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MARCH, 1981

LEIGH WHITEHEAD & ASSOCIATES
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DOUGLAS CREEK DRAINAGE BASIN

COLORADO SPRINGS
COLORADO

MARCH 1981

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TRANSMITTAL LETTER

LEIGH WHITEHEAD & ASSOCIATES
CONSULTING ENGINEERS AND SURVEYORS
5 WEST LAS VEGAS • PHONE 636-5179

COLORADO SPRINGS, COLORADO 80903

March 2, 1981

City of Colorado Springs
Department of Public Works
105 West Costilla Street
Colorado Springs, CO 80903

Re: Douglas Creek Drainage Study, Colorado Springs, Colorado

Gentlemen:

A restudy of the Douglas Creek Drainage Basin was authorized by the Colorado Springs City Council in August of 1980. A detailed engineering study has been completed on the entire basin and the results of the study are included herein.

The report includes a basin description, hydrology, hydraulics, a cost estimate, and a detailed summary information developed during the study. An orthophoto base map has been prepared as a Master Drainage Plan. The existing and proposed drainage facilities are included on this Plan.

The study has been prepared as a Master Plan guide for coordinated drainage facility construction as development occurs in the study area. The recommended improvements are often general in nature as to size and location. The intent of the preliminary facility design has been to include enough construction costs in the basin fee to insure a fund for reimbursement that will theoretically "zero out" after all facilities are in place. The recommendations included herein should therefore be used as a guide in planning future development in the Douglas Creek Drainage Basin.

Very truly yours,
LEIGH WHITEHEAD & ASSOCIATES

Roland G. Obering

Roland G. Obering, P.E. & L.S.

RGO/dar

CERTIFICATION

CERTIFICATION

I, Leigh Whitehead, a Registered Engineer in the State of Colorado, hereby certify that the attached Drainage Study for the Douglas Creek Drainage Basin was prepared under my direction and supervision and is correct to the best of my knowledge and belief. I further certify that said Drainage Study is in accordance with all City of Colorado Springs Ordinances, Specifications, and Criteria.

Leigh Whitehead, P.E. & L.S., Colorado 2692

APPROVAL

The City of Colorado Springs City Council and Department of Public Works does hereby approve the contents of the attached Douglas Creek Drainage Study. The Study shall be used as a guide for development of all drainage facilities within the study area.

Department of Public Works
(SEE ALSO ATTACHED MINUTES OF THE CITY OF COLORADO SPRINGS DRAINAGE BOARD)

(SEE ATTACHED RESOLUTION)
City Council

CITY OF COLORADO SPRINGS
DEPARTMENT OF PUBLIC WORKS • ADMINISTRATION (303) 471-6660 • ENGINEERING (303) 471-6606
105 WEST COSTILLA • P.O. BOX 1575
COLORADO SPRINGS, COLORADO 80901

M I N U T E S

City of Colorado Springs Drainage Board

June 18, 1981

The regularly scheduled meeting of the Colorado Springs Drainage Board was held on June 18, 1981 in the Department of Public Works Conference Room at 105 W. Costilla.

MEMBERS PRESENT	MEMBERS ABSENT	OTHERS PRESENT
Rick Simpson	Leigh Whitehead	Gerald J. Gromko, City Engineer
George Jury		Gary Haynes, Asst City Engineer
Gerald Watts		Jim Colvin, City Attorney
Bill Weber		Roland Obering, Leigh Whitehead Ass
		Jerry Novak, Ridge Development
		Don Jeffries, Consulting Engineer

The meeting was called to order at 3:29 P.M. by Acting Chairman George Jury.

Item One

Approval of the minutes of the May 21, 1981 meeting. It was moved by Mr. Watts that the minutes be approved as printed. The motion was seconded by Mr. Weber. The vote was 3 - 0 in favor of the motion. Mr. Simpson was not present for this item.

Item Two

Mr. Simpson arrived at this point. Presentation of the Douglas Creek Drainage Basin Master Study prepared by Leigh Whitehead & Associates and approval of the drainage fee and bridge fee for that basin.

A request from Ridge Development Company, Ltd to address the Drainage Board regarding the Douglas Creek Drainage Basin Study.

Mr. Gromko, City Engineer, presented the staff comments concerning the supplemental data submitted by the consulting engineer at the May 1981 Board Meeting. Mr. Gromko reviewed each item of the staff's comment sheet and answered questions from the Board members concerning the report (a copy of the report is attached to these minutes).

Mr. Novak, representing Ridge Development Company, addressed the Board and commented that the staff's comments comparing the hydrology of the 1974 master report with the current restudy hydrology differed from the statements made by the consulting engineer. Mr. Novak further disagreed with the staff's position concerning the Capp Homes Channel, Red Barn

System, Kaman Science's System, and the Systems in North Park Drive, Rusina Rd, and Elkton Drive. Mr. Novak requested that the Board again delay action on the approval of this report and allow him time to study the staff's comments and prepare his comments for the Board at the next regularly scheduled meeting.

After discussing the matter, Mr. Weber stated that the staff had reviewed this matter thoroughly and a fee could be revised at a later date if facts show that an adjustment is necessary. Mr. Weber moved that the Drainage Board approve the staff's recommendation of a drainage fee of $3,120 per acre and a bridge fee as reported by Leigh Whitehead & Associates of $72 per acre. The motion was seconded by Mr. Watts. The vote was 3 to 1 in favor of the motion.

Item Three

Open for discussion.

Mr. Haynes distributed to the Board members copies of the storm drainage fund balance sheet and the arterial roadway bridge fund balance sheet plus a copy of the drainage basin report of disbursement of funds. Mr. Haynes announced that the two balance sheets were showing balances as of May 31, 1981 in each drainage basin and arterial bridge fund, and that the disbursement report indicated the amounts of the disbursements made during the month of June 1981. The total amount drainage disbursements was $791,461.47, which will be subtracted from the May 31, 1981 balance of $2,113,466.00, leaving a balance total of $1,322,004.53.

Mr. Jeffries, representing Briargate Development Company, asked if the Board was discussing the detention pond request by Lew Christiansen of Briargate Development Company. Mr. Gromko explained that the item was not placed upon this month's agenda, but would be included on the July 1981 Board Agenda.

The meeting adjourned at 4:55 P.M.

Respectfully submitted,

DeWitt Miller
Director of Public Works

DM/GRH/ro

Atch

cc: Drainage Board Members
Drainage Board File
George H. Fellows, City Council
Jan Dudzinski, Land Development
Robert Martin, Special Projects
Gerald Gromko, City Engineer
Gary R Haynes, Asst City Engineer
Jack Smith, Asst City Attorney
Roland Obering, Leigh Whitehead
Jerry Novak, Ridge Development Co
Donell Jeffries, Consulting Enginee
Public Affairs Office

CITY OF COLORADO SPRINGS
COLORADO

INTER - OFFICE MEMORANDUM

Date: June 23, 1981

To: George H. Fellows, City Manager

From: DeWitt Miller, Director of Public Works

SUBJECT: DOUGLAS CREEK DRAINAGE FEE AND BRIDGE FEE

At the regularly scheduled Drainage Board Meeting on June 18, 1981 the City of Colorado Springs Drainage Board approved the Douglas Creek Master Drainage Report establishing a drainage fee of $3,120 per acre and a bridge fee of $72 per acre. The Douglas Creek Master Drainage Report was a restudy of this basin prepared under contract between the City and Leigh Whitehead & Associates.

This Department requests that the new drainage fee and bridge fee be approved by City Council at the July 14, 1981 City Council Meeting.

DeWitt Miller
Director of Public Works

DM/ro

cc: City of Colorado Springs Drainage Board
Gerald J. Gromko, City Engineer
Robert Martin, Special Projects Administrator

Resolution No. 219-81

A RESOLUTION ESTABLISHING DOUGLAS CREEK DRAINAGE BASIN AND ARTERIAL ROADWAY BRIDGE FEES FOR 1981

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF COLORADO SPRINGS:

Section 1. That Douglas Creek Drainage Basin and arterial roadway bridge fees for 1981, as recommended by the City of Colorado Springs Drainage Board at their June 18, 1981 meeting, are established for 1981 as follows:

Douglas Creek Drainage Basin Fee	-	$3,120.00 per acre
Douglas Creek Arterial Roadway Bridge Fee	-	$ 72.00 per acre

Dated at Colorado Springs, Colorado this 28th day of July, 1981.

Mayor

ATTEST:

City Clerk

ITEM NO. 13

SCOPE AND INTENT OF STUDY

SCOPE AND INTENT OF STUDY

Hydrologic studies of the Douglas Creek Drainage Basin have been prepared to City of Colorado Springs Criteria on two prior occasions. The first of these studies was in June of 1964, by United Western Engineers (George D. Morris, P.E.) and the second in June of 1974, by the Lincoln DeVore Testing Laboratory (George D. Morris, P.E.). The Basin has also been studied by the U.S. Army Corps of Engineers, Albuquerque office, for the purpose of flood plain definition to determine Federal Flood Insurance availability. The main purpose of the two studies completed to City of Colorado Springs Criteria was determining existing development and predicting future development; applying these factors together with geologic data to a design storm; and routing the runoff naturally, safely, and logically through the study area. The purpose and intent of this present study is to revise and update the two previous detailed hydrologic studies to more current City of Colorado Springs Drainage Criteria and the most recent development plans available.

The major road system within the Basin is Garden of the Gods Road (East-West), and Wilson Road (North-South). Development within the Basin, since the 1974 study, has occurred principally along Garden of the Gods Road and in the Holland Park area South of Garden of the Gods Road. The two major greenbelts that exist within the study area are "Douglas Creek" and an un-named drainageway, previously and hereinafter referred to as "South Douglas Creek". These two greenbelts are both well defined with "Douglas Creek" containing the greatest drainage area and estimated peak flow. A third relatively minor

and less clearly defined greenbelt exists in the extreme Northeast corner of the basin and drains a portion of Popes Bluff toward Monument Creek. All greenbelts remain relatively unobstructed by present development.

Development has occurred generally as was predicted in the 1974 report. The Garden of the Gods Road frontage is almost entirely industrial (PIP-1, PIP-2, PBC, etc.). Residential development along the fringes of the industrial areas has, for the most part, been occurring in the Easterly portion of the Basin with the most current activity spreading Westerly. That portion of the Basin West of Wilson Road is known as the Mountain Shadows Development. That portion of this area within the City Limits has recently been Master Planned and development is occurring at this time. For the most part, development has proceeded in a rather orderly fashion from East to West. Storm facilities have been constructed in these developed areas under the then current City Criteria. These existing facilities are inventoried and their capacities analyzed as part of this study.

The only street systems considered in this drainage study are those systems now in existence or included in an approved Master Plan. These major roads include (in addition to the two previously mentioned) Holland Park Boulevard, Centennial Boulevard, and Mountain Shadows Road. Generally, suitably sized culverts have been placed at these major roads with lined channels between. Lined channels seem to be more appropriate than underground systems due to the industrial nature of the Basin, however, more underground systems are required as development of the residentially zoned areas occurs. The intent of this study, or any of its type, is to establish a general location, size, and type of facility and not to determine a precise design for a particular area.

The Criteria under which this study has been prepared is current City of Colorado Springs Criteria for Determination of Storm Runoff, March, 1977, as

amended. This Criteria relies on the Soil Conservation Service "Procedures for Determining Peak Flows in Colorado" for determining peak runoff for a particular storm. The 5 year storm and 100 year storm frequencies are studied and a peak runoff in excess of 500 cfs is considered a "Major Channel" requiring sizing of facilities for that design storm. This methodology has been the principal change in Criteria since the 1974 study.

The Douglas Creek Drainage Basin is currently experiencing a major growth pattern, similar to that experienced in the Northeast area of Colorado Springs. For the most part this development has been, and appears to continue to be, in an orderly fashion in accordance with City of Colorado Springs rules and regulations. This present study, a re-study of the existing 1974 report, is general in nature from the standpoint of size and location of structures. An inventory of existing facilities and a determination of their adequacy is a major part of this study as is the change in Criteria used to predict peak runoffs and subsequent routing through the Basin.

GENERAL DESCRIPTION OF BASIN

GENERAL DESCRIPTION OF BASIN

The Douglas Creek Drainage Basin lies in the Northwest portion of the City of Colorado Springs. The entire Basin contains 10.1 square miles with the Westerly 2.9 square miles lying outside of the present Corporate City Limits and within the Pike National Forest. The origin of the Basin is in the Front Range of the Rocky Mountains.

