY CRITERIA FOR RATIONAL													*USING OVERALL Tc*			*USE LONGER*	
		OVERLAND			STREET			PIPE			CHANNEL			TOTAL	DIST	EL DIFF	TOTAL	FOR USE	LAG
BASIN	"C"	S(%)	L(FT)	t(MIN)	L(FT)	V(FPS)	t(MIN)	L(FT)	V(FPS)	t(MIN)	L(FT)	V(FPS)	t(MIN)	T(MIN)	(MI)	(FT)	T(MIN)	T(MIN)	L(HR)
I3	0.67	2.0	100	10.0	4050	10.0	6.8		10.0	0.0		10.0	0.0	16.8	0.79	92	20.6	20.6	0.21
J1	0.57	2.0	100	10.0	3050	10.0	5.1	2100	10.0	3.5		10.0	0.0	18.6	0.99	111	25.3	25.3	0.25
J2	0.44	2.0	200	13.9	950	10.0	1.6	2100	10.0	3.5	850	10.0	1.4	20.4	0.78	134	17.6	20.4	0.20
J3	0.63	2.0	400	14.0	1150	10.0	1.9	1250	10.0	2.1	700	10.0	1.2	19.2	0.66	46	22.2	22.2	0.22
K1	0.75	2.0	100	10.0	1200	10.0	2.0	3900	10.0	6.5		10.0	0.0	18.5	0.98	117	24.5	24.5	0.24
K2	0.56	2.0	200	11.4	3600	10.0	6.0	1450	10.0	2.4		10.0	0.0	19.8	0.99	134	23.5	23.5	0.23
K3	0.41	6.0	100	10.0	2050	10.0	3.4	1650	10.0	2.8	2300	10.0	3.8	20.0	1.16	111	30.0	30.0	0.30
K4	0.44	6.7	550	15.5	3120	10.0	5.2		10.0	0.0		10.0	0.0	20.7	0.70	86	18.4	20.7	0.21
K5	0.75	6.0	100	10.0	3500	10.0	5.8		10.0	0.0	200	10.0	0.3	16.2	0.72	98	18.2	18.2	0.18
L1	0.64	4.0	400	10.9	2150	10.0	3.6		10.0	0.0		10.0	0.0	14.5	0.48	108	11.1	14.5	0.14
L2	0.61	2.0	200	10.3	3700	10.0	6.2		10.0	0.0		10.0	0.0	16.5	0.74	111	17.9	17.9	0.18
L3	0.72	2.0	100	10.0		10.0	0.0		10.0	0.0	4000	10.0	6.7	16.7	0.78	112	18.9	18.9	0.19
L4	0.62	1.3	240	12.8	3430	10.0	5.7		10.0	0.0		10.0	0.0	18.5	0.70	118	16.3	18.5	0.18
M2	0.70	3.0	200	10.0	3700	10.0	6.2		10.0	0.0		10.0	0.0	16.2	0.74	124	17.2	17.2	0.17
M3	0.63	2.0	100	10.0	3600	10.0	6.0	1850	10.0	3.1		10.0	0.0	19.1	1.05	180	22.3	22.3	0.22
M4	0.59	2.0	100	10.0	3600	10.0	6.0		10.0	0.0		10.0	0.0	16.0	0.70	119	16.4	16.4	0.16
M5	0.83	2.0	100	10.0	1200	10.0	2.0	1200	10.0	2.0		10.0	0.0	14.0	0.47	18	21.4	21.4	0.21
N1	0.90	2.0	200	10.0	4000	10.0	6.7		10.0	0.0		10.0	0.0	16.7	0.80	158	17.0	17.0	0.17
N2	0.90	2.0	100	10.0	1800	10.0	3.0		10.0	0.0		10.0	0.0	13.0	0.36	97	8.2	13.0	0.13
N3	0.88	4.0	100	10.0	3180	10.0	5.3		10.0	0.0		10.0	0.0	15.3	0.62	146	13.2	15.3	0.15
N4	0.43	2.0	200	14.1	3300	10.0	5.5		10.0	0.0	2400	10.0	4.0	23.6	1.12	193	23.3	23.6	0.24
O1	0.87	2.0	100	10.0		10.0	0.0	2400	10.0	4.0		10.0	0.0	14.0	0.47	123	10.3	14.0	0.14
O2	0.50	6.5	500	13.5	2400	10.0	4.0		10.0	0.0		10.0	0.0	17.5	0.55	182	10.5	17.5	0.18
P1	0.71	5.9	800	11.5		10.0	0.0		10.0	0.0	550	10.0	0.9	12.4	0.26	80	6.0	12.4	0.12
P2	0.65	6.5	600	11.1	2350	10.0	3.9		10.0	0.0	2300	10.0	3.8	18.9	0.99	185	20.7	20.7	0.21

SPRING CREEK DBPS-HYDROLOGIC DATA SHEET - TIME OF CONCENTRATION
TABLE 4 - SHEET 3 OF 3

		USING CITY CRITERIA FOR RATIONAL													*USING OVERALL Tc*			*USE LONGER*	
		OVERLAND			STREET			PIPE			CHANNEL			TOTAL	DIST	EL DIFF	TOTAL	FOR USE	LAG
BASIN	"C"	S(%)	L(FT)	t(MIN)	L(FT)	V(FPS)	t(MIN)	L(FT)	V(FPS)	t(MIN)	L(FT)	V(FPS)	t(MIN)	T(MIN)	(MI)	(FT)	T(MIN)	T(MIN)	L(HR)
F2-1	0.66	2.0	100	10.0	3600	10.0	6.0		10.0	0.0		10.0	0.0	16.0	0.70	100	17.5	17.5	0.18
F2-2	0.90	2.0	350	10.0		10.0	0.0	650	10.0	1.1	1600	10.0	2.7	13.8	0.49	76	13.0	13.8	0.14
G2-1	0.49	5.0	240	10.4	1070	10.0	1.8	900	10.0	1.5		10.0	0.0	13.7	0.42	69	11.2	13.7	0.14
G2-2	0.60	4.5	300	10.0	1600	10.0	2.7	900	10.0	1.5		10.0	0.0	14.2	0.53	90	13.2	14.2	0.14
J1-1	0.60	2.0	100	10.0	3050	10.0	5.1		10.0	0.0		10.0	0.0	15.1	0.60	69	16.8	16.8	0.17
J1-2	0.53	1.0	200	15.1	1200	10.0	2.0	2100	10.0	3.5		10.0	0.0	20.6	0.66	58	20.3	20.6	0.21
K2-1	0.56	2.0	200	11.4	3600	10.0	6.0	1450	10.0	2.4		10.0	0.0	19.8	0.99	134	23.5	23.5	0.23
K2-2	0.57	1.0	100	10.0	2800	10.0	4.7		10.0	0.0		10.0	0.0	14.7	0.55	76	14.7	14.7	0.15
K3-1	0.42	6.0	100	10.0	2050	10.0	3.4	1650	10.0	2.8	1200	10.0	2.0	18.2	0.95	82	26.8	26.8	0.27
K3-2	0.40			10.0		10.0	0.0		10.0	0.0		10.0	0.0	10.0	0.27	70	6.7	10.0	0.10

SPRING CREEK DBPS – SUMMARY OF PEAK FLOWS – 100 YEAR
TABLE 5 24 HOUR

MAIN CHANNEL FLOWS FROM LARGER SUBBASIN COMPUTER MODEL (HEC-1)

DESIGN POINT	LOCATION / DESCRIPTION	PEAK FLOW **(CFS)
1	GALLEY ROAD	625
2	CHELTON ROAD AT CITADEL MALL	1,032
3	PLATTE AVENUE	2,320
* 4	BIJOU STREET	2,787
5	PIKE PEAK AVENUE – WAGNER PARK INFLOW	3,022
5DET	PIKE PEAK AVENUE – WAGNER PARK OUTFLOW	2,171
6DET	REDWING SANCTUARY OUTFLOW	3,177
7	AIRPORT ROAD	4,086
* 8	1/2 WAY AIRPORT & CHELTON	4,325
9 UPPER	JUST UPSTREAM OF CHELTON ROAD	4,383
* 9 LOWER	JUST DOWNSTREAM OF CHELTON ROAD	4,833
10	VALLEY HIGH LAKE INFLOW	6,304
10DET	VALLEY HIGH LAKE RELEASE	5,522
* 11	FOUNTAIN BLVD.	5,586
12	CIRCLE DRIVE	6,253
* 13	1/2 WAY CIRCLE & UNION	6,785
14 UPPER	JUST UPSTREAM OF UNION BLVD.	7,026
14 DET	JUST DOWNSTREAM OF UNION BLVD.	5,276
* 15	HANCOCK EXPRESSWAY	5,515
16	CONFLUENCE WITH FOUNTAIN CREEK	5,677

TRIBUTARY CHANNEL FLOWS FROM 100 ACRE SUBBASIN COMPUTER MODEL

DESIGN POINT	LOCATION / DESCRIPTION	PEAK FLOW (CFS)
2A	BOWSER DRIVE SOUTH OF GALLEY ROAD	774
6C	PLATTE AVENUE AT MURRAY BLVD.	493
6B	ACADEMY BLVD. BY BIJOU ST.	1,063
6A	ACADEMY BLVD. BY PIKES PEAK AVE.	1,575
10A	NORTHEAST SIDE OF VALLEY HI LAKE	898
10B	AIRPORT ROAD BY CIRCLE DR.	1,070
10C	NORTHWEST SIDE OF VALLEY HI LAKE	1,164
12A	SOUTH OF CIRCLE DR. & FOUNTAIN BLVD.	849
*13A	FOUNTAIN BLVD. BY HUTCHINSON DR.	700
14A	FOUNTAIN BLVD. BY UNION BLVD.	377

* MAIN CHANNEL PEAK FLOWS WERE INTERPOLATED BETWEEN FLOWS GENERATED IN LARGER SUBBASIN MODEL
** WITH DETENTION PONDS ABOVE DESIGN POINTS 5, 6, 10, AND 14

SPRING CREEK DBPS - RATIONAL FLOWS FOR SUBBASINS
TABLE 6 - SHEET 1 OF 2

RATIONAL METHOD PEAK FLOWS

BASIN	"C"	Tc(MIN)	INTENSITY (IN/HR)	AREA (AC)	Q100 (CFS)
A1	0.67	14.3	6.0	88.6	356
A2	0.78	14.3	6.0	81.0	379
B1	0.73	16.8	5.6	119.1	487
B2	0.68	25.4	4.6	122.9	384
B3	0.63	21.5	4.9	64.8	200
B4	0.77	14.1	6.0	74.8	346
B5	0.63	17.7	5.4	27.6	94
C1	0.81	29.0	4.2	115.2	392
C2	0.88	17.0	5.6	156.0	769
D1	0.87	20.8	5.0	89.4	389
D2	0.90	13.2	6.2	59.8	334
E1	0.84	12.5	6.4	50.7	273
F1	0.80	23.0	4.8	76.7	295
F2	0.82	19.8	5.1	148.8	620
F3	0.69	23.0	4.8	121.9	404
F4	0.84	17.1	5.6	29.9	141
F5	0.70	23.9	4.7	195.3	643
F6	0.63	13.6	6.1	45.4	174
F7	0.71	33.3	3.8	89.8	242
F8	0.73	10.0	7.0	32.9	168
G1	0.74	14.8	5.9	80.1	350
G2	0.68	24.7	4.6	127.0	399
G3	0.84	18.4	5.3	40.8	182
H1	0.82	18.7	5.3	138.6	602
I1	0.57	13.7	6.1	74.0	257
I2	0.72	14.5	5.9	45.3	192
I3	0.75	20.6	5.0	119.8	449
J1	0.66	25.3	4.6	162.5	494
J2	0.58	20.4	5.1	104.4	309
J3	0.74	22.2	4.8	54.0	192
K1	0.80	24.5	4.6	153.9	566
K2	0.65	23.5	4.7	174.0	533
K3	0.57	30.0	4.1	78.7	183
K4	0.63	20.7	5.0	81.5	257
K5	0.80	18.2	5.4	42.7	184
L1	0.73	14.5	5.9	89.3	385
L2	0.71	17.9	5.4	142.6	547
L3	0.78	18.9	5.3	38.4	159