The Basin has the following general boundaries. The West boundary is a Front Range ridge in the Rampart Range. The North boundary is Popes Bluff and its Northerly extension. The South boundary is the Mesa. The Basin outfalls into Monument Creek on the East, the existing natural drainage in the Northern Pikes Peak Region. The detailed portion of this study and mapping includes all of the Basin within the Colorado Springs City Limits. The Westerly portion of the Basin is quite steep and generally inaccessible. It lies within public lands and is therefore considered undevelopable.

The Douglas Creek Drainage Basin contains two distinct tributaries and a third not so distinct minor flow, all with individual outfall points into Monument Creek. The major tributary, known as "Douglas Creek", has the largest drainage area (approximately 6.4 square miles). Its origin is at the Western boundary of the Basin and its drainage area includes the Northern two-thirds of the Basin. The second major tributary, un-named on the U.S.G.S. Quad Sheets, has been designated "South Douglas Creek" in previous studies. The drainage area of this tributary is approximately 3.7 square miles. The third, less defined and un-named tributary, has a relatively small but certainly potentially damaging flow. Its designation is "North Tributary", and it has an

approximate contributing area of 2.56 acres. For the most part, all of these tributaries are intermittent. Several small springs feed the two larger tributaries as they approach their outfall points causing a continual, although sometimes quite small, flow. The area above Garden of the Gods Road is dry year round except for storm runoff flows.

The Douglas Creek Drainage Basin slopes generally from Northwest to Southeast. That portion of the Basin West of the Colorado Springs Corporate Limits has not been studied in detail in this report. This area is classified as mountainous with some very steep, wooded slopes. The portion of the Basin between the Corporate Limits and Wilson Road is an alluvial outwash. This area contains several "hogback" formations resulting from the Front Range uplift. Drainage flow is quite defined as it leaves these formations and spreads out into alluvial type fans by the time it reaches Wilson Road. From Wilson Road Easterly, the flow increases and forms more defined Greenbelt type channels. The average slope in this area is approximately 2.8%. Some significant erosion has occurred in the Basin, particularly in the steeper mountainous portion along the Westerly boundary as well as in the Easterly portion of the Basin as the tributaries increase in runoff volume and begin continual flow. The middle and most developable portion of the Basin contains little or no erosion problem.

A careful examination of the U.S.G.S. Quad Sheet (Pikeview, photorevised, 1975) indicates "Douglas Creek" and "South Douglas Creek" to be rather undefined in several areas (double channels) and to contain several retention ponds. These retention ponds have been, or will be, removed in the course of development. The double channels have been eliminated along "Douglas Creek" and the plans for development along "South Douglas Creek" include combining several small channels into one channel. This method of combining channels has been proven to be accomplished at an approximately equivalent cost while making

tracts of land more desirable for development by the elimination of easements and structures. Where possible to predict, this combination of close, yet independent, channels has been included in the Basin routing.

BASIN CHARACTERISTICS

V

BASIN CHARACTERISTICS

The geology of the Douglas Creek Drainage Basin is quite varied throughout. The Basin geology does have a major impact on the hydrology and hydraulics of the Basin. A summary of the Basin geology is included in the Appendix of this report as is the soil type and hydrologic classification in accordance with the Modified Soil Conservation Service method currently being used in the City Criteria.

The Douglas Creek tributary flow originally reached Monument Creek through the Dry Creek Basin on the North. The tributary has evolved geologically to its present form over a relatively short period of time. The "South Douglas Creek" tributary has been reduced in size due to a portion of its geologically historic flow now draining into the Camp Creek Drainage Basin and then to Fountain Creek. This naturally caused change in flow has occurred over a relatively short geologic period. The time involved for this to occur has been significantly long enough not to be a factor in estimating storm runoff in this study. In other words, the time period for which this study is valid is much shorter than the time in years required for even an insignificant diversion of flow to occur into or from the Douglas Creek Basin.

The portion of the Basin lying West of the Corporate Limits and on the Eastern slope of the Front Range consists almost entirely of Pikes Peak Granite (Ypp). This occurs in either its solid or decomposed form and results in a relatively low runoff rate due to the high infiltration. The area falls into the Hydrologic Soil Group A. This soil type generally stops at the Rampart Range Fault, a portion of the Front Range Fault extending the entire length of the Rocky Mountains.

This fault line is the Westerly boundary of a variety of sedimentary formations typical of those found in the Garden of the Gods. These formations create a number of "hogbacks" and valley characteristics, both of which effect runoff quite dramatically. The entire area of the Basin, running North/South for approximately a mile East of the fault, contains this combination of formations. This area falls into either Hydrologic Soil Group C or D depending on the exact nature of the hogback or valley.

The remainder of the Basin is underlain by Pierre Shale with various types of alluvium overlaying the shale. This includes Piney Creek (Qp), Louviers (Plo), Slocum (Qs), and Verdos (Qv) alluviums. All of these soil types are a silty sand or a clayey sand with runoff being higher toward Monument Creek than near the base of the mountains. These soils fall into the Hydrologic Soil Group B or C depending on their location within the Basin.

The Popes Bluff feature that forms the Northern boundary of the Basin, is of the Laramie Formation (Ke). This is a clay and sandstone containing coal deposits and has, in fact, been a commercial source of coal during the 1930's. The bluff itself is of the exposed formation with talus occurring near the base of the bluff. The Hydrologic Soil Group C has been assigned to this formation.

The Basin contains very little underground free water. The principal location of free underground water is along the tributaries as they approach Monument Creek. This free water surfaces from springs to create a nearly continual flow, however, its effect on storm runoff is considered insignificant in this report. This free water flow does tend to continue erosion in the channels, forming more definite natural greenbelts over a long period of time.

The geology and soils of this Basin are typical of other Basins originating in the Foothills, however, they are quite different from other major

Drainage Basins within the City of Colorado Springs (ie. Cottonwood Creek, Sand Creek, Templeton Gap, etc.). The geology and soils play a very significant role in storm runoff. The general conclusion is that runoff will be very high in a major storm due to the geology of the Basin. This has been taken into consideration in assigning Hydrologic Soil Groups to the various formations.

BASIN HYDROLOGY

The Colorado Springs area has been settled for some 120 years and weather records have been kept for only 70 years. Several damaging storms have occurred within this time period, however, no accurate records are available to help define the type of storm that may occur within the Basin. The average annual rainfall for the Colorado Springs Region is 15 inches. This rainfall occurs in three general types of storms: 1) snowfall (50%); 2) upslope storm conditions producing high precipitation amounts but over a 2 to 4 day period (30%) and; 3) intense thunderstorms of short duration with very high peak flows (20%). The third type of storm is the most damaging, in terms of flood potential, and is the type of storm for which all facilities in the Colorado Springs area have been sized.

The previous Basin study in 1974, involved investigation of a 50 year and 100 year frequency storm. This study revealed that the 50 year frequency, 1 hour duration, 2 inch intensity and the 100 year frequency, 1 hour duration, 3 inch intensity storms provided the highest peak runoff for local drainage and "Major Channel" (500 cfs flow) design. This restudy, under revised City Criteria, uses the Modified Soil Conservation Service method with a Type II A storm, 6 hour duration and 2.1 and 3.0 inch intensity respectively for a 5 year and 100 year designation. The net effect has been to increase the runoff volumes determined in the 1974 report. The 5 year designation is, in fact, very close to the previously designated 50 year storm.

The topographic features of this Basin, as well as its location relative to the major storm axis of the Region, would probably cause the actual storm to be less than the Type II A storm. The hogback features tend to form natural

detention facilities along the storm route. The major storm axis, the area of most intense thunderstorm activity, is located in a North/South direction some 7 miles East of the Front Range. The Type II A storm was used in this study and the results will probably tend to be somewhat conservative.

The Douglas Creek Drainage Basin has been divided into Seven (7) major sub-basins and ninety-six (96) minor sub-basins for purposes of this study. The minor sub-basins have been defined as a result of existing or planned development, natural topographic features, or crossings of roads. An outfall point for each sub-basin has been designated. Composite flows have been routed along greenbelts through the Basin. The Type II A design storm has been assumed to occur over the entire Basin. It is felt this assumption is valid due to the relatively small size of the Basin.

The peak runoff obviously increases toward the East end of the Basin. The flow in the West portion is of a significant volume to cause damage, however, a "flood" flow with a potential for serious damage does not occur until the vicinity of Interstate 25. It is in this area that the flow could exceed the capacity of the natural greenbelts and enter developed property in volumes and with velocities significant enough to cause damage to private property or to endanger lives.

The one area of that portion of the Basin lying outside the Corporate Limits of the City which has been given careful consideration in this restudy is the Pikeview Quarry. This quarry is an active limestone removal operation located in the Western portion of the study area. The mine operators, Castle Concrete Company, have an ongoing reclamation program which attempts to revegetate the surface of the mined area. This is, of course, a long process estimated to continue into the 2000's. The reclamation plan includes a number of small retention and detention facilities designed to retain runoff and to

catch sediment. The net effect of the operation is, however, to increase peak runoff from the sub-basin.

The Modified Soil Conservation Service Method uses several parameters for consideration and accurately estimating peak runoff. Several of these, including geology and soils, design storm frequency and type, have been previously discussed. One of the most important parameters is the selection of a proper curve number. The City Criteria contains a guideline for assigning these numbers, however, some additional consideration has been given to particular sub-basins and the effect of urbanization on them.

The final important parameter in estimating peak runoff quantities is proper determination of the time of concentration. The time of concentration (T.C.) is defined as the time it takes for runoff to travel from the hydraulically most distant point in the watershed to the point of interest. The three most common types of flow, all affecting time of concentration differently, are: 1) overland flow; 2) channel flow, and; 3) storm sewer or roadway gutter flow. Due to the somewhat general nature of this study and the lack of detailed street layout particularly in the Western portion of the study area, the storm sewer and gutter flow have been considered as overland flow. This assumption is true for the individual sub-basin computations and is not expected to cause any significant loss in accuracy. The accumulative flow computations have given detailed consideration to the routing of runoff down the system in channels, storm sewers, and roadway crossings that may be significant.

The seven (7) major sub-basins have been designated alphabetically (A through G). The North Branch is comprised of A, B, and C. Sub-basin D is comprised of the "Point of the Pines/Rusina Road" area. The South Branch has sub-basins E and F. Sub-basin G is a seventh area generally between the two major branches and below Holland Park Boulevard.

The ninety-six (96) minor sub-basins have been designated alpha-numerical, i.e. A-1 through A-14, B-1 through B-5, etc., for each major sub-basin. These minor sub-basins vary in size but have been defined to give a flow from or at a particular point of interest. The flow is then either used to size a storm system (existing or proposed) or combined with other sub-basins to produce an accumulated peak runoff for major channel sizing.

The accumulative flow computations have been done by designating hydrograph points in various major sub-basins. These points have been designated at points of major structures or where significant contributing runoff enters the major channel. A composite hydrograph has been developed at each of these points.

A summary of all of the hydrologic computations for all of the minor sub-basins and the accumulative flow routing computations are included in Exhibit 6 of the Appendix. A copy of the pertinent tables for determining Curve Numbers, Runoff Depth, Time of Concentration, and Peak Discharge are included in the Exhibit.

The accumulative peak flows in this restudy are consistently higher than those in the 1974 Study. This has resulted in some of the major channel facilities being slightly undersized for an ultimate flow condition. The two most significant reasons for this increase in peak runoffs are: 1) A density of development from the current Master Plans than was anticipated in the 1974 Study and; 2) A rather major change in the concept of routing along the major channels since the 1974 Study involving a change from the wide shallow "green-belt" idea to a narrow, deep symmetric channel with much higher velocities as have been recently approved and constructed. These factors together with some other possible factors have combined to increase the peak runoff in the major channels by 24% to 27%. A tabulation of comparisons of flows at similar points together with flows from other sources has been included in Exhibit 6c for interest and information only.

BASIN HYDRAULICS

The development of the Douglas Creek Drainage Basin has been in an orderly and well predicted manner. Very little change to the originally prepared studies has occurred that would affect the hydraulics of the basin with the exception of the change in City Criteria. This has produced somewhat higher peak flows and hence undersized some of the existing structures. Generally the greenbelt areas were well defined as to route, width, grade, etc., and have been, or will be, dedicated to the City as drainage courses. The storm detention concept was eliminated prior to the 1974 study and this has, in fact, been accomplished particularly in the Pinon Valley area. The other change in the hydraulics is the possible combining of a flow or flows in some of the very undefined drainage channels to eliminate some required channel. This occurs primarily in the Mountain Shadows Development Area.

Another principal purpose of this restudy has been to inventory all existing storm facilities in the Basin. Based on the newly computed peak runoff figures, a rating of each of the facilities as to capacity has been made. This has been done on all minor sub-basins in the study area.

The basin hydraulics have been considered in several categories. These include 1) Major Channel-North and South; 2) Bridge Inventory; 3) Culvert Inventory and; 4) Storm System Inventory. A brief description of each of these categories and the relative hydraulic considerations is included. The 100 year storm has been used to size all major channel, bridge, and culvert facilities. The 5 year design storm has been used to size all storm system facilities. The Manning Formula was used in sizing all structures. The

roughness coefficients used for this formula are as follows:

Concrete Pipe (RCP) and Box Culverts	0.013
Corrugated Steel Pipe (CSP) 3" X 1"	0.027
Concrete Lined Channel	0.015
Gunite Lined Channel	0.025
Rock Riprap Channel	0.045
Natural Channel	varies - 0.030-0.040

Several typical sections are included in the Appendix for various facilities proposed in this section. See Exhibit 5.

Major Channel North and South

This section considers routing and improvements--both existing and proposed--to what has been determined to be the major channel in each of the two branches of Douglas Creek. Both branches have their origins in the Pike National Forest and will experience no change from their natural state. When the channels approach the Corporate Limits they are still in a stable natural state and, for the most part, development is unlikely. A series of check dams has been proposed in these extreme upper reaches. The natural slope of these channels in the upper areas is usually in excess of 10%, making conventional improvement impossible. Rock riprap channels have been proposed in the areas where concrete lining and velocity control structures are impractical. As the natural channels leave the steep foothills area it becomes reasonable to improve them with conventional methods. These consist of concrete lining with velocity control structures to maintain a mean velocity of approximately 30 fps. A special 6-inch channel section with reinforcing is required for velocities in excess of 20 fps and this section has been used in this study. Guardrail has been included for channels parallelling roadways.

The grades used for sizing are average grades. Alignments attempt to follow existing natural drainage courses except in areas where the channel is undefined or a diversion has been proposed in an approved Master Plan. Special

consideration to transitions and superelevation on curves should be given in final design. A summary of all facilities, improvements, costs, and responsibilities is included in Exhibit 7a and 7b.

Bridge Inventory

This section considers specific roadway crossings of the Major Channel facilities. The City Arterial Road Plan has designated Garden of the Gods Road, and Centennial Boulevard in this category and these crossings are subject to the Arterial Roadway Bridge Ordinance. The structures proposed are all conventional box culvert construction. A final design consideration should analize the suitability of a typical bridge structure as an alternative to the box culvert. A suitable inlet and outlet condition should also be included as part of the final bridge/box design.

The construction of several of the bridge structures involves conflicts with existing public utilities. The most critical of these occurs in Garden of the Gods Road. The necessary utility modification is often a very high percentage of total construction cost. This condition also occurs in several areas in the next two hydraulic categories.

The cost of structures included in the Bridge Inventory has been used to estimate a basin Bridge Fee (See Costs and Exhibits 7c).

Culvert Inventory

This section is similar to the Bridge Inventory. The section includes an inventory of all existing and proposed structures required at major channels for roadway crossings. The roads are all those existing or proposed except the arterial roads. Much of the study area that is not developed has been Master Planned, giving a good indication of the required crossings. Several areas have not been Master Planned and reasonable assumption has been made in these areas as to the number of crossings and their approximate location.

As mentioned, utility conflicts will be encountered with several of the proposed facilities. Several of the structures in this category are not under the City's control, the most notable being the Denver and Rio Grande Western Railroad Company. An analysis and suggested facility has been determined, but not included in the fees for the basin.

Storm System Inventory

This category includes all facilities, either existing or proposed, not included in any of the above categories. Generally, each of the minor sub-basins have been considered for existing facilities, proposed development, runoff, and required facilities.

If the area is not yet developed, a reasonable assumption has been attempted as to roads, type of development, etc. and a storm system--sometimes schematic only--has been preliminary designed. This generally consists of either a small improved open channel (rock riprap, gunite, or concrete), a suitably sized underground storm system, and/or a series of catch basins of random size and location. For purposes of uniformity, RCP pipe was used in this report. It should be noted that many other materials may be suitable and can be substituted for RCP provided proper hydraulic adjustments are made.

When a more definite development plan was available the adequacy of the proposed facility was considered and the system was either included or modified to accommodate the design flow. In most cases the proposed system was adequate.

In areas of complete development the existing systems were inventoried and if they were inadequate, improvements were recommended. In several areas these deficiencies occur in land not under the City's control, i.e. private roads and platted and developed tracts and streets. An attempt has been made to define a responsible party for these improvements. The most frequent occurence of deficiency is in the East end of the study area.

The hydraulics of the study area has been summarized in Exhibit 6 of the report. It should be reiterated that in areas of undevelopment the systems are somewhat schematic. As the final road configurations and land uses are determined it may be necessary to add or delete improvements and change structure sizes. An underground system might be more easily substituted for an open channel or a bridge structure for a box culvert, for example.

A reasonable attempt has been made in all categories to include suitable number and size of facilities to adequately, safely, and economically handle storm water runoff throughout the basin.

AREAS OF CONCERN

VIII

AREAS OF CONCERN

One of the purposes of this study was to define areas where the existing system (or lack of system) would or could cause serious damage to property or endanger the health and safety of the public. Several of these areas have been located and are discussed herein in no order of priority, but rather in the North basin downstream and then the South basin downstream. Several general observations were made during the course of the preparation of this report and are also discussed.

General

A review was made of all drainage reports previously submitted in this basin. The most common denominator found was the use of "By Others" when designating construction of facilities adjacent to subdivisions. This has lead to deficiencies in several areas in the Basin. Although the reports dated over the past ten years and Criteria have changed, there is no real consistency in many of the reports supposedly prepared under the same general guidelines. There was a great lack of information on "as-built" facilities which had to be field checked for confirmation. The field inspections revealed some very poor construction and maintenance practices. Construction of new facilities has not been done to City Standards--demonstrating an apparent lack of good engineering, construction, and inspection practices.

North Branch

The North Branch is currently experiencing a great deal of development. It is important to have the newly developed peak runoff information included for final design of facilities, generally above Garden of the Gods Road. The

completed section of the Pinon Valley Ditch is undersized for a peak flow from total basin development.

The Garden of the Gods Road crossing is very undersized for ultimate development. An even more urgent situation is its present condition. For apparent structural reasons there are a series of rods crisscrossing the existing arch pipe. These rods act to trap debris in the channel and diminish the effective crossection dramatically. It is very important to have this facility investigated in detail and make suitable arrangements to have these obstructions and rods removed so the facility can operate at its full capacity.

The improved channel below this facility has inadequate superelevation protection. It will be difficult to upgrade this facility because of the existing building and grade problems. The capacity should be checked as each major upstream development is constructed.

The culvert crossing under the Denver and Rio Grande Western Railroad tracks is very seriously inadequate, even under present conditions. This structure is of course not in the City's jurisdiction. It should be brought to the attention of the Railroad for planned improvement.

A fully developed area near Garden of the Gods Road and Chestnut Drive/ Elkton Drive ("Red Barn") is in serious need of a storm sewer and open channel facility. This involves crossing the roadway (utility conflicts) and the Rusina Valley Railroad spur. The system should be constructed soon to prevent flooding, erosion, and deterioration of the existing road.

The area of "Point of the Pines Road" and East has experience some serious flooding, primarily due to erosion and the lack of maintenance of Colorado Department of Highways facilities. A complete system of improvements is needed East to the railroad right-of-way and beyond. The construction of the Garden of the Gods Road Overpass/Underpass will need to consider this runoff as it reaches the construction area. The private roads in the Crossroads Area are

deteriorating partly due to lack of adequate drainage facilities in several areas.

South Branch

Development along the South Branch is planned and is eminent but not to the degree of the North Branch. The peak runoffs developed in this report are timely enough to be included in all final design above Holland Park Boulevard.

The vicinity of Garden of the Gods Road and Wilson Road has been allowed to develope in a routing pattern that was not consistent with the approved Master Plan. This has resulted in requiring two crossings of Garden of the Gods Road (one existing and one proposed). It appears that the Master Plan was correct and the proposed routing should have been maintained so that duplicate crossings would not be required.

The lineal park area below Holland Park Boulevard has several construction deficiencies, including a questionable flood plain crossection just below Holland Park Boulevard. In order to prevent serious erosion, a suitable outlet from the road crossing has been proposed. Several small channel extensions are also required in this area.

The Chestnut Street structure is inadequate to convey the design flow. Under current conditions, a considerable amount of ponding will occur upstream. This will inundate private property (unplatted). A suitable structure should be constructed or arrangements made to encroach on the inundated property.

The Denver and Rio Grande Western Railroad structure is inadequate to pass the design flow. It has apparently been operating satisfactorily under current flow conditions. The problem should be brought to the attention of the Railroad so that they can budget for improvement of this facility.

In conclusion, the areas of concern addressed herein seem to be those needing the most immediate and direct attention. They should be prioritized and scheduled for improvement as part of the City's improvement program, or

required to be developer improvements, as the case may be. Facility planning, design, construction, and inspection should be made more consistent in accordance with the existing City Criteria and Standards.

COST ESTIMATE SUMMARY / FEE DETERMINATION

COST ESTIMATE SUMMARY AND FEE DETERMINATION

A detailed cost estimate has been prepared for all proposed drainage facilities and remedial type work required in this study. The unit prices used in preparation of the estimate are included in this section. A summary of the estimated cost for each hydraulic category, i.e. channel, bridge, culvert and storm system, is also included in this section. The estimated cost for improvements within each Subbasin or area is included in the inventory in Exhibit 7. Contingency percentages at 5% (9% for bridge facilities) and 10% for final design engineering and inspection has been added in the summary sheet and is not included in the inventory cost estimate.

The construction cost estimate has been prepared based on the unit prices included. These prices are a result of discussions with the Public Works Staff, Developers, and Contractors in an attempt to obtain realistic current costs. The basin improvements have been standardized throughout in an attempt to get realistic basin costs. All proposed facilities are subject to final design. Materials proposed, particularly in the storm system section, can be substituted for hydraulically equivalent other materials. In an attempt to reduce the possibility of contingencies, items such as asphalt repair, utility conflicts, guardrail, etc. have been included where they are definable. The Design Engineer, at the time of final design, should be sure to check capacities, grades, sizes, right of way widths, etc. as a refinement to all facilities proposed in this study.

The basin area has been determined from the best available records. All platted property (as of January 1, 1981) has been tabulated and included in Exhibit 4. All developed but unplatted area has also been determined. This

includes both developed parcels and existing rights of way (streets, I-25, railroads, etc.). The area of the Pike National Forest within the study area has also been determined. Several existing platted subdivision have had their Drainage Fee obligation deferred. These areas have been included in the total area subject to fees, a summary of which is included in Exhibit 4. The net result is an area determination subject to Drainage Fees (as of January 1, 1981) of 3,339 acres. The basin Drainage Fee has been computed using this acreage.

A separate estimate has been prepared for facilities that have been determined by the Director of Public Works to be subject to the Aerterial Roadway Bridge Ordinance and are referred to in this study as Bridge Facilities. These facilities have been estimated separately and, in accordance with the guidelines set forth in the Ordinance, a Bridge Fee has been determined. The basin area subject to Bridge Fees is the total basin area less the National Forest or 4,684 acres. The City's obligation towards the basin Bridge Fund includes: 1) The percentage of the basin acreage that is platted (1,345 acres/4,684 acres or 29%) and; 2) That portion of the bridge structure cost that is in excess of 68 feet as measured perpendicular to the roadway center-line. These factors have all been considered in determination of the Bridge Fee.

A summary of the fee determination is included in this section. The basin Bridge Fee has been determined to be $72 per acre. The basin Drainage Fee has been determined to be $3,109 per acre. This compares with a Bridge Fee of $86 per acre and a Drainage Fee of $2,274 per acre based on the 1974 Basin Study.