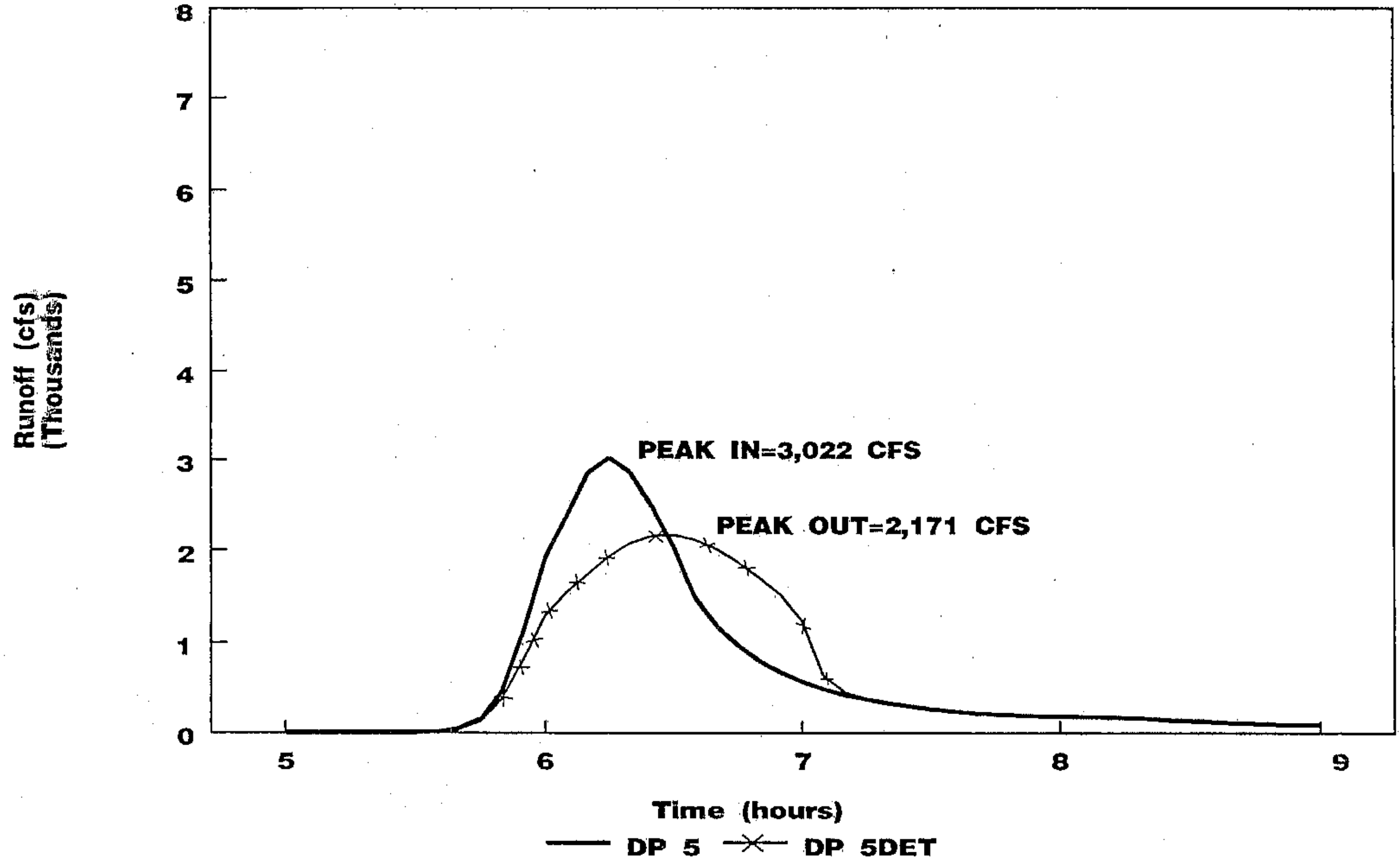
SPRING CREEK DBPS - RATIONAL FLOWS FOR SUBBASINS
TABLE 6 - SHEET 2 OF 2

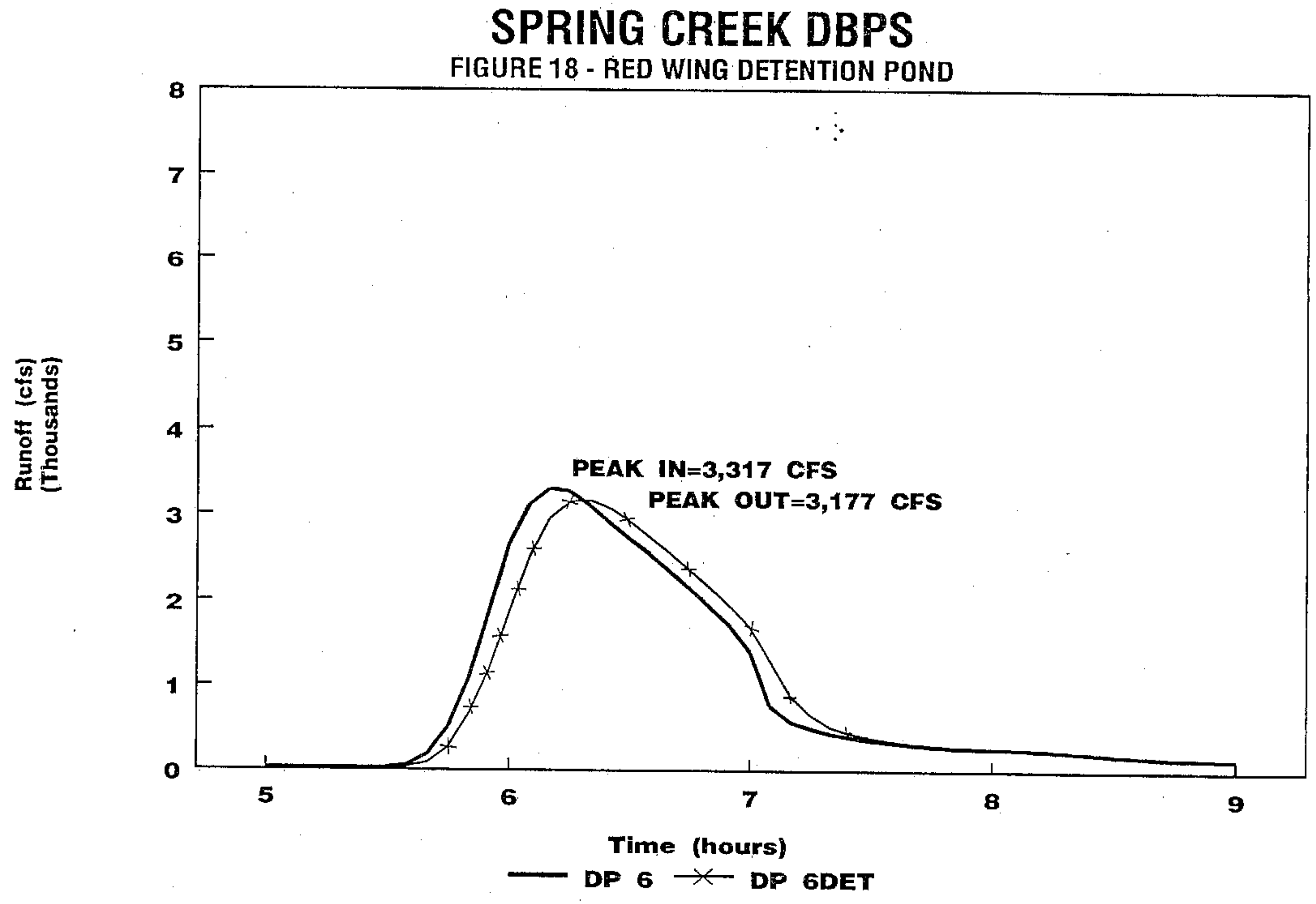
RATIONAL METHOD PEAK FLOWS

BASIN	"C"	Tc (MIN)	INTENSITY (IN/HR)	AREA (AC)	Q100 (CFS)
L4	0.69	18.5	5.3	79.2	290
M2	0.76	17.2	5.6	73.5	313
M3	0.71	22.3	4.8	126.1	430
M4	0.68	16.4	5.7	100.3	389
M5	0.85	21.4	4.9	47.9	200
N1	0.90	17.0	5.6	97.8	493
N2	0.90	13.0	6.3	45.9	260
N3	0.89	15.3	5.8	21.4	110
N4	0.63	23.6	4.7	66.9	198
O1	0.88	14.0	6.0	60.9	322
O2	0.67	17.5	5.5	94.4	348
P1	0.80	12.4	6.4	19.8	101
P2	0.77	20.7	5.0	129.7	499
F2-1	0.75	17.5	5.5	82.9	342
F2-2	0.90	13.8	6.0	65.9	356
G2-1	0.67	13.7	6.1	69.5	284
G2-2	0.70	14.2	6.0	57.5	241
J1-1	0.69	16.8	5.6	82.3	318
J1-2	0.63	20.6	5.0	80.2	253
K2-1	0.65	23.5	4.7	134.9	412
K2-2	0.66	14.7	5.9	39.1	152
K3-1	0.51	26.8	4.5	33.5	77
K3-2	0.61	10.0	7.0	45.2	193

SPRING CREEK DBPS

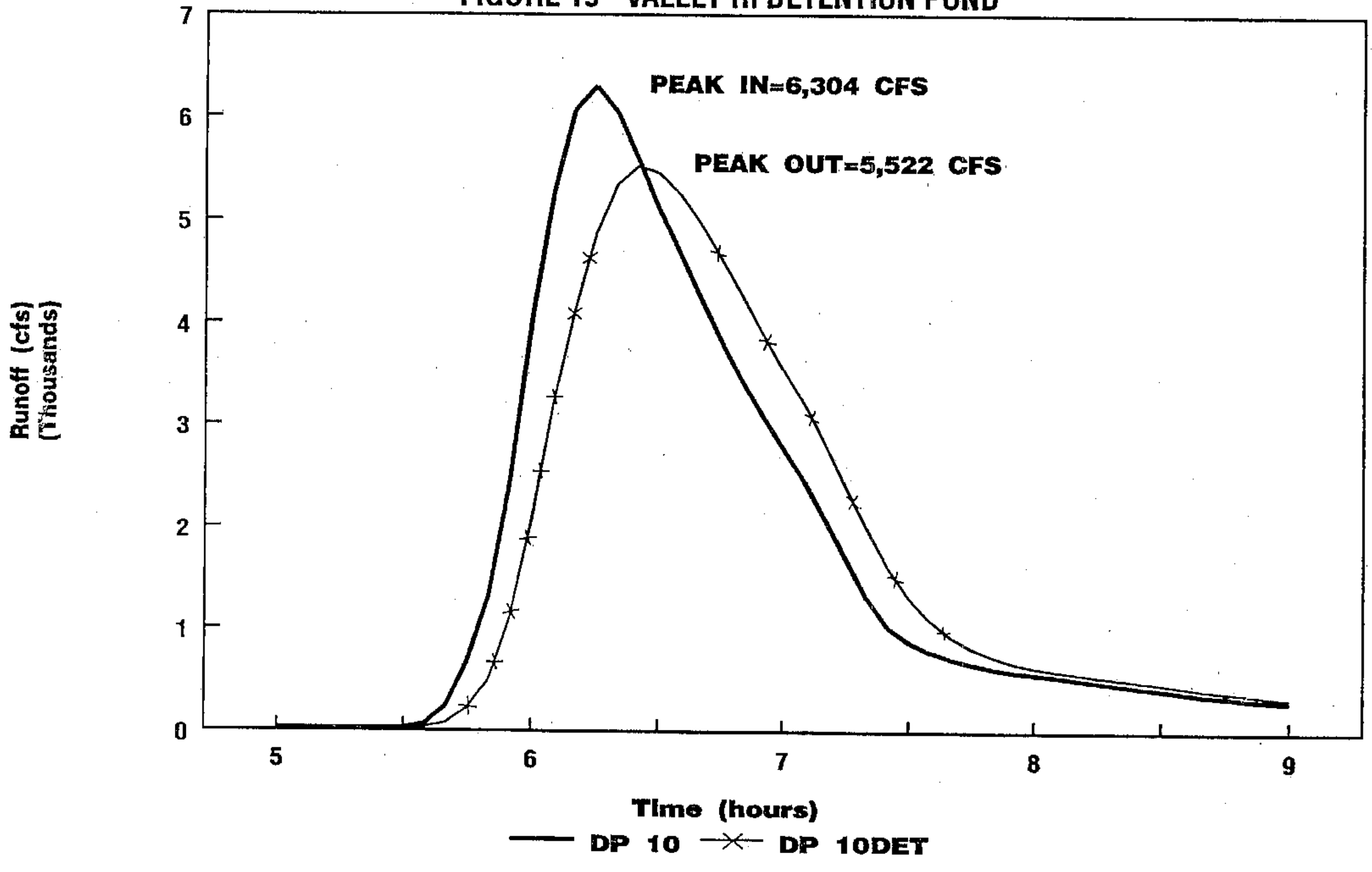
FIGURE 17 - WAGNER PARK DETENTION POND

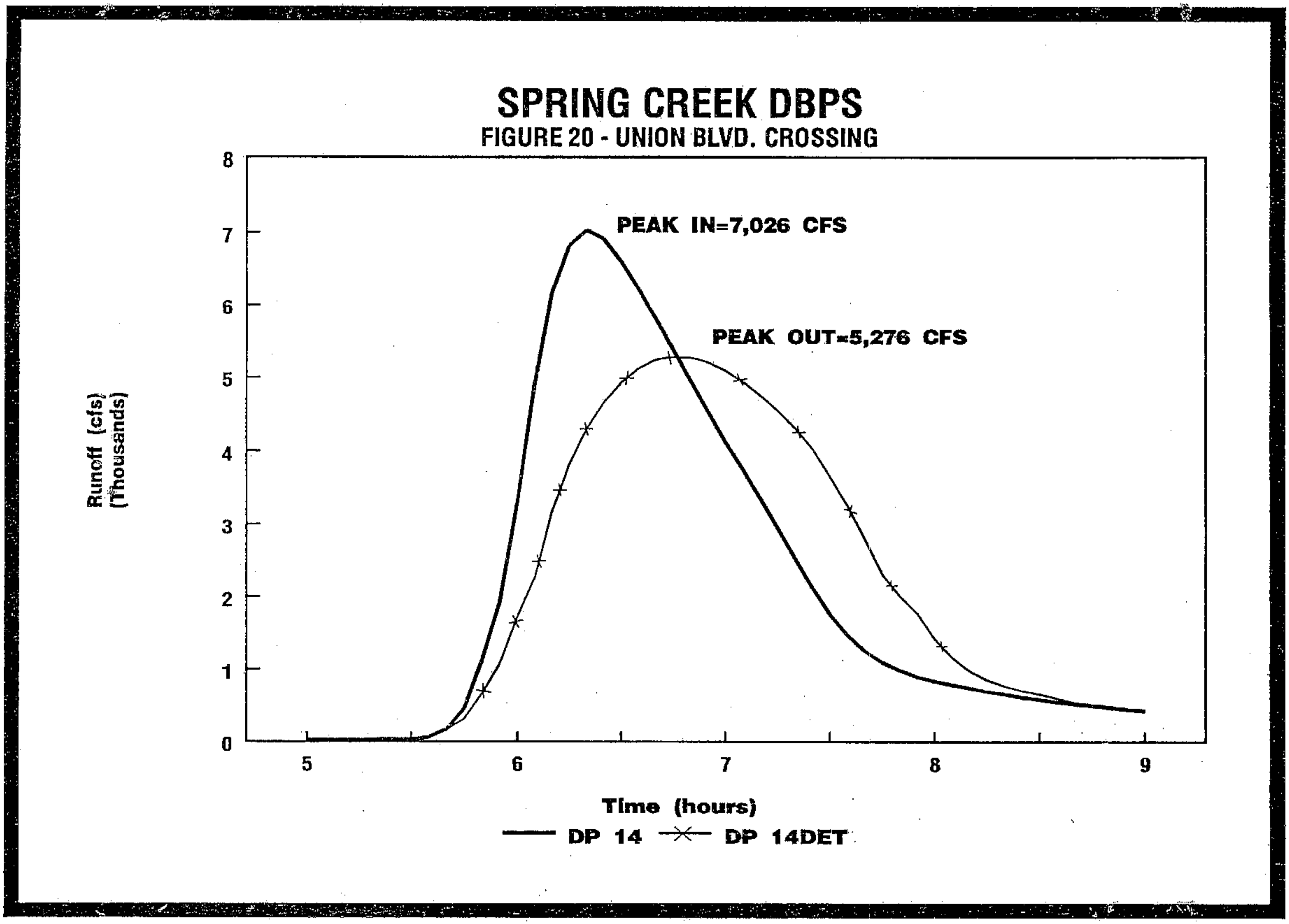



SPRING CREEK DBPS
FIGURE 18 - RED WING DETENTION POND
8
7
6
5
4
3
2
1
0
Runoff (cfs)
(Thousands)
PEAK IN=3,317 CFS
PEAK OUT=3,177 CFS
5
6
7
8
9
Time (hours)
DP 6
DP 6DET