UNIT PRICE SUMMARY

THE FOLLOWING UNIT PRICES WERE USED IN ESTIMATING CONSTRUCTION COSTS FOR THIS STUDY. NO ENGINEERING OR CONTINGENCIES ARE INCLUDED IN THESE UNIT PRICES.

DESCRIPTION	UNIT	UNIT PRICE
Channel Excavation	C.Y.	Varies $1 to $2
Concrete Channel (6" w/Reinforcing)	S.F.	$ 2.50
Rock Riprap Channel (Size Varies)	C.Y.	Varies $20-$25
Gunite Channel	S.Y.	$ 17.50
Rock Riprap Check Dams	C.Y.	$ 20.00
Structure Excavation	C.Y.	$ 6.50
Structure Backfill	C.Y.	$ 8.50
Structure Concrete	C.Y.	$ 190.00
Structure Steel	LB.	$ .40
18" R.C.P.	L.F.	$ 19.00
21" R.C.P.	L.F.	$ 22.25
24" R.C.P.	L.F.	$ 26.50
27" R.C.P.	L.F.	$ 29.50
30" R.C.P.	L.F.	$ 34.00
36" R.C.P.	L.F.	$ 51.00
42" R.C.P.	L.F.	$ 62.50
48" R.C.P.	L.F.	$ 73.50
54" R.C.P.	L.F.	$ 110.00
Manhole (5' I.D.)	EA.	$1,750.00
Catch Basin - 4'	EA.	$1,500.00
Catch Basin - 6'	EA.	$1,800.00
Catch Basin - 8'	EA.	$2,200.00
Catch Basin - 10'	EA.	$2,700.00
Catch Basin - 12'	EA.	$3,000.00
Catch Basin - 10' RAD.	EA.	$2,500.00
Guardrail (Type 5)	L.F.	$ 25.50
Asphalt Repair/Replace	S.Y.	$ 5.00
Utility Adjustments		Varies w/situation

SUMMARY OF FEE CALCULATIONS	

COST SUMMARY

	7a. MAJOR CHANNEL NORTH	7b. MAJOR CHANNEL SOUTH	7d. CULVERT INVENTORY NORTH	7d. CULVERT INVENTORY SOUTH	7e. STORM SYSTEMS	TOTAL
DEVELOPER COSTS	$3,214,000	$1,469,000	$ 304,000	$ 394,000	$3,607,030	$8,988,030
DEVELOPER 5% CONTINGENCY 10% ENGINEERING	$ 498,170	$ 227,695	$ 47,120	$ 61,070	$ 559,090	$1,393,145
CITY COSTS	-	-	-	-	$ 236,270	$ 236,270
CITY 5% CONTINGENCY 10% ENGINEERING	-	-	-	-	$ 36,625	$ 36,625
RAILROAD COSTS	-	-	$ 53,000	$ 10,000	-	$ 63,000
RAILROAD CONTINGENCY & ENGINEERING As Noted	-	-	$ 106,000 (200%)	$ 1,500 (15%)	-	$ 107,500
PARK COSTS	-	-	-	-	$ 10,000	$ 10,000
PARK 5% CONTINGENCY 10% ENGINEERING	-	-	-	-	$ 1,550	$ 1,550

BRIDGE COST SUMMARY

BRIDGE FEE COST		$ 281,890	CITY COST		$ 92,110
CONTINGENCIES	@ 9%	$ 25,370	CONTINGENCIES	@9%	$ 8,290
ENGINEERING	@ 10%	$ 30,730	ENGINEERING	@ 10%	$ 10,040
TOTAL		$ 337,990	TOTAL		$ 110,440

SUMMARY OF FEE CALCULATIONS

BASIN DRAINAGE FEE

TOTAL BASIN AREA SUBJECT TO DRAINAGE FEES (See Summary Sheet - Exhibit 4)	3339 AC	
CONSTRUCTION COST ESTIMATE (DEVELOPER COST)		$ 8,988,030
CONTINGENCIES @ 5%/ENGINEERING @ 10%		$ 1,393,145
TOTAL COST ESTIMATE TO BASIN		$10,381,175

DRAINAGE FEE/ACRE $\frac{\$\ 10,381,175}{3339\ AC} = \$\ 3,109/AC$

BASIN BRIDGE FEE

TOTAL BASIN AREA	6588 AC	
PIKE NATIONAL FOREST	1904 AC	
BASIN AREA SUBJECT TO BRIDGE FEE PARTICIPATION	4684 AC	
CONSTRUCTION COST ESTIMATE TO BASIN (DEVELOPER COSTS)		$ 281,890
CONTINGENCIES @ 9%/ENGINEERING @ 10%		$ 56,100
TOTAL COST ESTIMATE (EXCLUDING CITY OBLIGATION)		$ 337,990

BRIDGE FEE/ACRE $\frac{\$\ 337,990}{4684\ AC} = \$\ 72/AC$

CONCLUSIONS AND RECOMMENDATIONS

X

CONCLUSIONS AND RECOMMENDATIONS

The Douglas Creek Drainage Basin virtually consists of two individual Basins, North and South, and has been studied accordingly. Development has occurred in the downstream portion of both Basins and is gradually extending Westward. This study has considered all available development information, both existing and proposed, in order to develope reasonable peak runoff quantities for storm facility design purposes. This peak runoff information has been compiled according to the most current City Criteria. Runoff has been routed through both drainages along natural drainage courses in suitably sized facilities. Necessary road crossings and local storm systems have been preliminarily designed throughout the undeveloped area and checked for adequacy in developed areas. A detailed summary of all hydrology and hydraulics is included in the Appendix.

Cost estimates for construction have been prepared. The undeveloped acreage has been determined and a per acre drainage fee has been established. This has also been accomplished for a bridge fee.

During the course of the study and field inspections several areas of concern were noted. They have been discussed in more detail in the body of the report. They should be prioritized and scheduled for improvements. A consistent application of current Criteria and Standards for analysis, design, construction, and inspection of drainage facilities should be accomplished.

It is recommended that this drainage study and subsequent recommendations be used by the City and Developers as a general guide to a timely and orderly sizing and construction of drainage facilities in the Douglas Creek Basin. The recommended facilities are all subject to final design considerations and

must be considered with that in mind. In order to finance the ultimate construction of all proposed facilities it is recommended that a Drainage Fee of $3,109 per acre and a Bridge Fee of $72 be collected on all undeveloped land at the time of platting. This fee should be adjusted annually for inflation.

The Appendix of this report contains a detailed summary of information used in preparing this report, a summary of hydrology and hydraulics, and typical section that should be helpful in planning a detailed design for any portion of the Basin. A Drainage Plan on a contour orthophoto at 1"=400' illustrates all of the existing and proposed facilities included in this study.

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BIBLIOGRAPHY/REFERENCES

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APPENDIX

SUB-BASIN AND HYDROGRAPH POINT INDEX

EXHIBIT 1

MASTER DRAINAGE PLAN
DOUGLAS CREEK DRAINAGE BASIN

SUB-BASIN & HYDROGRAPH POINT INDEX - EXHIBIT 1

DATE: JANUARY, 1981
PROJECT NUMBER: 80061

PREPARED BY:
LEIGH WHITEHEAD & ASSOCIATES
CONSULTING ENGINEERS
5 WEST LAS VEGAS ST.
COLORADO SPRINGS, COLORADO

DRY CREEK DRAINAGE BASIN

DOUGLAS CREEK DRAINAGE BASIN BOUNDARY

CITY LIMITS

ROCKRIMMON DRAINAGE BASIN-NORTH

ROCKRIMMON SOUTH DRAINAGE BASIN

POPES BLUFF DRAINAGE BASIN

CAMP CREEK DRAINAGE BASIN

MESA DRAINAGE BASIN

ROSWELL DRAINAGE STUDY AREA

A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9, A-10, A-11, A-12, A-13, A-14

B-1, B-2, B-3, B-4, B-5

C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9, C-10, C-11, C-12, C-13, C-14, C-15, C-16, C-17, C-18, C-19, C-20, C-21, C-22, C-23, C-24, C-25, C-26, C-27, C-28, C-29

D-1, D-2, D-3

E-1, E-2, E-3, E-4, E-5, E-6, E-7, E-8, E-9, E-10, E-11, E-12, E-13, E-14, E-15, E-16, E-17, E-18, E-19

F-1, F-2, F-3, F-4, F-5, F-6, F-7, F-8, F-9, F-10, F-11, F-12, F-13, F-14, F-15, F-16, F-17, F-18, F-19, F-20

G-1, G-2, G-3, G-4, G-5, G-6

A, B, C, D, E, F, G

H-1A, H-1B, H-1C, H-1D, H-1E, H-1F, H-1G
H-2A, H-2B, H-2C, H-2E, H-2F
H-3A, H-3B, H-3C, H-3E, H-3F
H-4A, H-4C, H-4E, H-4F
H-5A, H-5C, H-5E, H-5F
H-6C, H-6E
H-7C, H-7E
H-8C, H-8E
H-9C
H-10C
H-11C
H-12C
H-13C

SCALE: 1" = 2000'
HYDROGRAPH POINT

SUB-BASIN AND HYDROGRAPH POINT INDEX

EXHIBIT 1

HYDROLOGIC SOIL GROUPS MAP

EXHIBIT 2

MASTER DRAINAGE PLAN
DOUGLAS CREEK DRAINAGE BASIN

HYDROLOGIC SOIL GROUPS
EXHIBIT 2
DATE: JANUARY, 1981
PROJECT NUMBER: 8006I

PREPARED BY:
LEIGH WHITEHEAD & ASSOCIATES
CONSULTING ENGINEERS
5 WEST LAS VEGAS ST.
COLORADO SPRINGS, COLORADO

DOUGLAS CREEK DRAINAGE BASIN BOUNDARY

HYDROLOGIC SOIL GROUP INDEX					
SYMBOL	FORMATION	A	B	C	D
Qp	PINEY CREEK ALLUVIUM			■	
Qls	LANDSLIDE DEPOSITS	■			
Qb	BROADWAY ALLUVIUM	■			
Qle	LOUVIER'S ALLUVIUM			■	
Qs	SLOCUM ALLUVIUM		■		
Qv	VERDOS ALLUVIUM	■			
Kdc	DAWSON FORMATION			■	
Kl	LARAMIE FORMATION			■	
Kf	FOX HILLS FORMATION			■	
Kp	PIERRE FORMATION				■
Kn	NIOBRARA FORMATION				■
Kcgg	CARLILE, GREENHORN & GRANEROS FM.			■	
Kdp	DAKOTA & PURGATOIRE FORMATIONS				■
Jmr	MORRISON & RALSTON CREEK FMS.			■	
PPl	LYKINS FORMATION			■	
Ply	LYONS FORMATION		■		
PPf	FOUNTAIN FORMATION			■	
MCr	MANITOU FORMATION		■		
Ypp	PIKES PEAK GRANITE		■		

SCALE: 1" = 2000'

HYDROLOGIC SOIL GROUPS

EXHIBIT 2

LAND USE MAP

EXHIBIT 3

MASTER DRAINAGE PLAN
DOUGLAS CREEK DRAINAGE BASIN

LAND USE MAP EXHIBIT 3	PREPARED BY LEIGH WHITEHEAD & ASSOCIATES CONSULTING ENGINEERS 5 WEST LAS VEGAS ST. COLORADO SPRINGS, COLORADO
DATE: JANUARY 1981 PROJECT NUMBER: 8006I	

DOUGLAS CREEK DRAINAGE BASIN BOUNDARY

PIKE NATIONAL FOREST

INTERSTATE HWY. NO. 25

SCALE 1" = 2000'

ND USE TABULATION
D LEGEND

OL	DESCRIPTION	PROPOSED & EXIST. CITY ZONES
	HIGH DENSITY RESIDENTIAL	M H P MULTI-FAM R-1 (6000) R-2 R-5 PUD MS R6, R30
	RESIDENTIAL	R-1 (9000) R A-1 A MS R2, 1/2
	COMMERCIAL	C-6 C-4 PBP PBC SCHOOLS
	INDUSTRIAL	PIP R-S D M-1
	OPEN SPACE	PARKS
	SUB-BASIN DIVISION	
	CITY LIMITS	

LAND USE MAP

EXHIBIT 3

PLATTED AREA MAP AND TABULATION

EXHIBIT 4

DEV. = Area fully developed but not platted.
RD. = Existing R.O.W. - Ground not subject to Drg. Fee