SPRING CREEK DBPS

FIGURE 19 - VALLEY HI DETENTION POND





SPRING CREEK DBPS
FIGURE 20 - UNION BLVD. CROSSING
PEAK IN=7,026 CFS
PEAK OUT=5,276 CFS
Runoff (cfs)
(Thousands)
0
1
2
3
4
5
6
7
8
5
6
7
8
9
Time (hours)
DP 14
DP 14DET

SPRING CREEK DBPS – EXISTING CHANNEL\STORM SEWER CAPACITIES
TABLE 7 – SHEET 1 OF 2

DESIGN POINTS	MAIN CHANNEL REACH	EXISTING IMPROVEMENT	SLOPE (%)	MANNINGS n–VALUE	B (FT)	DEPTH (FT)	SIDES (x:1)	CAPACITY w/o FB(CFS)	VELOCITY (FPS)	CAPACITY w/FB(CFS)	VELOCITY (FPS)
16 TO 15	FOUNTAIN CR. TO LAS VEGAS ST.	NATURAL	1.20	0.035	30	8.0	3.5	6,526	14.1	4,092	12.4
16 TO 15	LAS VEGAS ST. TO HANCOCK EXP.	NATURAL	0.70	0.035	50	16.0	1.5	20,796	17.6	16,109	16.3
15 TO 14	HANCOCK EXP. TO UNION BLVD.	NATURAL	0.90	0.035	20	8.0	5.0	5,444	11.3	3,396	10.0
15 TO 14	HANCOCK EXP. TO UNION BLVD.	NATURAL	2.50	0.035	40	14.0	1.5	25,605	30.0	17,094	26.7
14 TO 12	UNION BLVD. TO CIRCLE DR.	IN CBC (CDOT)	1.00	0.015	24	12.0	0.0	5,935	20.6	5,640	23.8
12 TO 11	CIRCLE DR. TO FOUNTAIN BLVD.	CONC. LINED	1.50	0.015	36	10.0	1.5	22,811	44.7	11,118	36.1
11 TO 10	FOUNTAIN BLVD. TO VALLEY HI LAKE	CONC. LINED	0.80	0.015	22	10.0	0.0	3,704	16.8	3,500	19.6
10 TO 9	VALLEY HIGH LAKE TO CHELTON DR.	PART. LINED	0.80	0.025	40	4.0	1.5	2,204	12.0	1,047	9.3
9 TO 7	CHELTON DR. TO AIRPORT RD.–LWR.	PART. LINED	0.50	0.035	30	10.0	1.5	4,855	10.8	3,557	9.9
9 TO 7	CHELTON DR. TO AIRPORT RD.–UPP.	PART. LINED	0.50	0.035	40	8.0	1.5	4,143	10.0	2,900	8.9
7 TO 6	AIRPORT RD. TO RED WING SANC.	PART. LINED	0.70	0.025	50	5.5	1.5	4,399	13.7	2,517	11.4
6 TO 5	RED WING SANC. TO PIKES PEAK AVE.	NATURAL	0.70	0.035	20	15.0	2.0	11,194	14.9	8,403	13.9
5 TO 4	PIKES PEAK AVE. TO BIJOU ST.	NATURAL	1.00	0.035	40	15.0	1.5	18,432	19.7	13,774	18.1
4 TO 3	BIJOU ST. TO PLATTE AVE.	CONC. LINED	1.00	0.015	15	5.0	1.5	2,523	22.4	1,096	17.6

DESIGN POINTS	MAIN STORM SEWER REACH	EXISTING IMPROVEMENT	SLOPE (%)	CAPACITY (CFS)
3 TO 2	PLATTE AVE. TO CHELTON DR.	96" RCP	1.20	1,000
3 TO 1	PLATTE AVE. TO GALLEY RD.	66" RCP	1.20	368
3 TO C1	PLATTE AVE. TO ACADEMY BLVD.	72" RCP	4.30	878

SPRING CREEK DBPS - EXISTING CHANNEL\STORM SEWER CAPACITIES
TABLE 7 - SHEET 2 OF 2

DESIGN POINTS	TRIBUTARY CHANNEL REACH	EXISTING IMPROVEMENT	SLOPE (%)	MANNINGS n-VALUE	B (FT)	DEPTH (FT)	SIDES (x:1)	CAPACITY w/o FB(CFS)	VELOCITY (FPS)	CAPACITY w/FB(CFS)	VELOCITY (FPS)
14A TO N.	UNION BLVD. TO FOUNTAIN BLVD.	NATURAL	2.90	0.035	20	10	2	9,740	24.3	5,835	21.2
13 TO 13A	U.S. 24 BYPASS TO FOUNTAIN BLVD.	NATURAL	4.00	0.035	10	15	2	20,011	33.4	11,958	29.3
10C TO 10B	VALLEY HI GOLF COURSE TOWARDS NW	NATURAL	1.10	0.035	10	4	1.5	542	8.5	262	6.9
10A TO E.	VALLEY HI GOLF COURSE TOWARDS NE	CONC. LINED	0.50	0.015	28	4.0	1.5	2,071	15.2	912	11.6
6A TO 6B	BIJOU ST. TO PIKES PEAK	CONC. LINED	3.25	0.015	12	4.0	1.5	2,509	34.8	631	23.0
6B TO 6C	PLATTE AVE. TO BIJOU ST.	CONC. LINED	1.00	0.015	8	4.0	1.5	1,021	18.2	382	13.9
M4 TO 13A	FOUNTAIN BLVD. TO WINNEPEG	CONC. LINED	3.00	0.015	0	6.8	1	1,424	30.8	461	23.2

DESIGN POINTS	TRIBUTARY STORM SEWER REACH	EXISTING IMPROVEMENT	SLOPE (%)	CAPACITY (CFS)
12A	CIRCLE DR. TO VERDE DR.	3-54" CMP	1.40	380
6A TO 6B	ACADEMY BLVD. TO PIKES PEAK	12 X 6 CBC	1.50	1,390
6B TO 6C	PLATTE AVE. TO BIJOU ST.	66" CSP	2.00	260
10C TO 10B	VALLEY HI GOLF COURSE TOWARDS NW	42" CSP	2.50	86

Proposed Alternative Solutions-Channels

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SPRING CREEK DBPS – EXISTING CROSSING CAPACITIES
TABLE 8

DESIGN POINT	MAIN CHANNEL CROSSING	EXISTING IMPROVEMENT	UPSTREAM IMPROVEMENT	CAPACITY (CFS)		REMARKS
15/16	LAS VEGAS STREET	BRIDGE–30' SPAN, 15' D	NATURAL/CONCRETE	4,500	(1)	A=408 SF, P=55', S=1%
15/16	RAILROAD	BRIDGE–61' SPAN, 13' D	NATURAL	7,850		A=685 SF, P=155', S=1%
15	HANCOCK EXPRESSWAY	BRIDGE–75' SPAN, 19' D	NATURAL	7,140		A=673 SF, P=171', S=1%
14	UNION BLVD (CDOH)	DOUBLE–13'X 10' CBC	WETLAND REPLACEMENT AREA	5,530		INLET CONTROL, HW/D=2.4
12	CIRCLE DRIVE	DOUBLE–10'X 6' CBC	CONCRETE LINED CHANNEL	2,400	(2)	USE VELOCITY OF 20 FPS
11	FOUNTAIN BLVD.	BRIDGE–31' SPAN, 10' D	CONCRETE LINED CHANNEL	6,200		USE VELOCITY OF 20 FPS
10	VALLEY HI LAKE SPILLWAY	109' WIDE CONC. SPILLWAY	LAKE/DETENTION POND	2,141	(3)	DAM OVERTOPPED
9	CHELTON ROAD	QUADRUPLE–8'X 6' CBC	PARTIALLY LINED CHANNEL	1,375	(3)	INLET CONTROL, HW/D=1.0
7	AIRPORT ROAD	2–13'X 5',1–18'X 5' CBC	PARTIALLY LINED CHANNEL	3,400	(4)	USING HEC–2 ANALYSIS
5	PIKES PEAK AVENUE	DOUBLE–12'X 6' CBC	NATURAL	1,824	(5)	INLET CONTROL, HW/D=1.7
4	BIJOU STREET	TRIPLE–8'X 5' CBC	CONCRETE LINED CHANNEL	1,972	(4)	MANNINGS,D=4.9',S=1.0%
3	PLATTE AVENUE (S.H. 24)	10'X 8' CBC	UNDERGROUND STORM SEWER	2,610		MANNINGS,D=7.9',S=2.5%

DESIGN POINT	TRIBUTARY CHANNEL CROSSING	EXISTING IMPROVEMENT	UPSTREAM IMPROVEMENT	CAPACITY (CFS)		REMARKS
6B	BIJOU STREET	DOUBLE–8'X 5' CBC	CONCRETE LINED CHANNEL	1,315		MANNINGS,D=4.9',S=1.0%
6A/6B	PIKES PEAK AVENUE	DOUBLE–8'X 4' CBC	CONCRETE LINED CHANNEL	1,190		MANNINGS,D=3.9',S=1.5%
6C	PLATTE AVENUE	2– 8'x 3' CBC	UNDERGROUND STORM SEWER	650		MANNINGS,D=2.9',S=1.0%
6A	ACADEMY BLVD.	DOUBLE–10'x 4' CBC	UNDERGROUND STORM SEWER	1,303	(4)	MANNINGS,D=3.9',S=1.0%
10B	AIRPORT ROAD	14'–4"X 4'–4' CSP ARCH	UNDERGROUND STORM SEWER	400+/–	(3)	UPSTREAM CAPACITY, SILTED
12A	VERDE DRIVE	TRIPLE–54" CMP	CONCRETE LINED CHANNEL	380	(3)	INLET CONTROL, HW/D=1.5
13A	FOUNTAIN BLVD.	60" RCP	CONCRETE LINED CHANNEL	450	(6)	FULL PIPE FLOW, S=3.0%

(1) UNDER CAPACITY, MARGINAL – TO REMAIN
(2) UNDER CAPACITY – REPLACED BY CDOT PROJECT
(3) UNDER CAPACITY – MUST BE REPLACED
(4) UNDER CAPACITY – PROVIDE ADDITIONAL STRUCTURE
(5) UNDER CAPACITY – TO REMAIN AS FUTURE POND OUTLET
(6) UNDER CAPACITY – OUTLET FACILITY REQUIRED

IV. PROPOSED ALTERNATIVE SOLUTIONS

A. OVERVIEW

The analysis of alternatives for the basinwide study is organized into the following three sections:

The Main Channel of Spring Creek
Major Tributaries of Spring Creek
Existing Underground Systems

Existing underground systems were analyzed to see what type of upgrade is required in areas where there have been flooding problems. The main channel and major tributaries were analyzed by channel reach based on results of the basin inventory, community values for that reach, feasible alternatives, and environmental consequences of each alternative. This process is shown graphically on Figure 21. The community values for each reach include twelve factors that affect the selection of channel alternatives. These factors were then grouped into four general categories to compare the results for each channel reach. The factors and general categories considered are as follows:

COST
- ECONOMICS
- EMPLOYMENT
- WATER SUPPLY
- OWNERSHIP

SAFETY
- FLOOD HAZARD
- PUBLIC SAFETY
- EROSION/DEPOSITION
- LAND USE

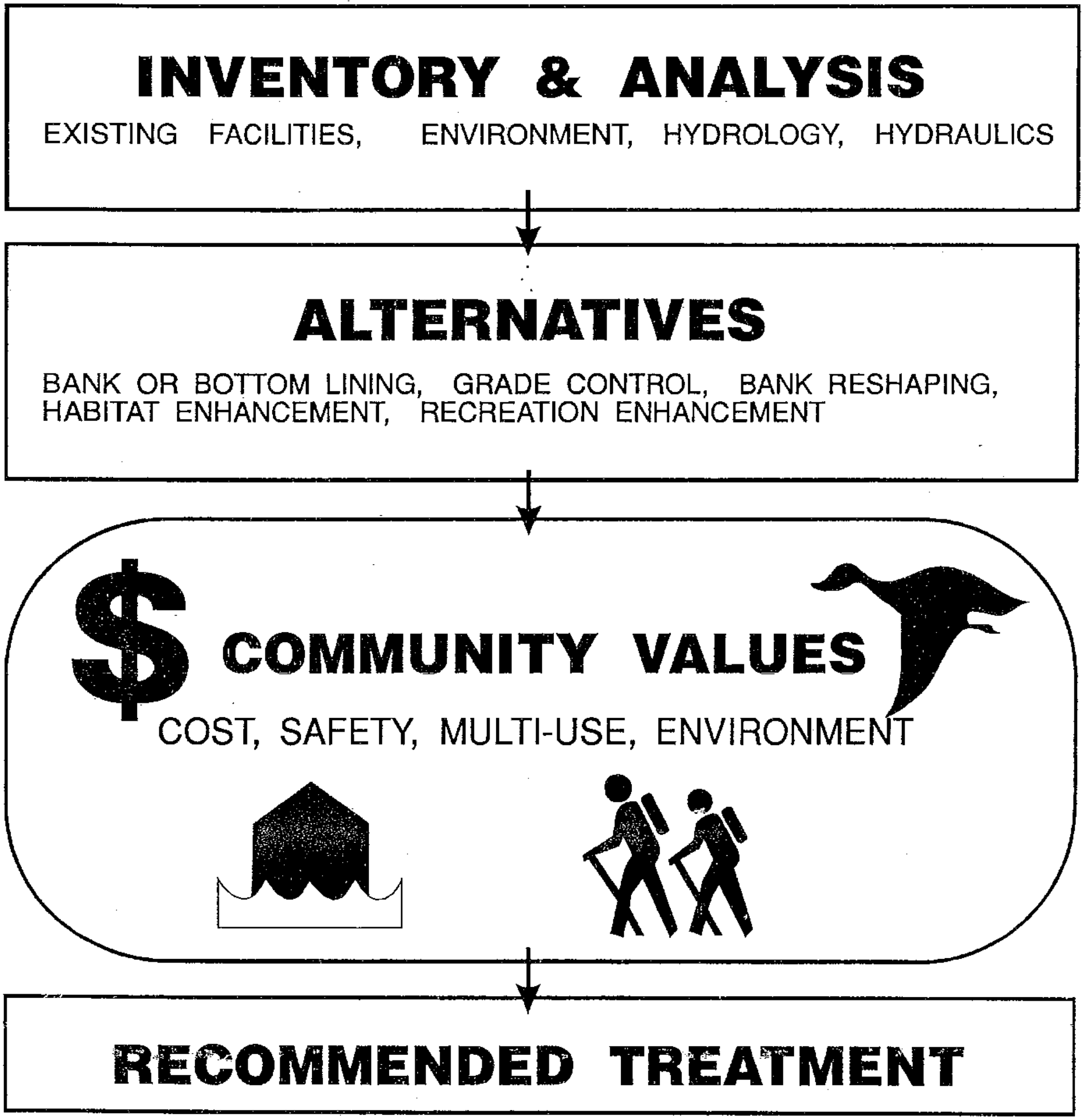
MULTI-USE
- AESTHETICS
- CULTURAL VALUES
- RECREATION
- FLOODPLAIN VALUES

ENVIRONMENT
- CONSERVATION
- WATER QUALITY
- WETLANDS
- WILDLIFE

SPRING CREEK DBPS

PROCESS FOR SELECTING ALTERNATIVES

FIGURE 21



To ensure consistency in rating the value of these factors, the following definitions were used for each factor:

COST

ECONOMICS - The relative cost of construction and maintenance for potential improvements. This considers how the existing physical constraints affects proposed improvements. A high rating means that there are significant physical constraints (i.e. - existing buildings, roadways, or other facilities) that limit the number of feasible alternatives. A low rating would mean that there are no significant physical constraints present.

EMPLOYMENT - The potential for providing jobs on the property adjacent to the location studied. This considers if the adjacent land uses provide opportunities for employment within the community. A high rating means that the adjacent land uses are higher density commercial, office, or manufacturing land uses which provide employment for the community. A low rating would mean that there are residential or park/open space adjacent land uses which do not provide employment for the community.

WATER SUPPLY - The opportunities for recharging and/or discharging water sinks and/or sources. This includes water in Fountain Creek and groundwater.

OWNERSHIP - The relative cost of land acquisition for the location studied. The cost of land is directly related to land uses with higher densities getting a higher rating and lower densities getting a lower rating.

SAFETY

FLOOD HAZARD - The existing and future potential for damages to property in the location studied if no improvements are made. Locations of buildings, parking lots, and other structures were considered for this parameter. Also considered is the existing flooding potential for the location. Higher ratings mean that the potential damages are higher and lower ratings mean that the potential for damages are lower.

PUBLIC SAFETY - The existing and future risk for injury to people in the location studied. Locations of areas of significant activities or gatherings of people were considered for this parameter. Also considered is the severity of flooding for the location. Higher ratings mean that the potential for injury are higher and lower ratings mean that the potential for injury is lower.

EROSION/DEPOSITION - The existing potential for erosion and/or deposition of sediment in the location studied. The erodibility of the soils and visual evidence of past erosion/deposition for the location were considered. Higher ratings mean that there is significant evidence of past problems and/or the potential for this to occur is high. Lower ratings mean that the location is relatively stable when considering all factors including soil types, vegetation, and slopes.

LAND USE - The importance of the effects of flooding on development in the location studied. The relative severity of damages to adjacent land is included. Land uses are from existing zoning and master plans in the basin. A high value indicates that flooding would be damaging to existing uses such as where there are buildings. A low value indicates flooding would not be damaging to existing use such as where there is open space.

MULTI-USE

AESTHETICS - The relative value of the appearance of the drainage system and how well it fits into the surrounding uses. Visibility of the drainage system from adjacent roadways, parks, trails, or development is considered. Locations with natural diverse, dense, and/or interesting features received higher ratings. Locations that are hidden from view and/or already fully lined would have a lower rating.

CULTURAL VALUES - The values of passive uses of the drainage system for the community. The importance of the drainage system being a community amenity is considered. Locations of historical or archeological significance are also considered. A high value indicates the presence of historical, archeological, and/or watchable wildlife in the location. A low value indicates an absence of these features.

RECREATION - Active recreational uses of the drainage system for the community are considered. Active parks, trails, ballfields, golf courses, etc. would be considered high ratings for active recreational uses.

FLOODPLAIN VALUES - The importance of opportunities for multiple uses of the drainage system. Planned parks, open space, and trails in the location all would result in a higher rating for the location. Locations where the channel and floodplain area are already fully built out in limited right-of-way were rated lower.

ENVIRONMENT

CONSERVATION - The relative importance of preserving the existing environment for the location studied. A high rating indicates that the existing environment is unique and/or it is difficult to mitigate any losses. A low rating indicates that the existing environment is not significant such as when there is already existing concrete lined channels.

WATER QUALITY - The opportunities available to enhance downstream water quality. A high rating indicates that significant opportunities are still available to enhance the water quality. A low rating indicates that there are limited opportunities available to enhance the water quality.

WETLANDS - The relative importance of existing hydrophytic vegetation. A significant amount of wetlands present would result in a high rating. If little or no wetlands are present then a low rating would be the result.

WILDLIFE - The relative importance of existing wildlife corridors for the location studied. If the location has a significant diversity of wildlife and habitat the result would be a high rating. Areas with little or no wildlife present received a low rating.

The analysis of alternatives was organized by reach or detention pond location. Each reach has all of the evaluation parameters presented consecutively prior to proceeding to the next reach. This enables the reader to get an overview of what is important for that particular reach prior to proceeding to the next reach. The reaches are organized from downstream to upstream. Our preliminary recommendations are presented in Section V in the same format as this section. Generally, the channel alternatives considered are as follows:

Soft Bank Lining	-	Use vegetation to protect banks
Hard Bank Lining	-	Use buried riprap or concrete to protect banks
No Bank Lining	-	Leave the bank as it is currently
Soft Bottom Lining	-	Use vegetation to protect bottom of channel
Hard Bottom Lining	-	Use buried riprap or concrete to protect bottom of channel
No Bottom Lining	-	Leave the bottom of channel as it is currently
Grade Control	-	Use drop structures or cutoff walls to reduce channel slopes and velocities
Bank Reshaping	-	Reshape bank to flatten side slope

In the case of channels that are already severely constrained by existing buildings and development, the choices were more limited. Alternatives in these cases were considered based on what is feasible within the existing constraints. Detention pond alternatives also were limited to what is feasible for the locations studied. At the end of this Section, prior to the Recommendations Section, sketches (Figures 56 through 63) showing the channel alternatives graphically are included to clarify what was considered.

B. MAIN CHANNEL

1. REACH 16-14 FROM FOUNTAIN CREEK TO UNION BLVD.

a. Description of Existing Characteristics

The existing channel is natural with some improvements at the bridges for Las Vegas Street, the railroad tracks, and Hancock Expressway. The bridge at Las Vegas Street has a 30 foot span and a maximum depth of 15 feet. The bridge is currently experiencing downcutting and the County would like to stabilize this situation. The railroad bridge has a 61 foot span, a maximum depth of 13 feet, and three piers, each two feet wide. The bridge at Hancock Expressway has a 75 foot span, a maximum depth of 19 feet, and two piers 0.8 feet wide. The U.S. 24 Bypass also crosses Spring Creek at this location but does not affect the flows since it bridges over the Hancock bridge. The channel bottom varies from 20 to 50 feet, the depth is from 8 to 16 feet, and the side slopes vary from 1.5:1 to 3.5:1. The channel longitudinal slopes are from 0.6% to 2.5%, with overall slopes of 1.2% downstream of Hancock and 0.9% upstream of Hancock.

The existing soils are sandy resulting from alluvial deposits and are highly erodible. The vegetation consists of riparian grasslands which are made up of grasses and shrubs along the channel bottoms. There is some mature riparian forest above the channel bottom near Union Blvd. The area is mostly undeveloped ground and future land uses are projected to be industrial or commercial areas outside of the Fountain Creek Flood Plain.

b. Constraints

The existing channel and bridge capacities are marginal to under capacity for the 100-year design storm. With future upstream detention to reduce the flows, the railroad and Hancock Expressway bridges are probably adequate. The Las Vegas Street bridge has a much smaller opening than the upstream bridges and is probably not adequate. The channel capacities with detention have some sections able to carry the flows and some areas still being under capacity. The channel velocities are high for the 100-year storm and range from 12 to 17 feet per second. This greatly exceeds the allowable velocities for this type of soil and vegetation.

The high velocities point out the need to flatten the channel slopes in this reach. This has caused the existing vertical erosion, therefore, some type of grade control needs to be provided in this reach to control the vertical degradation near the bridges and bank erosion if hard lining is not used. The current channel is not wide enough to contain the 100-year flow in some locations, so the cross section or right-of-way would have to be wider in these locations to accommodate the design flow for this reach.

This reach of channel is one of the few remaining natural channel settings in the basin. Concerns were expressed in the coordination meetings on how any regrading or channel protection would affect the existing riparian habitat. These concerns are of particular concern for this reach and point towards minimizing the amount of channel improvements and resulting disruption of the existing habitat.

c. Community Values

The community values determined for this reach are presented on Figure 22. The most important community value factor for this reach was determined to be the environment. Not too far behind were cost and multi-use with safety ranking last. With largely undeveloped ground and a fairly natural setting it is not difficult to see why the environment and multi-use had high rankings. Due to the many important transportation links in this reach, cost was also a consideration. The property adjacent to this reach is under private ownership but has been master planned. Upstream of Hancock Expressway, a park/open space area is planned on the east side between the channel and the U.S. 24 Bypass.

d. Alternatives Considered

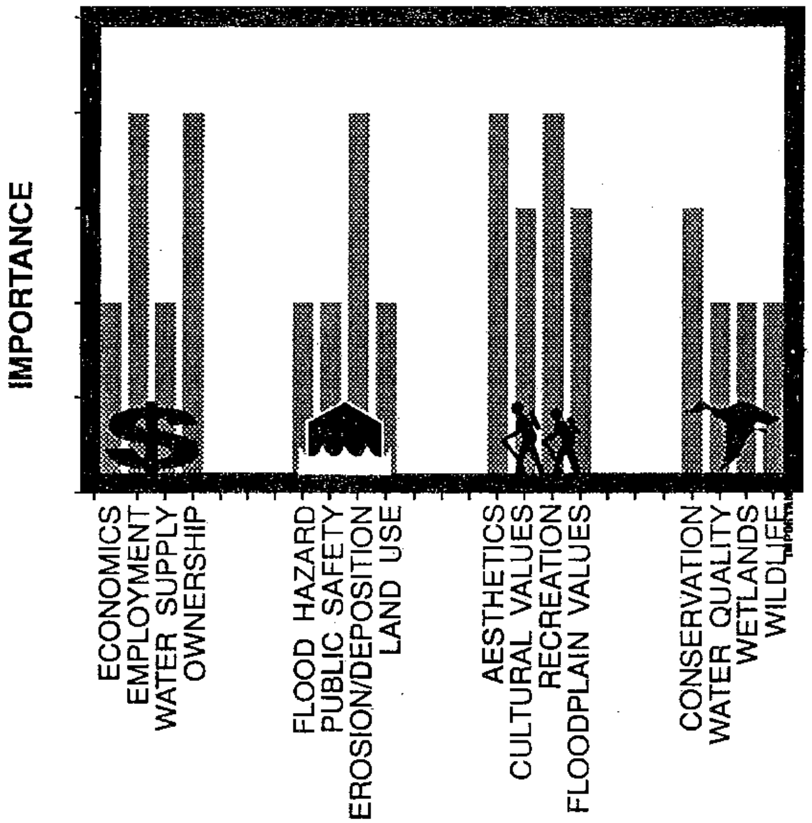
The alternatives were selected from a wide range of possible alternatives. From this range of possible alternatives, the list was narrowed down to the following alternatives:

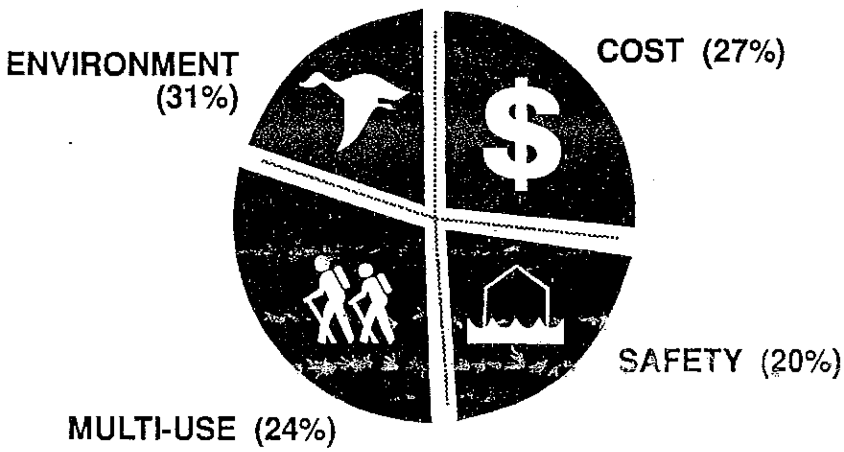
Soft Bank Lining	-	Use vegetation to protect banks
Hard Bank Lining	-	Use buried riprap or concrete to protect banks
No Bank Lining	-	Leave the bank as it is currently
Soft Bottom Lining	-	Use vegetation to protect bottom of channel
No Bottom Lining	-	Leave the bottom of channel as it is currently
Grade Control	-	Use drop structures or cutoff walls to reduce channel slopes and velocities
Bank Reshaping	-	Reshape bank to flatten side slope

An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 23. The following alternative was not considered further for the reason noted:

Hard Bottom Lining - There is no practical location to mitigate the damages to the environment in this reach.