* When different than Total Area of Plat

SUBDIVISION NAME	PLAT BOOK/PG.	TOTAL AREA PLAT Acres	AREA WITHIN BASIN * Acres
Allied Sales	DEV.	4.22	
Beatrice Foods Co. Subdivision	A-2 15	3.871	
Blair Center Subdivision	J-2 2	4.847	
Buckingham Industrial Subdivision	M-2 22	16.923	
Budweiser Subdivision	E-3 77	3.499	
By Subdivision No. 1	R-2 52	0.546	
By Subdivision No. 2	A-3 11	5.430	
Capp Homes Filing No. 1	B-3 22	18.740	
Cascade Mobile Home Park	DEV.	21.54	
Chevron Subdivision Filing No. 2	L-2 45	5.000	
C & L Subdivision No. 1	W-2 88	4.599	
Cowen Subdivision No. 1	M-2 9	4.065	
Crossroads North Filing No. 1	L-2 29	3.300	
Crossroads North Filing No. 2	L-2 30	1.210	
Crossroads North Filing No. 3	M-2 1	4.000	
Crossroads North Filing No. 4	O-2 74	4.000	
Crossroads North Filing No. 5	N-2 74	3.170	
Crossroads North Filing No. 6	N-2 75	1.195	
Crossroads North Filing No. 7	N-2 76	4.420	
Crossroads North Filing No. 8	T-2 55	3.674	
Crossroads North Filing No. 9	V-2 44	6.134	
Crossroads North Filing No. 10	X-2 53	2.000	
Crossroads North Filing No. 11	W-2 78	0.823	
Crossroads North Filing No. 12	Z-2 29	1.730	
Crossroads North Filing No. 20	O-2 72	5.384	
Crossroads North Filing No. 21	P-2 52	5.673	
Crossroads North Filing No. 24	W-2 12	4.415	
Crossroads North Filing No. 30	Y-2 8	6.410	
Crossroads North Filing No. 31	G-3 54	5.318	
Crossroads North Filing No. 32	J-3 40	0.923	
C. S. International	DEV.	5.61	
Dixon Paper Co.	DEV.	3.00	
Fillmore & I-25 Mini Storage Subdivision	J-3 90	3.847	
Fire Station No. 9	DEV.	1.010	
Garden of the Gods Bank Subdivision	D-3 46	2.220	
Garden of the Gods Ind. No. 1	K-3 32	4.111	

PLATTED AREA TABULATION - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 4

DEV. = Area fully developed but not platted.
RD. = Existing R.O.W. - Ground not subject to Drg. Fee

* When different than Total Area of Plat

SUBDIVISION NAME	PLAT BOOK/PG.	TOTAL AREA PLAT Acres	AREA WITHIN BASIN * Acres
Garden of the Gods Ind. No. 2	L-3 44	1.578	
Garden of the Gods Ind. No. 3	M-3 34	1.408	
Graves Subdivision Filing No. 1	X-2 40	3.970	
Hallamore Subd. Filing No. 1 (Woodshed)	U-2 32	10.230	
Hewlett Packard First Filing	W-2 37	97.140	
H-K Subdivision	K-2 26	1.147	
Hilton Inn Subdivision No. 1	Y-2 6	14.666	
Holiday Park	N-2 63	38.082	3.00
Holland Park Park Tract	DEV.	19.63	
Holland Park Sub. No. 1 Filing No. 1	A-2 58	98.318	
Holland Park Subdivision No. 2	F-2 76	109.561	
Holland Park Subdivision No. 3	K-2 47	17.388	216.00
Holland Park Subdivision No. 5	M-2 41	8.313	Due to
Holland Park Subdivision No. 6	R-2 43	19.804	Overlap in Subdivision
Holland Park Subdivision No. 7	V-2 35	20.377	Boundaries
Holland Park Townhomes Subdivision	M-3 52	2.498	
Holland Park West No. 1	F-3 89	44.841	
Holland Park West No. 2	G-3 31	55.313	
Holland Park West No. 2A	G-3 26	2.967	
Holland Park West No. 3	H-3 88	19.877	
Holland Park West No. 4	K-3 16	4.950	
Holli Heights Subdivision	K-3 4	7.080	
Hotsy Subdivision	E-3 42	10.000	
J.B. & Adams Subdivision Filing No. 1	T-2 77	3.000	
J. & M. Subdivision Filing No. 4	I-3 7	4.177	
Jays Place	DEV.	1.62	
Jones-Sharp Subdivision	L-3 91	1.210	
Jones-Sharp Unplatted Drainage	DEV.	0.550	
Kaman Sciences Subdivision No. 1	X-2 25	11.065	
Kaman Sciences Subdivision No. 2	Z-2 17	16.032	
KSSS Subdivision	B-3 68	20.500	
K & W Subdivision No. 1	C-3 59	2.186	
K & W Subdivision No. 2	D-3 13	2.797	
Max-DonNorth Subdivision Filing No. 1	H-3 1	5.182	
McCullough Subdivision	Z-2 66	2.078	
Miles Hills Corporation Subdivision	U-2 77	3.000	
Mobile Oil Subdivision No. 1	O-2 43	0.781	

PLATTED AREA TABULATION - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 4

DEV. = Area fully developed but not platted.

* When different than Total Area of Plat

RD. = Existing R.O.W. - Ground not subject to Drg. Fee

SUBDIVISION NAME	PLAT BOOK/PG.	TOTAL AREA PLAT Acres	AREA WITHIN BASIN * Acres
Mostek Subdivision No. 1	K-3 45	32.020	
Mountain Shadows Subdivision Filing No.1	M-3 47	69.717	
Oak Valley Ranch Filing No. 1	M-3 73	40.484	
Oaks Filing No. 1	D-3 10	5.404	
Oaks Filing No. 2	D-3 76	3.020	
Oaks Filing No. 3	K-3 41	4.518	
Park West Filing No. 2	X-2 8	1.480	
Park West Filing No. 3(Replat No. 1)	H-3 97	4.536	
Pikes Peak Industrial Park No. 1	K-2 82	3.440	
Pikes Peak Industrial Park No. 2	L-2 57	19.411	
Pikes Peak Ind. Park Sub.No. 2 Fil.No.2	P-2 27	19.215	
Pikes Peak Ind. Park Sub.No. 2 Fil.No.3	P-2 60	2.998	
Pikes Peak Ind. Park No. 4	O-2 58	2.048	
Pinecliff No. 1	K-2 69	23.650	8.270
Pinecliff No. 2	S-2 51	24.917	0
Pinecliff No. 3	X-2 58	19.881	1.549
Pinecliff No. 4	J-3 80	27.340	23.250
Pinon Valley Filing No. 1	I-3 70	59.912	
Pinon Valley Industrial Park No. 1	M-3 8	2.023	
Pinon Valley Industrial Park No. 3	M-3 76	4.575	
Port Acres Subdivision	DEV.	1.270	
Quackenbush Subdivision	Y-2 5	0.689	
Ramada Inn	DEV.	6.785	
Red Barn Subdivision	P-2 32	5.710	
Reinhard Subdivision No. 1	X-2 61	0.804	
Russina Valley Subdivision	J-2 92	4.155	
Russina Valley Subdivision Filing No. 2	P-2 8	5.864	
Schroll Subdivision No. 3	E-3 20	3.188	
Sinton Dairy Subdivision	P-2 72	10.061	
Springs Business Park	I.P.	17.600	
Sunbird Cliffs	F-3 17	25.103	2.020
Sunbird Filing No. 1	Z-2 73	3.957	
Superior Subdivision	E-3 41	1.000	
Superior Subdivision Filing No. 2	I-3 82	1.304	
Sutton Subdivision No. 1	Z-2 57	1.347	
Tulsa Subdivision	K-2 36	5.100	
UTMC Subdivision	I.P.	14.468	

PLATTED AREA TABULATION - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 4

P.P. = Plat in the Process of being recorded.
DEV. = Area fully developed but not platted.
RD. = Existing R.O.W. - Ground not subject to Drg. Fee

* When different than Total Area of Plat

SUBDIVISION NAME	PLAT BOOK/PG.	TOTAL AREA PLAT Acres	AREA WITHIN BASIN Acres *
Western Auto Rental	DEV.	3.92	
Western Tool & Die Subdivision	A-3 23	1.527	
Wigand Subdivision	D-3 40	6.000	
MISCELLANEOUS RIGHTS-OF-WAY NOT SUBJECT TO DRAINAGE FEE			
Cascade Avenue	RD.	6.8	
Centennial Boulevard	RD.	10.5	
D&RGW Railroad	RR	18.2	
Ellston Drive	RD.	0.6	
Garden of the Gods Road	RD.	27.8	
Interstate 25	RD.	83.3	
Pikeview Reservoir & Monument Creek	DEV.	39.65	
Point of the Pines Road	RD.	1.5	
Rusina Railroad Spur	RD.	5.3	
Sinton Road	RD.	4.4	
Sutton Road	RD.	0.45	
Wilson Road	RD.	26.2	
GROUND CONSIDERED UNDEVELOPABLE (WEST OF CITY LIMITS)			
National Forest & Pikeview Quarry	-	1903.5	

PLATTED AREA TABULATION - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 4

SUMMARY OF AREAS

TOTAL BASIN AREA		6588 AC.
Platted Area within Basin (As of January 1, 1981)--Including Plat in Progress	1102 AC.	
Area Developed but Unplatted (Including 1904 AC. in Pike National Forest)	1974 AC.	
Area of Existing Rights-of-Way	225 AC.	
BASIN AREA PLATTED OR DEVELOPED		-3301 AC.
BASIN AREA UNPLATTED		3287 AC.
PLATTED AREA SUBJECT TO DRAINAGE FEES (See Below)		+ 52 AC
BASIN AREA SUBJECT TO FEES		3339 AC

The following subdivisions are platted but have not constructed facilities required or been credited for fee obligations:

NAME	ACREAGE
Capp Homes Filing No. 1	18.74
Red Barn Subdivision	15.71
Kaman Sciences Subdivision No. 1	11.07
Kaman Sciences Subdivision No. 2	16.03
	51.55 (Use 52 Acres)

MASTER DRAINAGE PLAN
DOUGLAS CREEK DRAINAGE BASIN

PLATTED AREAS MAP
EXHIBIT 4

DATE: JANUARY 1981
PROJECT NUMBER: 80061

PREPARED BY:
LEIGH WHITEHEAD & ASSOCIATES
CONSULTING ENGINEERS
5 WEST LAS VEGAS ST.
COLORADO SPRINGS, COLORADO

CITY LIMITS

OAK VALLEY RANCH

WILSON RD

GARDEN OF THE GODS RD.

CENTENNIAL BLVD.

CITY LIMITS

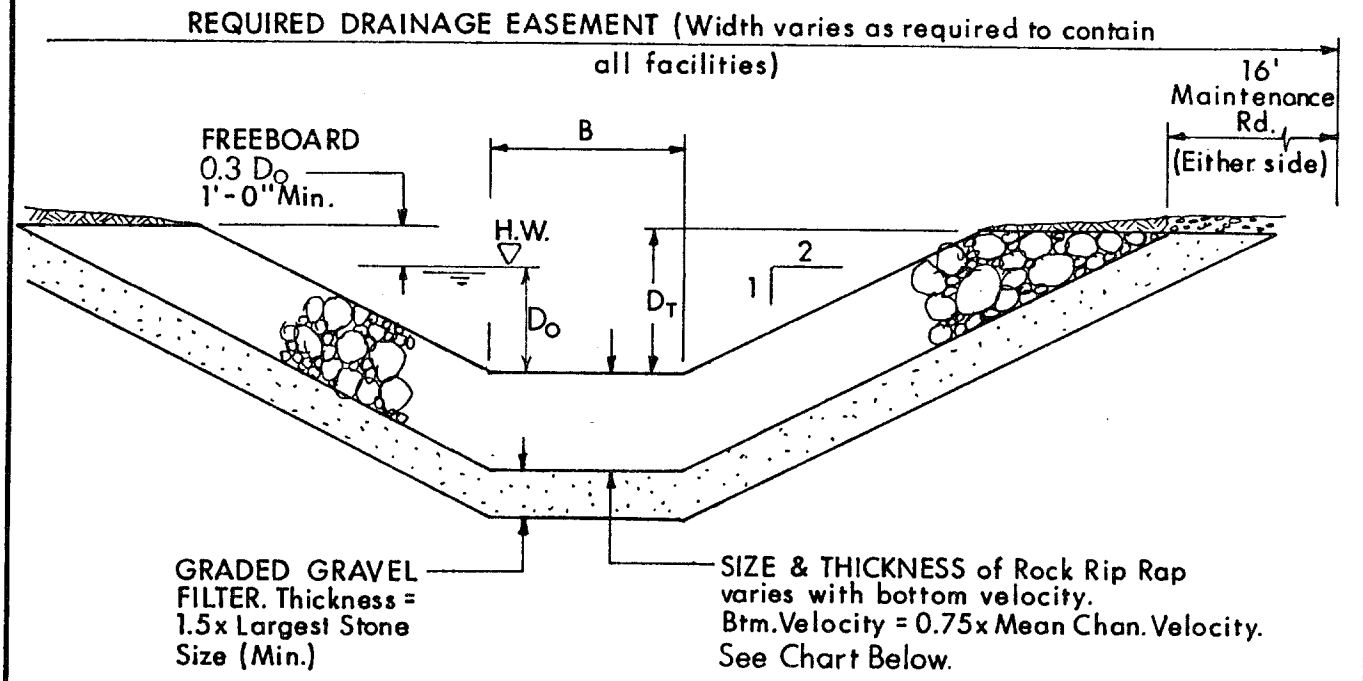
SUMMARY OF PLATTED AREA WITHIN THE BASIN		
DESCRIPTION	AREA	CODE
TOTAL PLATTED AREA WITHIN BASIN (INCL. PLATS IN PROCESS)	1102	
TOTAL AREA DEVELOPED BUT UNPLATTED INCLUDING FOREST PROPERTY (1904 AREA)	1974	
TOTAL AREA EXISTING RIGHT-OF-WAYS	225	
TOTAL PLATTED AREA IN BASIN	3301	
TOTAL BASIN AREA	6588	
TOTAL UNPLATTED BASIN AREA	3287	