SPRING CREEK DBPS
COMMUNITY VALUES
FOUNTAIN CREEK TO UNION BLVD.
FIGURE 22





ENVIRONMENTAL EVALUATION

FIGURE 23 - FOUNTAIN TO UNION BLVD. - Sheet 1 of 2

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS		ACRES	PERCENT		ACRES	PERCENT
	1. Structural or Upland	3.0	5	4. Riparian Grassland	42.1	64
	2. Open Water	0	0	5. Herbaceous Wetland	0	0
	3. Mature Riparian Forest	20.6	31	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
Soft Bank Lining	0.9 Acres of Mature Riparian Forest. 1.7 Acres of Riparian Grassland.	No net loss.	On site replacement of wetland vegetation and/or riparian habitat lost during construction using native plant materials.
Hard Bank Lining	3.6 Acres of Mature Riparian Forest. 1.7 Acres of Riparian Grassland.	1.4 Acres of Mature Riparian Forest. 1.7 Acres of Riparian Grassland.	No on site mitigation. Off site mitigation and/or bottom enhancement required.
No Bank Lining	None.	Major- Natural erosion will widen and incise channel causing loss of most vegetation.	Not applicable.
Soft Bottom Lining	0.2 Acres of Mature Riparian Forest. 0.1 Acres of Riparian Grassland.	No net loss.	On site replacement of wetland vegetation and/or riparian habitat lost during construction using native plant materials. Could be an opportunity to mitigate other items through enhancement of bottom.
No Bottom Lining	None.	Moderate- Natural erosion will widen and incise channel causing loss of some vegetation.	Not applicable.

ENVIRONMENTAL EVALUATION

FIGURE 23 - FOUNTAIN TO UNION BLVD. - Sheet 2 of 2

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS

	ACRES	PERCENT		ACRES	PERCENT
1. Structural or Upland	3.0	5	4. Riparian Grassland	42.1	64
2. Open Water	0	0	5. Herbaceous Wetland	0	0
3. Mature Riparian Forest	20.6	31	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
Grade Control	0.1 Acres of Mature Riparian Forest. 0.1 Acres of Riparian Grassland.	Permanent vegetation only lost at drop structure (less than .1 acres total).	Areas lost to drop structure mitigated through enhanced wetlands behind drop structures.
Bank Reshaping	0.9 Acres of Mature Riparian Forest. 0.1 Acres of Riparian Grassland.	No net loss for soft lining with bank reshaping.	On site mitigation provided with soft lining of banks using native vegetation.
		0.9 acres of Mature Riparian Forest and 0.1 acres of Riparian Grassland lost for hard lining with bank reshaping.	Off-site mitigation or enhancement of channel bottom required for hard lining of banks.

2. REACH 14-12 FROM UNION BLVD. TO CIRCLE DRIVE

a. Description of Existing Characteristics

The existing channel was natural when this study was initiated. The channel bottom varies from 30 to 70 feet and the side slopes are very steep with some near vertical sections. The average channel longitudinal slope is 1%. Currently, the existing channel has changed considerably due to construction of the U.S. 24 Bypass as described below.

The existing soils are fine alluvial deposits with some Pierre Shale outcrops. The vegetation consists of bare areas or riparian grasslands which are made up of grasses and shrubs along the channel bottoms. The area is mostly undeveloped ground and future land uses are projected to be multi-family or commercial areas outside of the ROW for the U.S. 24 Bypass project.

b. Constraints

The Colorado Department of Highways has proposed facilities as part of the U.S. 24 bypass project. The capacity of these facilities is less than the 100-year flow through design storm for this basin. The flows are higher in this study due to different design assumptions used in the hydrology calculations. This study is looking at detention upstream of Circle Drive in order to meet the capacity limitations for the drainage improvements on the bypass project. In addition, the backwater produced by the culvert at Union Blvd. for the U.S. 24 bypass project, creates in effect some reduction in peak flow downstream of Union Blvd (although not designed as a true detention pond with an overflow spillway).

c. Community Values

The community values determined for this reach are presented on Figure 24. The most important community value factors for this reach were determined to be cost and safety. Not too far behind was multi-use with the environment ranking last. This ranking was due to the location of the U.S. 24 Bypass project, a critical east/west transportation link for Colorado Springs.

d. Alternatives Considered

This reach of channel is currently under construction as part of the U.S. 24 Bypass project which has final designs completed and an approved individual Section 404 permit. This reach is entirely within the CDOT right-of-way. It will consist of a double 13 foot by 10 foot concrete box culvert at Union Blvd., a new wetland habitat area upstream of Union Blvd, and a 1300 foot long, double 12 foot by 12 foot concrete box culvert to Circle Drive as part of this project. Since the work is already underway, no alternatives are being considered for this section of Spring Creek.

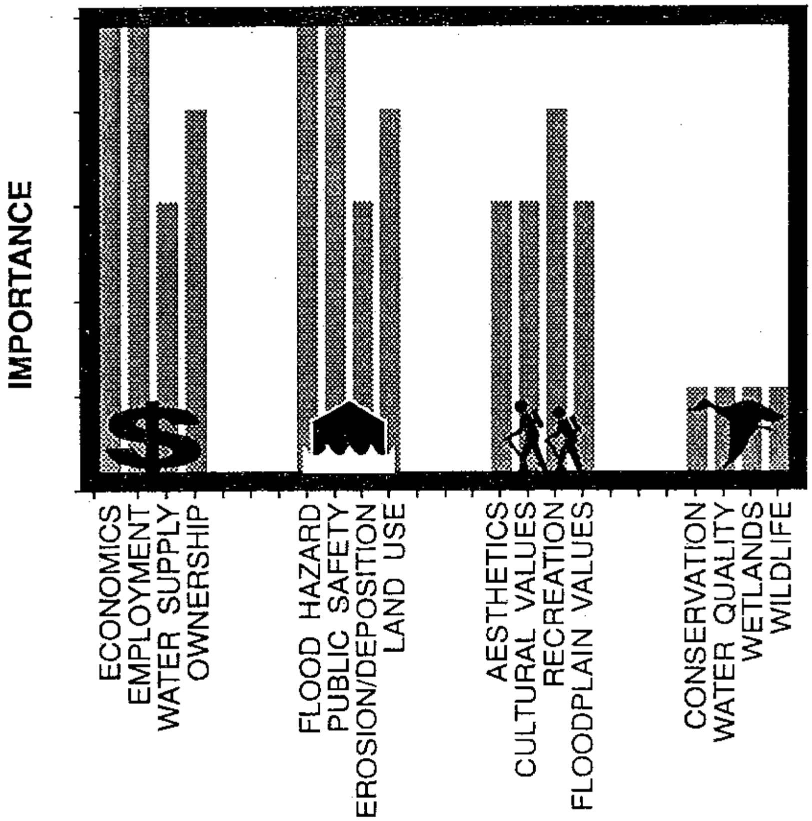
An evaluation of the environmental disturbance, losses, and mitigation required in the individual Section 404 permit is shown on Figure 25.

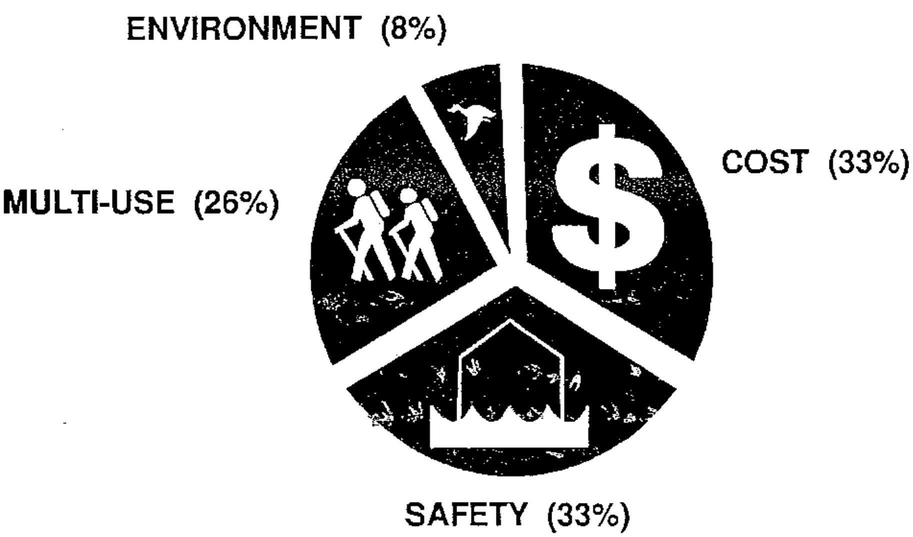
SPRING CREEK DBPS

COMMUNITY VALUES

UNION BLVD. TO CIRCLE DRIVE

FIGURE 24





ENVIRONMENTAL EVALUATION

FIGURE 25 - UNION BLVD. TO CIRCLE DRIVE

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS

	ACRES	PERCENT
1. Structural or Upland	0	0
2. Open Water	1	9
3. Mature Riparian Forest	2	18
4. Riparian Grassland	6	55
5. Herbaceous Wetland	1	9
6. Emergent Wetland	1	9

TREATMENT	IMPACT: DISTURB	IMPACT: LOSS	MITIGATION OPPORTUNITIES
Already Under Construction as Part of U.S. 24 Bypass Project	Major- Approximately 0.5 acres of willow shrub wetland, 0.5 acres of cottonwood/willow riparian habitat and 2.75 acres of cottonwood riparian habitat removed during construction. Note: These areas and mapping units are from the Individual Section 404 Permit for the U.S. 24 Bypass Project.	Minor - Individual Permit states 1:1 replacement	In kind mitigation at 1:1 replacement is proposed at the northeast side of the interchange for the U.S. 24 Bypass and Union Blvd.

3. REACH 12-10 FROM CIRCLE DRIVE TO VALLEY HI LAKE

a. Description of Existing Characteristics

The existing channel in this reach is fully concrete lined. The Circle Drive crossing is a double 10 foot by 6 foot concrete box culvert. It is a trapezoidal concrete lined section between Circle Drive and Fountain Blvd. The Fountain Blvd. crossing is a rectangular bridge with a 31 foot span and 10 foot depth. It is a rectangular concrete lined section upstream of Fountain Blvd. The existing trapezoidal concrete lined channel between Circle and Fountain has a 36 foot bottom width, a 10 foot depth, and 1.5:1 side slopes. The channel upstream of Fountain Blvd. is a rectangular concrete lined channel 22 feet wide and 10 feet deep. A concrete roof has been built on this channel for a significant portion of its length to accommodate a parking lot for the previous commercial use. The existing soils consist alluvial deposits, Pierre Shale, and manmade fills. Since the channel is fully lined there is no vegetation in the channel. The area is fully built out with commercial land uses on the downstream side of this reach and the Valley Hi Golf Course on the upstream side.

b. Constraints

The existing Circle Drive crossing and channel upstream of Fountain Blvd. are inadequate to pass the 100-year design storm. The bridge under Fountain Blvd. and the channel segment between Circle Drive and Fountain Blvd. need adequate upstream improvements and minor modifications to pass the 100-year design storm. Even with detention, the limiting segments are still not adequate to carry the peak flow. A significant amount of flooding has occurred at the Circle/Fountain intersection.

c. Community Values

The community values determined for this reach are presented on Figure 26. The most important community value factor for this reach was determined to be cost. Not too far behind were safety and multi-use with the environment ranking last. Since this channel is already fully lined with development right up to the channel cost, safety, and multi-use are very important.

d. Alternatives Considered

The alternatives were selected considering what is feasible within the existing constraints. This list includes the following alternatives:

Expand capacity of the existing fully lined open channel
Replace this segment with a concrete box culvert

Many of the alternatives had to be eliminated from consideration. Between Circle Drive and Fountain Blvd. the soft lining or no lining alternatives are not feasible due to the existing commercial development and parking lot around the existing channel. Upstream of Fountain Blvd. the soft lining or no lining alternatives do not seem feasible due to the existing grounding and guy wires for the radio transmission tower and other constraints on the Valley Hi Golf Course.

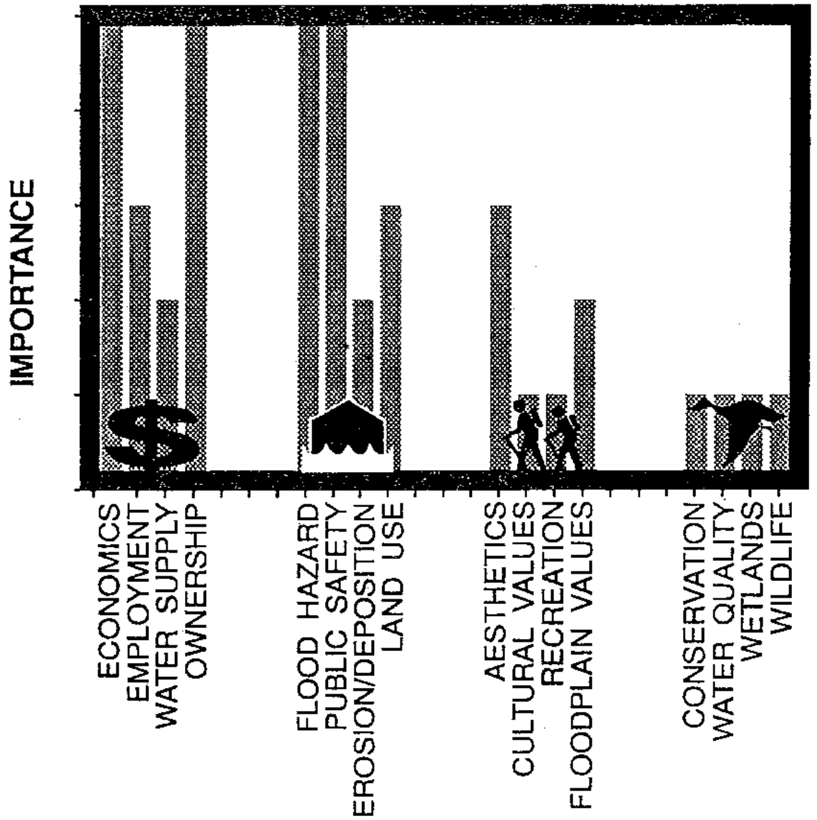
An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 27.