PLATTED AREA MAP

EXHIBIT 4

TYPICAL SECTIONS

EXHIBIT 5



Design Grade (S) shall be as indicated.

D_o = Operating Depth

D_T = Total Depth

$D_T = 1.3\ D_o (D_o + 1.0'\text{Min.})$

CHANNEL DESIGN DATA

$$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$$

$n = 0.045$

$V_{max.} = 20$ f.p.s. (Mean Channel Velocity)

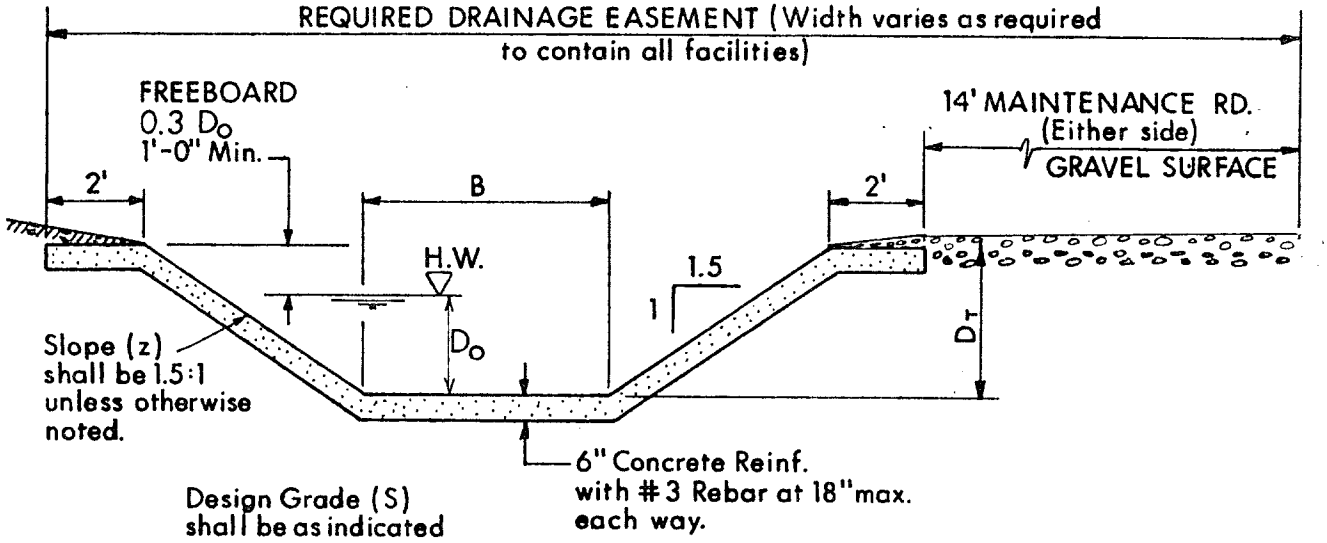
RIP RAP STONE SIZING CHART	
BTM.VELOCITY	STONE SIZE (Equiv. Diam.)
9	6"
12	9"
14	12"
16	18"
18	24"
20	30"
Thickness shall be 2 times stone size for stone sizes less than 12" and 1.5 times stone size for stone sizes greater than 12"	

NOTES

1. All final design and construction shall be to current City of Colorado Springs Standards and Specifications.
2. Final channel sizing is subject to Detailed Drainage Reports of the subject area.
3. Cutoff walls and Transitions may be required.

TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 5a. TYPICAL MAJOR CHANNEL SECTION - RIP RAP



CHANNEL DESIGN DATA

$$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$$

$n = 0.015$

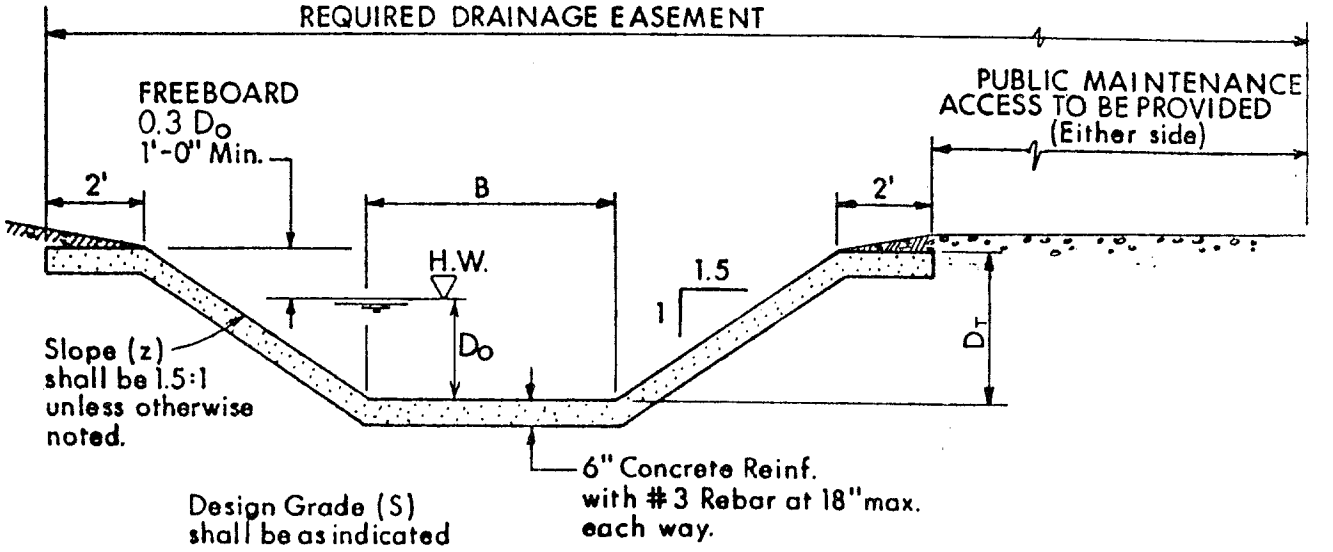
$V_{max.} = 30$ f.p.s.

D_O = Operating Depth
D_T = Total Depth

NOTES

1. All final design and construction shall be to current City of Colorado Springs Standards and Specifications.
2. Final channel sizing is subject to Detailed Drainage Reports of the subject area.
3. Cutoff walls shall be provided at maximum 200 intervals.
4. Extra height shall be provided along the outside edge of all curves.
5. Suitable transitions in and/or out of culvert headwalls or box culverts shall be provided at final design.
6. Drop structures shall be required as noted. SEE DETAIL-EXHIBIT 5d.
7. Guard rail required when major channel is adjacent to a public street.
8. The required 16' maintenance road can include 2' channel lip.
9. The reinforcing and concrete thickness is based on a Vmax of 30 fps. If lower velocities are attainable (20 fps) these parameters are subject to possible change at the discretion of the city engineer.

TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 5b. TYPICAL MAJOR CHANNEL SECTION - CONCRETE



CHANNEL DESIGN DATA

$$Q = A \frac{1.486}{n} R^{2/3} S^{1/2}$$

$n = 0.015$

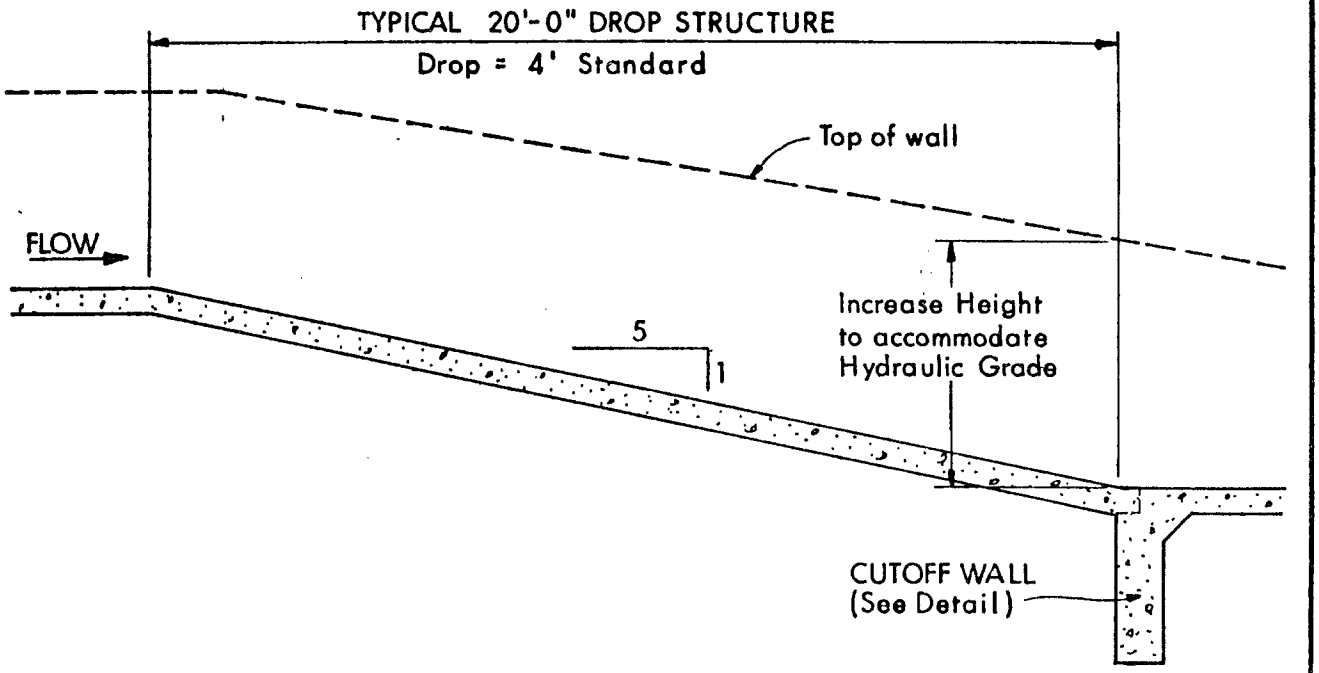
$V_{max.} = 30$ f.p.s.