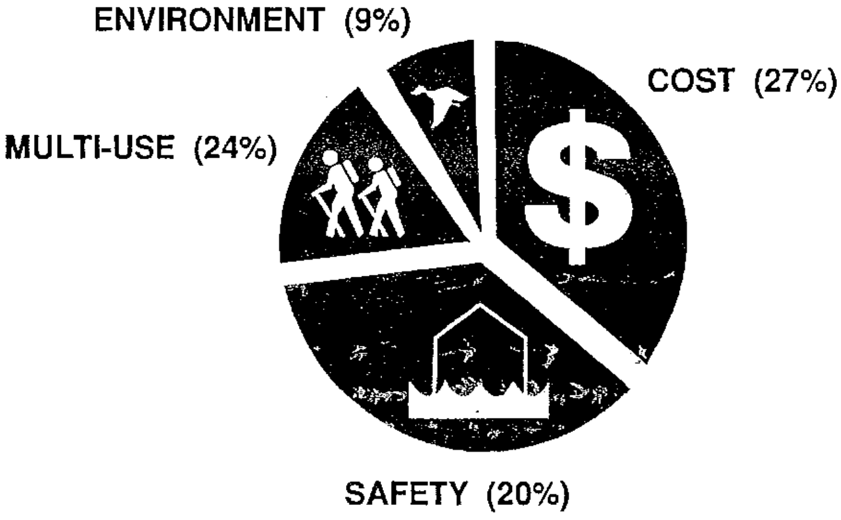
SPRING CREEK DBPS

COMMUNITY VALUES

CIRCLE DRIVE TO VALLEY HI LAKE

FIGURE 26





ENVIRONMENTAL EVALUATION

FIGURE 27 - CIRCLE DRIVE TO VALLEY HI LAKE

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS

	ACRES	PERCENT		ACRES	PERCENT
1. Structural or Upland	3.0	100	4. Riparian Grassland	0	0
2. Open Water	0	0	5. Herbaceous Wetland	0	0
3. Mature Riparian Forest	0	0	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
No Action	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable. No opportunities available to create wetlands or habitat due to space limitations.
Expand Capacity - Hard Lined Sides & Bottom	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable. No opportunities available to create wetlands or habitat due to space limitations.
Replace with Concrete Box Culvert	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable. No opportunities available to create wetlands or habitat due to space limitations.

4. DESIGN POINT 10 — VALLEY HI LAKE

a. Description of Existing Characteristics

The Valley Hi Lake is a manmade lake with a concrete lined overflow spillway. The maximum elevation of the dam embankment is 50.2, the spillway crest used for analysis was Elev. 45.0, and the lowest point downslope of the pond is 36.6. These elevations were obtained from the topographic maps used for the overall study for consistency. It should be noted that a survey of the spillway crest was performed by the City which indicates a slightly lower existing spillway elevation. Final design of this facility requires a more detailed survey of the dam and spillway. The actual existing elevations and datum used needs to be verified during final design. The dam and resulting lake were constructed by the private Pikes Peak Golf Club owners prior to acquisition by the City Parks Department in October, 1980. Since there is a gated outlet, which is normally closed, the lake has a permanent water level at the elevation of the spillway crest. The Colorado State Engineer's files do not indicate any record of this dam. The lake has collected a significant amount of silt from the upstream part of the basin. As a result, it is fairly shallow in most places and has a significant diversity of birds and wildlife present. The wetlands around the permanent pool consists of emergent wetlands. This area is used by local bird watchers who have logged a significant number of different species present in this area.

b. Constraints

The overall basin has very limited land area available for providing detention ponds due to the amount of development that has already occurred in the basin. This is one of the few locations left where it is feasible to locate a detention pond. However, the permanent lake currently does not have the volume above the spillway or spillway capacity to safely detain and pass the 100-year design storm. Even smaller storms have overtopped the dam in the past and washed out parts of it. Even assuming the dam does not fail, the pond does not have the volume to significantly reduce the peak flows for the basin. There is also a problem with the buildings to the south of the lake since they are built with the main floor elevations nearly the same as the top of the dam and could flood when a significant amount of runoff occurs. Serious flooding has occurred at the intersection of Fountain Blvd. and Circle Drive due to the overtopping of the dam.

c. Community Values

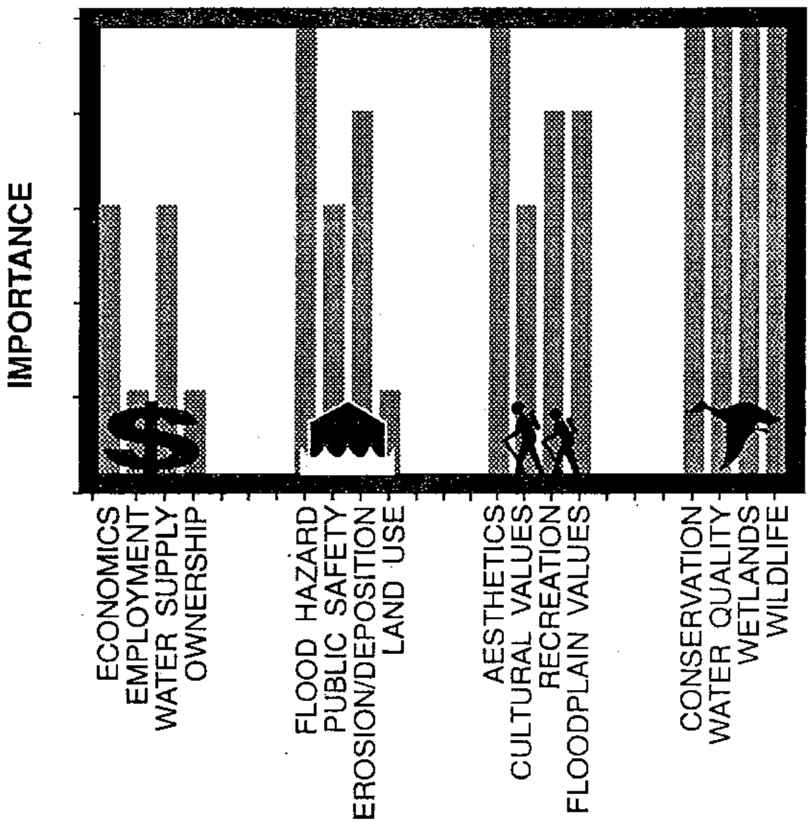
The community values determined for this location are presented on Figure 28. The most important community value factor for this reach was determined to be the environment. Not too far behind were safety and multi-use with cost ranking last. The wildlife habitat that the lake provides is a very important consideration. However, safety and multi-use still play a major role since failure of the dam could endanger downstream property/people and the lake is on the golf course.

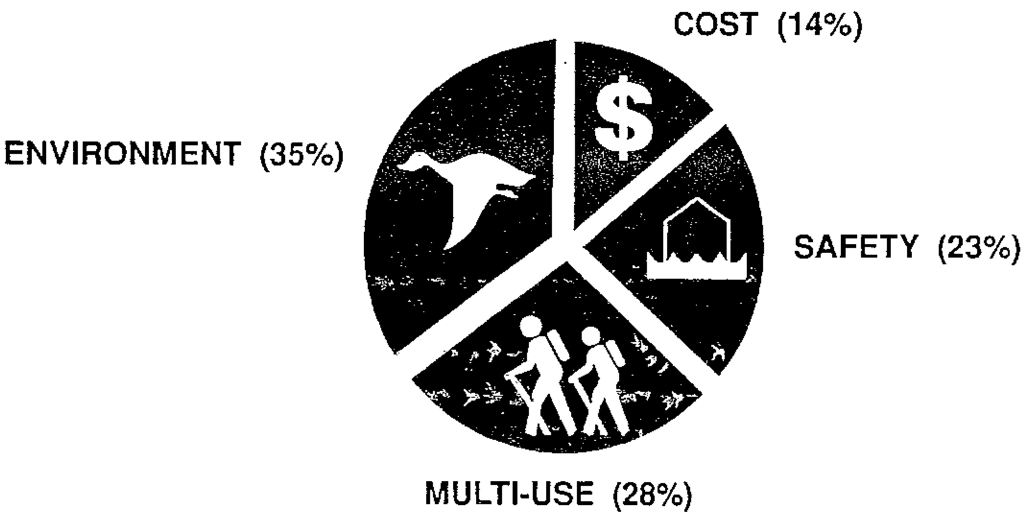
d. Alternatives Considered

This site appears to be a viable location for an improved detention pond since some detention benefit is already provided. There are several options available for this area. It is desirable to use this lake as a detention facility to reduce the peak flows to the limiting capacity downstream of Circle Drive. Alternatives are to increase the spillway capacity along with raising the dam, increase the spillway capacity while lowering the bottom of the spillway, or increase the spillway capacity and tolerate less than the desired freeboard while maintaining the same spillway elevation. One of these alternatives is needed to reduce the downstream flows to an acceptable level and to avoid overtopping the existing dam. This should be done with the consideration that some permanent pool may be retained for wildlife habitat.

Several variations of these alternatives were analyzed for the detention pond at Valley Hi Lake. Variations of the second alternative considers lowering the spillway by different amounts and see how the pond operates during the 100-year design storm. This location is constrained by how much water you can pass out of the emergency spillway without modifying the existing bridge at Fountain Blvd. and replacing the conveyance structure between Fountain Blvd. and the pond. An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 29.

SPRING CREEK DBPS
COMMUNITY VALUES
VALLEY HI LAKE DETENTION POND
FIGURE 28





ENVIRONMENTAL EVALUATION

FIGURE 29 - VALLEY HI LAKE DETENTION POND

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS		ACRES	PERCENT		ACRES	PERCENT
	1. Structural or Upland	3	13	4. Riparian Grassland	4	17
	2. Open Water	5	22	5. Herbaceous Wetland	1	4
	3. Mature Riparian Forest	0	0	6. Emergent Wetland	10	44

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
Raise Dam	.3 Acres Emergent Wetlands	No net loss.	On site replacement of wetland vegetation and/or riparian habitat lost during construction using native plant materials. Potential opportunity to enhance the bottom with wetlands vegetation to mitigate for another site.
Spillway Reconstruction Establish Low Flow Channel	Short term disturbance during construction of 5 acres +/-. Long term disturbance would be minimal.	Minor- There would be some loss of open water and sand bar. An increase in Riparian weltand due to transformation of existing emergent wetlands.	May enhance diversity of habitat. May lose open water and fringe area wetlands which can not be mitigated.
Increase Spillway Capacity (widening)	None- No significant wetlands or habitat present.	Moderate- Potential dam overtop and/or dam failure could cause loss of vegetation and habitat due to erosion.	Potential opportunity to enhance the bottom with wetlands vegetation to mitigate for another site.
No Action	None- No significant wetlands or habitat present.	Major- Potential dam overtop and/or dam failure could cause loss of vegetation and habitat due to erosion.	Not applicable.

5. REACH 10-7 FROM VALLEY HI LAKE TO AIRPORT ROAD

a. Description of Existing Characteristics

The existing trapezoidal channel has some riprap bank lining on the sides, a natural bottom and some grade control structures. There is a crossing at Chelton Drive which consists of a quadruple 8' by 6' concrete box culvert. In addition, there are several other pipe crossings of Chelton Drive available just to the north of the box culvert. The north crossing of Chelton Drive and downstream is discussed in the major tributaries section for the northeast tributary to Valley Hi Lake. In this section we are just considering the main channel of Spring Creek. There are two channel sections being used for this reach. The first channel section, from Valley Hi Lake to Chelton Drive, has a bottom width of 40 feet and a depth of 4 feet. The second channel section, from Chelton Drive to Airport Road, has a bottom width of 34 feet and a depth of 6.5 feet. The soils consist of fine grained alluvial deposits. The vegetation in the channel is very limited. The channel is entirely contained within the Valley Hi Golf Course.

b. Constraints

The existing channel and Chelton Drive culvert crossings do not have adequate capacity to carry the 100-year design storm and Chelton Drive is frequently overtopped. The water tends to back up on the golf course upstream of Chelton Drive. It will then also cross Chelton through the golf cart crossing north of the box culverts. There is additional depth available upstream of Chelton but there is not any additional depth available downstream of Chelton. There have been complaints of flooding along the south bank and the golf course area within this reach.

c. Community Values

The community values determined for this reach are presented on Figure 30. The most important community value factor for this reach was determined to be multi-use. Not too far behind were cost and safety with the environment ranking last. The location of the channel with the golf course on one side and development on the other dictates much of the ranking for this reach. The environment is ranked low because there is no significant wetlands or wildlife habitat present.

d. Alternatives Considered

The alternatives were selected from a wide range of possible alternatives. From this range of possible alternatives, the list was narrowed down to the following alternatives:

Soft Bank Lining	-	Use vegetation to protect banks
Hard Bank Lining	-	Use buried riprap to protect banks
Soft Bottom Lining	-	Use vegetation to protect bottom of channel
No Bottom Lining	-	Leave the bottom of channel as it is currently
Grade Control	-	Use drop structures or cutoff walls to reduce channel slopes and velocities
Bank Reshaping	-	Reshape bank to flatten side slope

An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 31. The following alternatives were not considered further for the reasons noted:

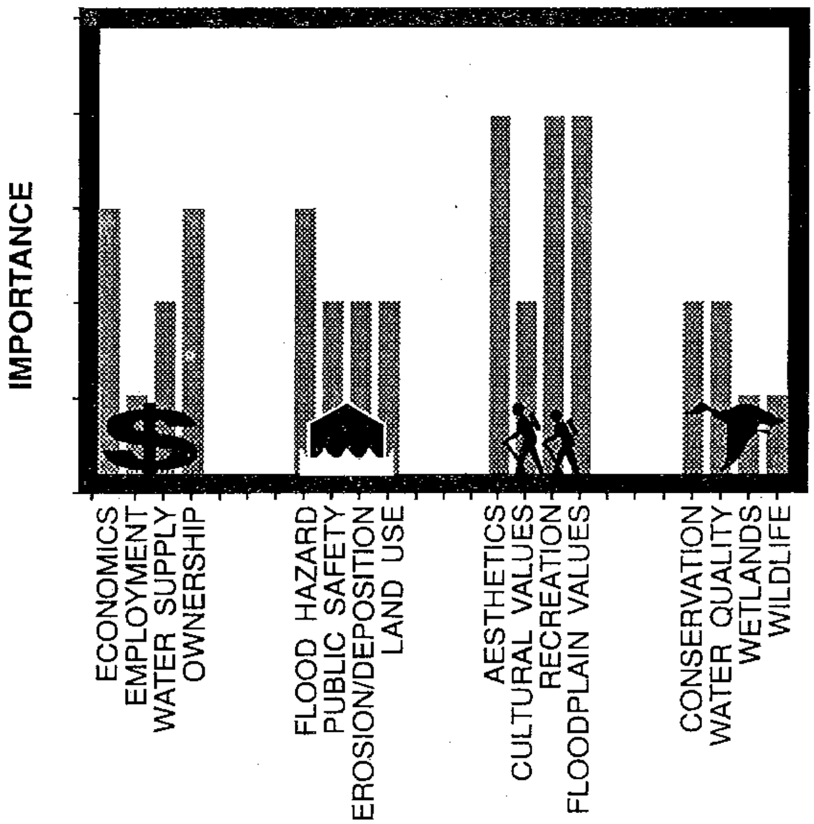
No Bank Lining	-	N/A since the bank is already lined in some locations
Hard Bottom Lining	-	Not required due to moderate velocities

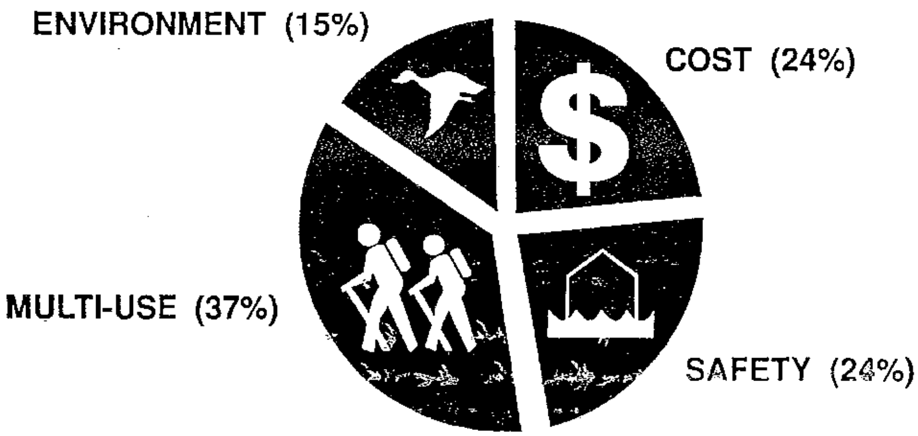
SPRING CREEK DBPS

COMMUNITY VALUES

VALLEY HI LAKE TO AIRPORT RD.

FIGURE 30





ENVIRONMENTAL EVALUATION

FIGURE 31 - VALLEY HI LAKE TO AIRPORT RD.

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS	ACRES	PERCENT		ACRES	PERCENT
1. Structural or Upland	6	100	4. Riparian Grassland	0	0
2. Open Water	0	0	5. Herbaceous Wetland	0	0
3. Mature Riparian Forest	0	0	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
Soft Bank Lining	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Potential opportunity to enhance the bank with wetlands vegetation to mitigate another site.
Hard Bank Lining	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable.
Soft Bottom Lining	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Potential opportunity to enhance the bank with wetlands vegetation to mitigate another site.
No Action	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable.
Grade Control	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Potential opportunity to enhance the bank with wetlands vegetation to mitigate another site.
Bank Reshaping	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Potential opportunity to enhance the bank with wetlands vegetation to mitigate another site.

6. REACH 7-6 FROM AIRPORT ROAD TO RED WING BIRD SANCTUARY

a. Description of Existing Characteristics

The existing channel banks are concrete lined in this reach. The concrete box culvert at Airport Road consists of two 13 foot by 5 foot cells and one 18 foot by 5 foot cell. The bare channel bottom is 43 feet wide and 5.5 feet deep and the side slopes are 1.5:1. The channel longitudinal slope is 0.7%.

The existing soils are fine grained alluvial deposits and some Pierre Shale outcrops. The channel sides are concrete lined and the bottom is unlined with no vegetation in the channel. The area is developed on the east side of the channel and undeveloped on the west side. It has commercial land uses adjacent to the channel.

b. Constraints

The existing concrete channel and Airport Road bridge capacities are under capacity for the 100-year design storm assuming adequate freeboard in the channel. However, the channel will carry the flow without overtopping. Extreme erosion is occurring immediately downstream of the Airport Road crossing. The Airport Road crossing should have adequate capacity with an improved transition on the upstream side of the crossing. The channel velocities are high for the 100-year storm and range from 18 to 23 feet per second. The upstream end of the channel is currently eroding behind and underneath the channel lining.

c. Community Values

The community values determined for this reach are presented on Figure 32. The most important community value factors for this reach were determined to be cost and safety. Not too far behind was multi-use with the environment ranking last. Since this channel is already lined with development right up to the channel cost and safety are very important.

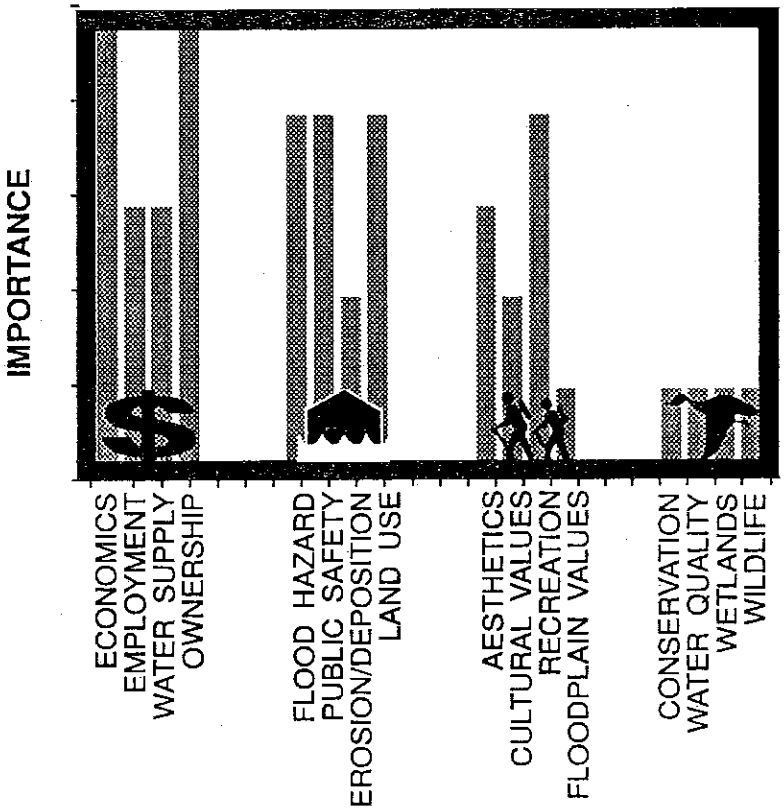
d. Alternatives Considered

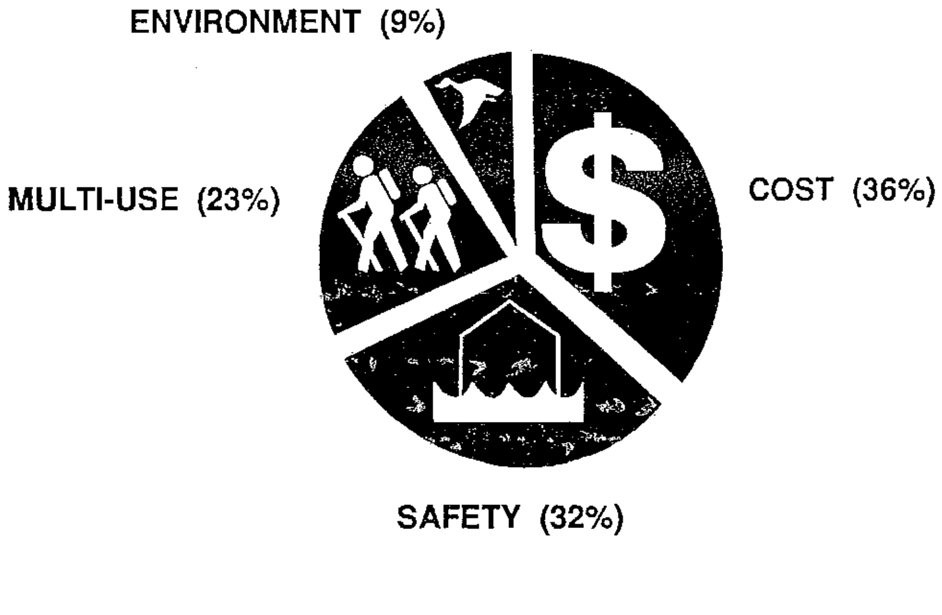
The alternatives were selected from what is feasible given the existing constraints. The alternatives considered include the following:

Expand capacity of the existing bank lined open channel with a hard lined bottom
Expand capacity of the existing bank lined open channel with a soft lined bottom
Expand capacity of the existing bank lined open channel with a bare bottom

An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 33.

SPRING CREEK DBPS
COMMUNITY VALUES
AIRPORT RD. TO REDWING SANCTUARY
FIGURE 32





ENVIRONMENTAL EVALUATION

FIGURE 33 - AIRPORT RD. TO REDWING SANCTUARY

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS

	ACRES	PERCENT		ACRES	PERCENT
1. Structural or Upland	2.0	100	4. Riparian Grassland	0	0
2. Open Water	0	0	5. Herbaceous Wetland	0	0
3. Mature Riparian Forest	0	0	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
No Action	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable.
Expand Capacity - Hard Lined Sides and Bottom	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable.
Expand Capacity - Hard Lined Sides with Soft Bottom Lining	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Potential opportunity to enhance the bottom with wetlands vegetation to mitigate for another site.
Expand Capacity - Hard Lined Sides with No Bottom Lining	None- No significant wetlands or habitat present.	None- No significant wetlands or habitat present.	Not applicable.

7. DESIGN POINT 6 DOWNSTREAM (SOUTH) SIDE OF RED WING SANCTUARY

a. Description of Existing Characteristics

The existing area is near the confluence between the main channel and east tributary of Spring Creek. The main channel has meandered a significant amount creating an oxbow on the main channel. The channel has some vegetation on the steep banks but the bottom is mostly bare soil. The lateral erosion has caused some trees to fall into the channel. The meander creates an area of some potential volume to store water temporarily in a detention facility. The existing soils are fine grained alluvial deposits overlaying Pierre Shale. It appears that the channel has eroded into the shale layer which may explain to some degree why the area has dried out from its previous marshy setting. The vegetation around the site consists of riparian forest and wetland grasses. The sanctuary is currently owned by the Audubon Society and is considered a valuable urban habitat area by the members. There are no plans to develop the area and it is expected to remain in its natural setting.

b. Constraints

The overall basin has very limited land area available for providing detention ponds due to the amount of development that has already occurred in the basin. This is one of the few locations left where it is feasible to locate a detention pond. Also, a better type of transition is needed to accelerate the flow from the natural section into the concrete lined channel downstream without eroding the natural section. This pond is located on private property, however, the Audubon Society is currently considering some type of dam at the downstream side of the sanctuary to help reduce the erosion in the sanctuary. Detention is being considered as one method to accomplish this and to reduce the vertical degradation occurring upstream. The detention site at Red Wing Bird Sanctuary is limited by the existing volume available upstream of the concrete lined channel. Any excavation to increase the volume upstream would do a significant amount of damage to the wetlands and habitat requiring extensive mitigation. Therefore, we used the existing volume available and this was not varied for alternative detention schemes.

c. Community Values

The community values determined for this location are presented on Figure 34. The most important community value factors for this location were determined to be the environment and multi-use. With considerably lower rankings were safety and cost. The wildlife habitat that the sanctuary provides is a very important consideration along with multi-use for bird watching in the sanctuary.

d. Alternatives Considered

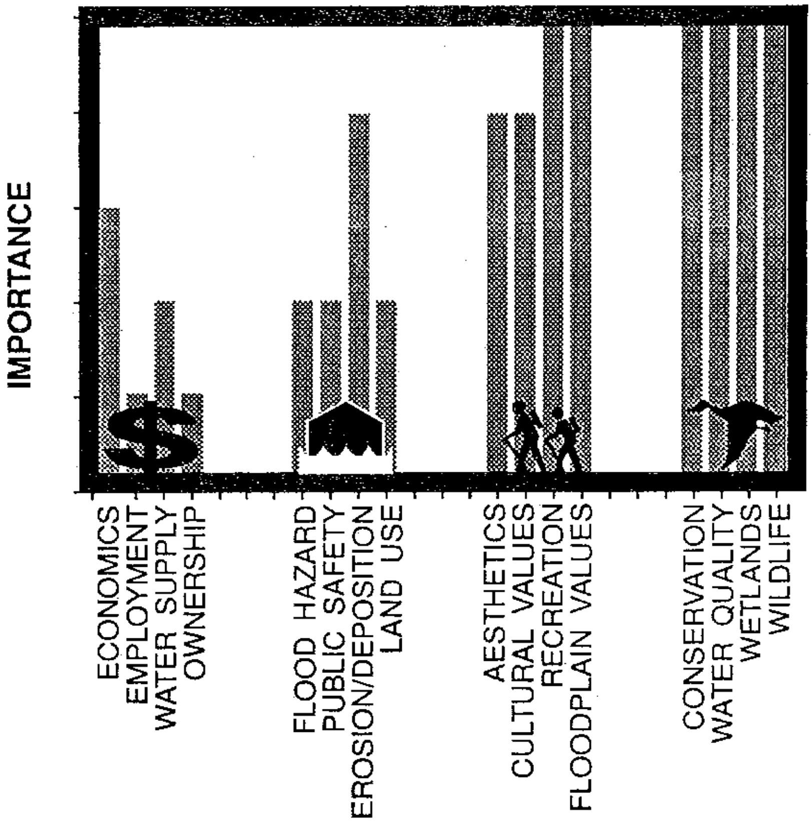
This site appears to be a viable location for a detention pond. This will be considered in order to help stop the vertical and lateral degradation that is occurring upstream. Some grade control in the lower part of the pond will aid in both flattening the upstream gradient to some degree and to slowing erosive velocities. The backup of water in the pond during larger storms will also tend to flatten the gradient upstream and will increase the hydraulic head downstream in the concrete channel section therefore better utilizing the downstream channel capacity. It was assumed that an overflow type spillway with a low flow outlet be used to limit the outflows to what is attainable and to transition into the existing concrete lined channel immediately downstream of the dam. An evaluation of the environmental disturbance, losses, and mitigation required for the detention pond is shown on Figure 35.

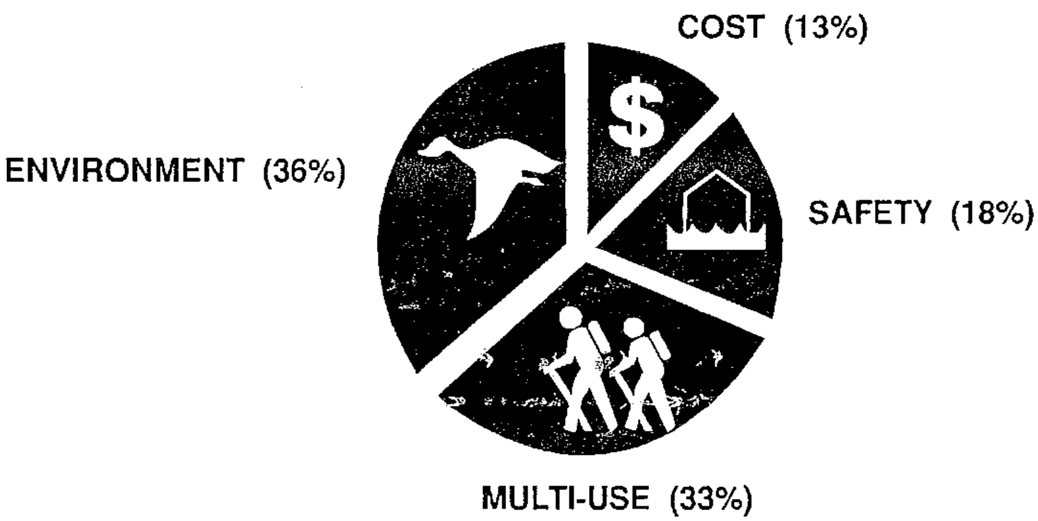
SPRING CREEK DBPS

COMMUNITY VALUES

RED WING BIRD SANCTUARY DETENTION SITE

FIGURE 34





ENVIRONMENTAL EVALUATION

FIGURE 35 - RED WING BIRD SANCTUARY DETENTION SITE

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS		ACRES	PERCENT		ACRES	PERCENT
	1. Structural or Upland	0	0	4. Riparian Grassland	5	42
	2. Open Water	0	0	5. Herbaceous Wetland	0	0
	3. Mature Riparian Forest	7	58	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
Detention Pond	0.8 Acres of Mature Riparian Forest	No net loss. Will reduce upstream soil loss.	On site replacement of vegetation lost during construction. Areas lost to drop structure mitigated through enhanced wetlands behind drop structures.
No Action	None- All vegetation left undisturbed.	Moderate- Natural erosion upstream will widen and incise channel causing loss of most vegetation.	Not applicable.

8. REACH 6-4 FROM RED WING BIRD SANCTUARY TO BIJOU ST.

a. Description of Existing Characteristics

The existing channel is natural in this reach (Red Wing Bird Sanctuary and Wagner Park). The crossing at Pikes Peak Ave. consists of a double 12 foot by 6 foot concrete box culvert. The existing channel has a bottom width of from 20 to 40 feet, a depth of from 15 to 30 feet, and a channel slope of 0.7% to 1%. The natural channel has been highly eroded and includes a section of channel that is eroding laterally in the Sanctuary area to considerably wider than the bottom widths above.

The existing soils are fine grained alluvial deposits and some Pierre Shale outcrops. The vegetation for the natural channel consists of mature riparian forest and riparian grasslands. The area is mostly planned open space including the Red Wing Bird Sanctuary and Wagner Park. The Colorado Springs Fire Department Training Station is also located on the northeast side of this reach near Bijou Street.

b. Constraints

The existing channel has the capacity for the 100-year design storm. However, the crossing at Pikes Peak is under capacity and will cause a backwater effect upstream. The channel velocities are high for the 100-year storm and range from 11 to 16 feet per second. This greatly exceeds the allowable velocities for this type of soil/vegetation and extreme erosion is evident in some portions of this reach.

c. Community Values

The community values determined for this reach are presented on Figure 36. The most important community value factors for this location were determined to be the environment and multi-use. With considerably lower rankings were safety and cost. The wildlife habitat that the sanctuary provides is a very important consideration along with multi-use for bird watching in the sanctuary and active recreation in the park.

d. Alternatives Considered

The alternatives were selected from a wide range of possible alternatives.From this range of possible alternatives, the list was narrowed down to the following alternatives:

Soft Bank Lining	-	Use vegetation to protect banks
Hard Bank Lining	-	Use buried riprap to protect banks
No Bank Lining	-	Leave the bank as it is currently
Soft Bottom Lining	-	Use vegetation to protect bottom of channel
No Bottom Lining	-	Leave the bottom of channel as it is currently
Grade Control	-	Use drop structures or cutoff walls to reduce channel slopes and velocities

An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 37. The following alternatives were not considered further for the reasons noted:

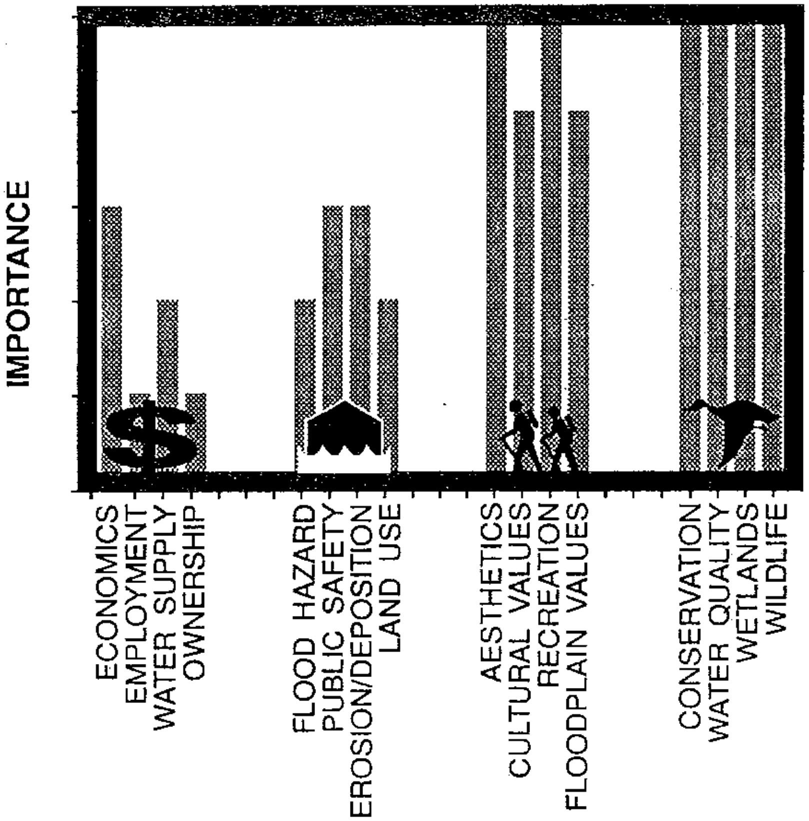
Hard Bottom Lining	-	There is no practical location to mitigate the damages to the environment in this reach.
Bank Reshaping	-	Extensive bank reshaping is not possible for all locations in this reach due to the extreme depth of the existing channel. However, see the next location, which is within this reach, where bank reshaping was considered in order to provide detention.

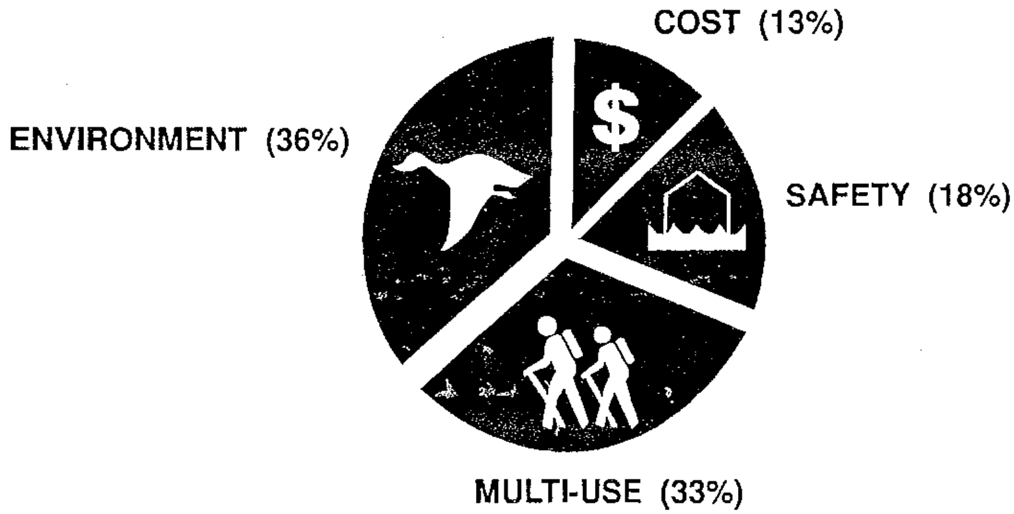
SPRING CREEK DBPS

COMMUNITY VALUES

RED WING BIRD SANCTUARY TO BIJOU STREET

FIGURE 36





ENVIRONMENTAL EVALUATION

FIGURE 37 - RED WING BIRD SANCTUARY TO BIJOU STREET

INVENTORY OF CURRENT ENVIRONMENT CONDITIONS		ACRES	PERCENT		ACRES	PERCENT
	1. Structural or Upland	1.0	17	4. Riparian Grassland	3.4	59
	2. Open Water	0	0	5. Herbaceous Wetland	0	0
	3. Mature Riparian Forest	1.4	24	6. Emergent Wetland	0	0

TREATMENT	IMPACT		MITIGATION OPPORTUNITIES
	DISTURB	LOSS	
Soft Bank Lining	1 Acre of Mature Riparian Forest 1 Acre of Ripaian Grassland	No net loss.	On site replacement of wetland vegetation and/or rparian habitat lost during construction using native plant materials.
Hard Bank Lining	1 Acre of Mature Ripaian Wetland 2 Acres of Riparian Grassland	1 acre of Mature Riparian Forest. 2 acres of Riparian Grassland.	No on-site mitigation. Off-site mitigation opportunities limited.
No Bank Lining	None	Moderate- Loss of streambank due to erosion will continue.	Not applicable.
Soft Bottom Lining	1 Aces of Riparian Grassland	No net loss.	On site replacement of wetland vegetation and/or rparian habitat lost during construction using native plant materials. Opportunity to mitigate other items through enhancement of bottom.
No Bottom Lining	None	Moderate- Channel incising will continue.	Not applicable
Grade Control	0.4 Acres of Riparian Grassland	0.2 acres of Riparian Grassland.	Areas lost to drop structure mitigated through enhanced wetlands behind drop structures.

9. DESIGN POINT 5 WAGNER PARK DETENTION POND

a. Description of Existing Characteristics

This location is a subset of the previous reach. The crossing at Pikes Peak Ave. consists of a double 12 foot by 6 foot concrete box culvert which is undersized. The existing soils are fine grained alluvial deposits and some Pierre Shale outcrops. The vegetation for the natural channel upstream of Pikes Peak Avenue consists of riparian grasslands. The area is all City owned and planned as open space including Wagner Park. The park has improved baseball fields on the west side of the channel and is not improved on the east side of the channel.

b. Constraints

This is one of the few locations left in the basin where it is feasible to locate a detention pond. The existing channel has the capacity for the 100-year design storm. However, the crossing at Pikes Peak is under capacity and will cause a backwater effect upstream. Improving the crossing of Pikes Peak Avenue would require significant detours due to the high volume of traffic on this road. There is enough room to create a benched area on the east side of the channel to gain volume required for the detention pond and to provide an additional improved recreation area on this side. Regrading the west side of the channel would take away much of the existing baseball field in the park.

c. Community Values

The community values determined for this reach are presented on Figure 38. The most important community value factors for this location were determined to be multi-use and the environment. With considerably lower rankings were the safety and cost. It is possible and desirable to increase the active and passive recreation values in the park.

d. Alternatives Considered

This site appears to be a viable location for a detention pond. Benching the east bank of the channel seems to be the most viable location to obtain detention volume. A 10-year design low flow channel was considered to keep the benched area dry during most periods. The benched area could be used for either active or passive recreation. Alternatives considered either making this a detention site or leaving it as it is with minor variations on the detention scheme used. An evaluation of the environmental disturbance, losses, and mitigation required for each alternative is shown on Figure 39.