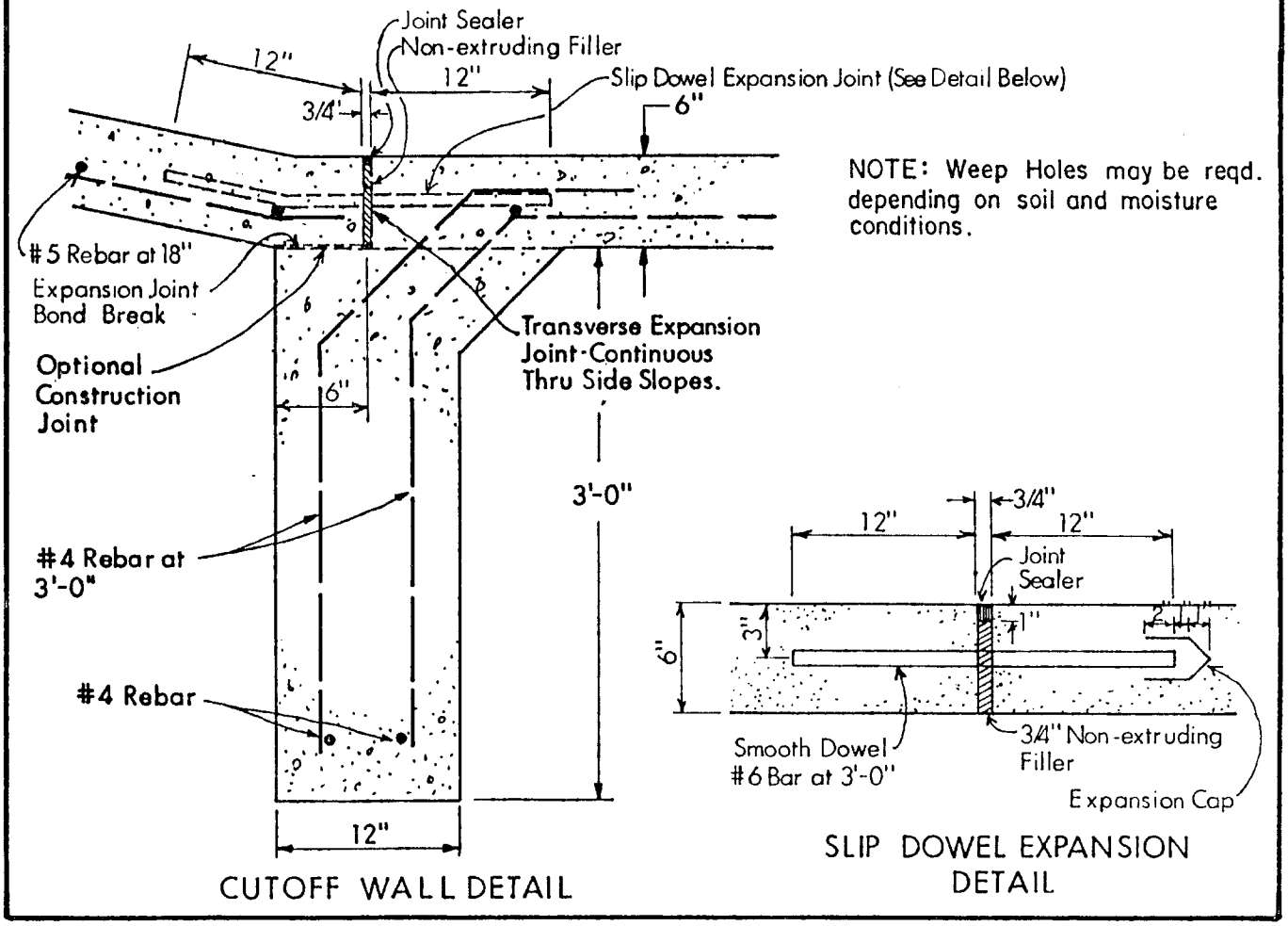
D_O = Operating Depth
D_T = Total Depth

NOTES

1. All final design and construction shall be to current City of Colorado Springs Standards and Specifications.
2. Final channel sizing is subject to Detailed Drainage Reports of the subject area.
3. Cutoff walls shall be provided at maximum 200 intervals.
4. Extra height shall be provided along the outside edge of all curves.
5. Suitable transitions in and/or out of culvert headwalls or box culverts shall be provided at final design.
6. Drop structures shall be required as noted. SEE DETAIL-EXHIBIT 5d.
7. Guard rail or other means of protection may be required by the city engineer when the storm system ditch is adjacent to public streets.
8. The reinforcing and concrete thickness is based on a Vmax of 30 fps. If lower velocities are attainable (20 fps) this parameters are subject to possible change at the discretion of the city engineer.

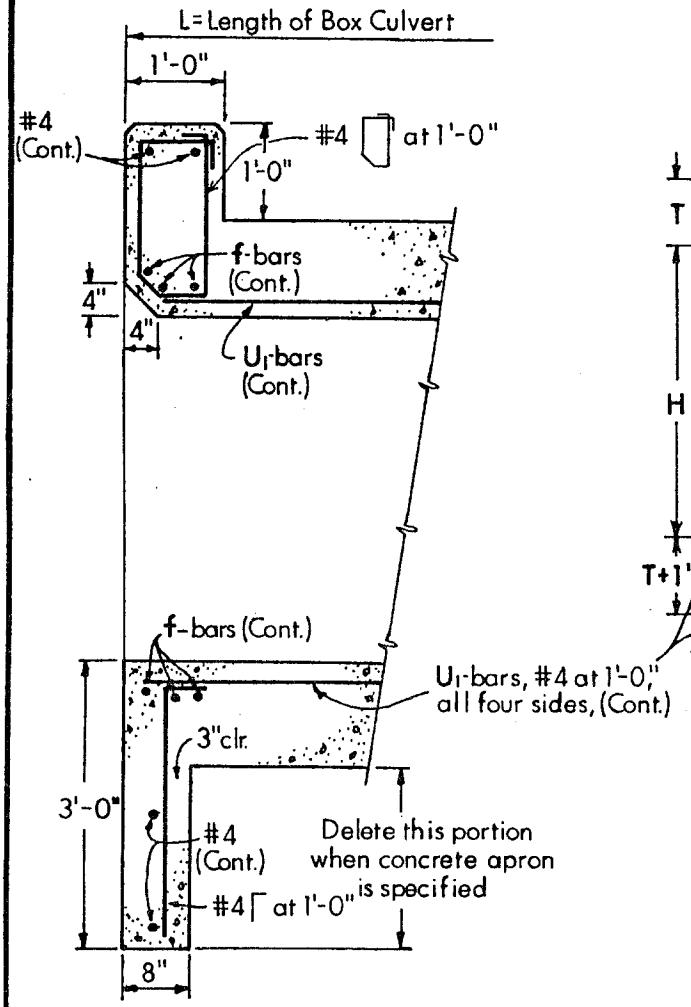
TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 5c. TYPICAL STORM SYSTEM DITCH SECTION



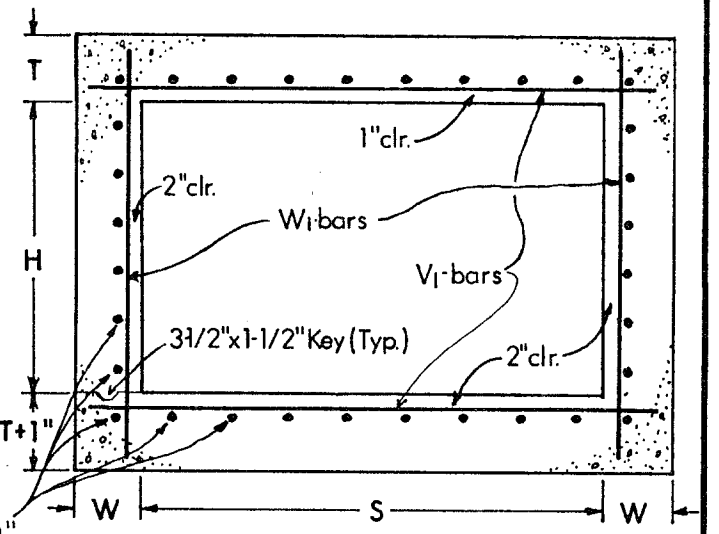


TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 5d. TYPICAL CHANNEL DROP STRUCTURE



NOTE: Size and spacing for V_1 & W_1 bars is shown in Table below.



GENERAL NOTES

1. ALL CONCRETE SHALL BE CLASS A.
2. CONSTRUCTION JOINTS SHALL BE SPACED AT 35' MAX. CENTERS AND SHALL EXTEND THRU THE ENTIRE CROSS SECTION OF THE BOX.
3. DESIGN DATA: AASHTO, 1973
   UNIT STRESSES: f_s = 20,000 p.s.i. f_c = 1,200 p.s.i.
   n = 10
4. LOADING DATA:
   LIVE LOAD = AASHTO, HS-20-44
   DEAD LOAD = Earth 84 lb./c.f. Fluid 30 lb./c.f.

BOX DIMENSIONS and QUANTITIES

MAX. HT. FILL	SPAN	HEIGHT	SLAB	WALL	BAR SIZE AND SPACING				NO. BARS REQ'D.	QUANTITIES Per Lin. Ft. of Box	
					V_1		W_1				
Ft.	S	H	T	W	SIZE	SPACING	SIZE	SPACING	U_1	CONCRETE Cu.Yds.	STEEL Lbs.
10	8	4	9-1/2"	10"	#6	7"	#4	7"	24	0.844	75.8
5	10	4	10-1/2"	12"	#7	8"	#4	8"	28	1.112	101.0
7	9	5	10"	11"	#7	8"	#5	8"	28	1.040	102.7
5	12	6	12"	12"	#7	7"	#4	7"	36	1.525	137.4

f-BARS (Cont.)

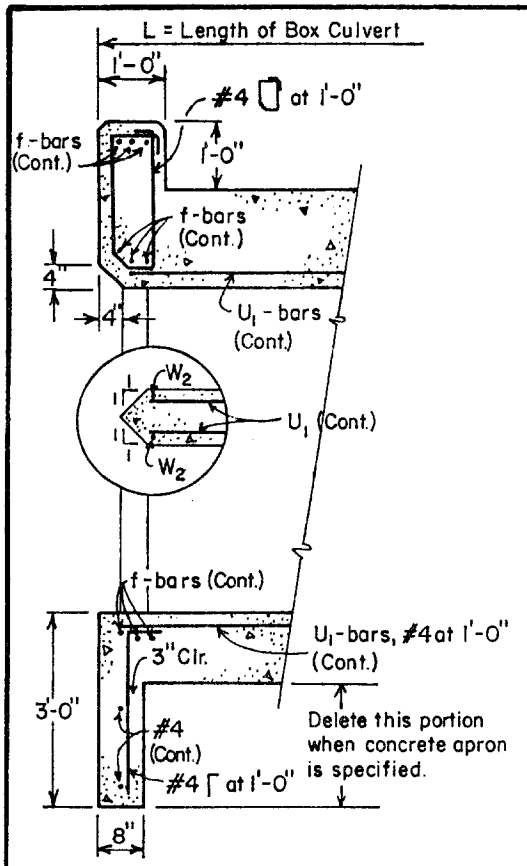
SPAN S	HEADWALL SKEW ANGLE		
	90° To 75°	74° To 60°	59° To 45°
7 or 8	#4	#5	#6
9 or 10	#5	#6	#7
11 or 12	#6	#7	#8

SIX f-BARS REQUIRED FOR EACH HEADWALL

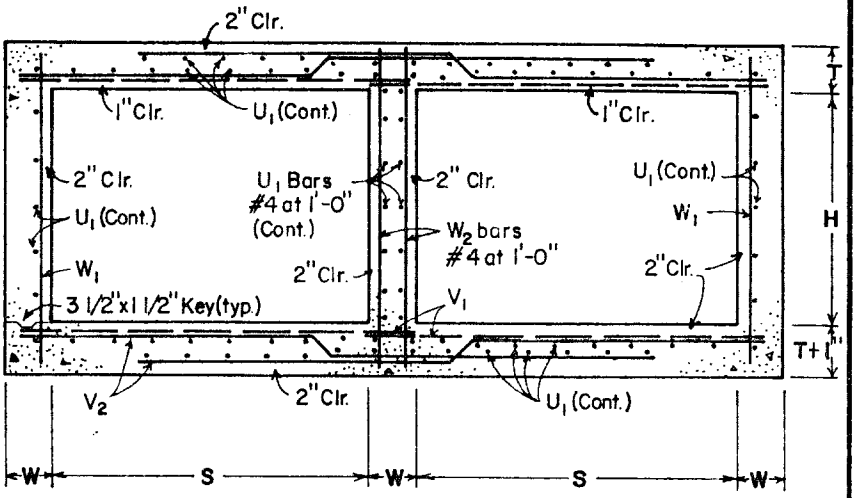
f-BAR SIZE	Approx. Quan./1 Hdwl. & Toe Wall (Lbs. per Linear Ft.)
4	13
5	15
6	18
7	21
8	25

CONCRETE: 0.085 Cu.Yd./Lin. Ft.

TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 5e. TYPICAL BOX CULVERT - SINGLE



NOTE: Size and spacing for V_1, V_2 and W_1 bars is shown in Table below.



GENERAL NOTES

1. ALL CONCRETE SHALL BE CLASS A.
2. CONSTRUCTION JOINTS SHALL BE SPACED AT 35' MAX. CENTERS AND SHALL EXTEND THRU THE ENTIRE CROSS SECTION OF THE BOX.
3. DESIGN DATA: AASHTO, 1973
   UNIT STRESSES: f_s = 20,000 psi f_c = 1,200 psi
   n = 10
4. LOADING DATA:
   LIVE LOAD = AASHTO, HS-20-44
   DEAD LOAD = Earth 84 lb./c.f. Fluid 30 lb./c.f.

BOX DIMENSIONS and QUANTITIES

MAX. HT. FILL	SPAN	HEIGHT	SLAB	WALL	BAR SIZE AND SPACING						NO. BARS REQ'D.	QUANTITIES Per Lin. Ft. of Box	
					V_1		V_2		W_1			CONCRETE	STEEL
Ft.	S	H	T	W	SIZE	SPACING	SIZE	SPACING	SIZE	SPACING	U_1	Cu. Yds.	Lbs.
10	8	5	10"	10"	#5	6"	#6	6"	#4	12"	68	1.662	185.2
5	10	5	10"	12"	#5	7"	#7	7"	#5	15"	82	2.046	235.2
5	10	7	10"	12"	#5	7"	#7	7"	#5	13"	90	2.269	249.0
5	10	8	10"	12"	#5	7"	#7	7"	#5	12"	94	2.380	255.2
5	10	10	10"	12"	#5	7"	#7	7"	#5	9"	102	2.602	275.5
5	12	6	12"	12"	#5	7"	#7	7"	#5	15"	98	2.751	278.9
5	12	8	12"	12"	#5	7"	#7	7"	#5	12"	106	2.973	294.5
5	12	10	12"	12"	#5	7"	#7	7"	#5	9"	114	3.195	315.0

f - BARS (Cont.)

SPAN S	HEADWALL SKEW ANGLE		
	90° TO 75°	74° TO 60°	59° TO 45°
8	#4	#5	#6
10	#5	#6	#7
12	#6	#7	#8

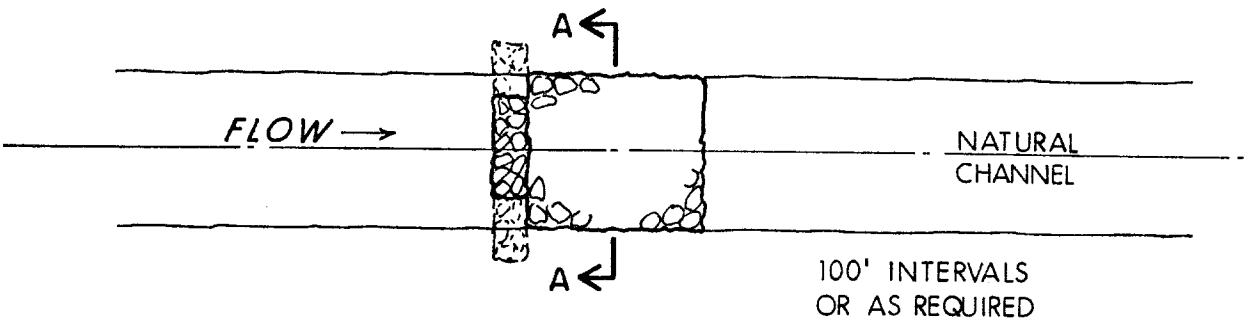
NINE f-BARS REQUIRED FOR EACH HEADWALL

f-BAR SIZE	Approx. Quan./1 Hdwl. & Toe Wall (Lbs. per Linear Ft.)
4	13
5	17
6	21
7	26
8	31

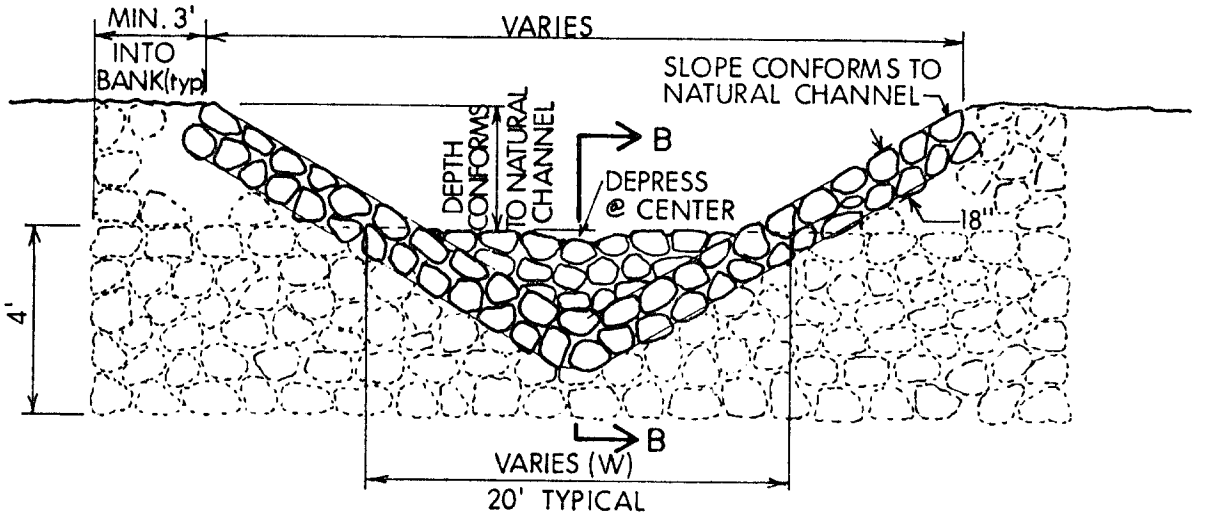
CONCRETE: 0.085 Cu.Yd./Lin.Ft.

TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN

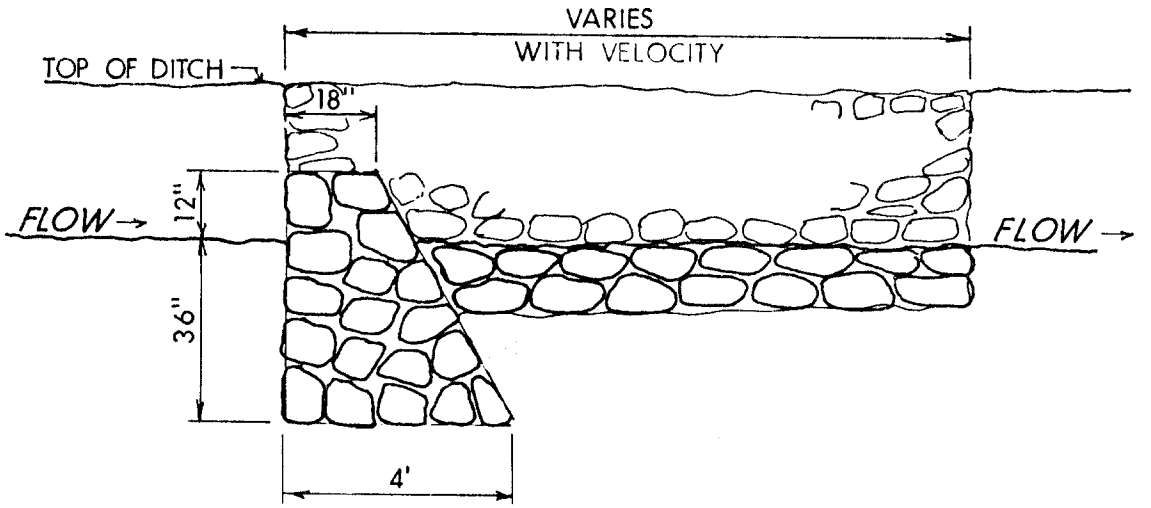
EXHIBIT 5f TYPICAL BOX CULVERT - DOUBLE



PLAN VIEW



SECTION A-A



SECTION B-B

NOTE: STONE SIZE VARIES WITH VELOCITY.
SEE EXHIBIT 5a. FOR SIZE.

TYPICAL SECTIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 5g. TYPICAL ROCK RIP RAP DITCH CHECK DAM

SUMMARY OF HYDROLOGIC COMPUTATIONS

EXHIBIT 6

SUB BASIN	AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
A 1	26	0.041	0.115	1.569	4.189	60	1240	0.08	0.53	4	27
2	106	0.166	0.143	1.586	4.235	60	1180	0.08	0.53	16	163
3	192	0.300	0.185	1.611	4.301	68	1095	0.23	0.90	76	296
4	143	0.223	0.116	1.570	4.192	76	1235	0.47	1.36	129	375
5	36	0.058	0.154	1.592	4.251	77	1150	0.505	1.43	34	95
6	39	0.061	0.123	1.574	4.203	76	1210	0.47	1.36	35	100
7	35	0.055	0.135	1.581	4.221	69	1195	0.255	0.955	17	63
8	56	0.088	0.096	1.558	4.160	80	1260	0.62	1.64	69	182
9	99	0.155	0.165	1.599	4.269	78	1130	0.54	1.50	95	263
10	38	0.059	0.095	1.557	4.157	78	1260	0.54	1.50	40	112
11	52	0.081	0.121	1.573	4.199	75	1230	0.435	1.30	43	130
12	111	0.173	0.208	1.625	4.338	82	1055	0.71	1.78	130	325
13	65	0.102	0.191	1.615	4.312	79	1080	0.58	1.57	64	173

SUMMARY OF HYDROLOGIC COMPUTATIONS-DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN	AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
	Acres	Sq. Miles						5 YR.	100 YR.	5 YR.	100 YR.
A 14	79	0.123	0.273	1.664	4.443	88	950	1.05	2.27	123	265
B 1	865	1.350	0.518	1.811	4.835	67	715	0.205	0.85	198	822
2	199	0.311	0.262	1.657	4.424	68	970	0.23	0.90	69	272
3	133	0.208	0.182	1.609	4.296	68	1100	0.23	0.90	53	206
4	36	0.056	0.190	1.614	4.309	75	1080	0.435	1.30	26	79
5	34	0.053	0.266	1.660	4.432	82	960	0.71	1.78	36	91
C 1	87	0.136	0.192	1.615	4.312	68	1080	0.23	0.90	34	132
2	75	0.117	0.269	1.661	4.435	60	955	0.08	0.53	9	59
3	94	0.147	0.212	1.627	4.344	60	1055	0.08	0.53	12	82
4	93	0.145	0.208	1.625	4.339	86	1050	0.92	2.10	140	320
5	41	0.064	0.220	1.632	4.357	81	1035	0.665	1.71	44	113

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN	AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
C 6	82	0.128	0.212	1.627	4.344	78	1055	0.54	1.50	73	203
7	110	0.172	0.180	1.608	4.293	72	1100	0.34	1.12	64	212
8	21	0.033	0.098	1.559	4.163	73	1260	0.37	1.18	15	49
9	23	0.036	0.084	1.550	4.139	78	1260	0.54	1.50	24	68
10	45	0.070	0.188	1.613	4.307	82	1085	0.71	1.78	54	135
11	87	0.136	0.136	1.582	4.224	82	1195	0.71	1.78	115	289
12	140	0.219	0.268	1.661	4.435	83	960	0.765	1.86	161	391
13	131	0.205	0.290	1.674	4.470	88	935	1.05	2.27	201	435
14	47	0.073	0.304	1.682	4.491	89	915	1.115	2.36	75	158
15	122	0.191	0.315	1.689	4.510	84	900	0.82	1.94	141	334
16	52	0.081	0.193	1.616	4.314	91	1080	1.255	2.545	110	223
17	73	0.114	0.266	1.660	4.432	87	960	0.985	2.185	108	239
18	52	0.081	0.212	1.627	4.344	86	1055	0.92	2.10	79	179

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN	AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
C 19	27	0.042	0.234	1.640	4.379	91	1010	1.255	2.545	53	108
20	49	0.077	0.242	1.645	4.392	89	1000	1.115	2.36	86	182
21	40	0.063	0.133	1.580	4.219	91	1190	1.255	2.545	94	191
22	69	0.108	0.325	1.695	4.526	83	890	0.765	1.86	73	178
23	22	0.034	0.186	1.612	4.303	86	1095	0.92	2.10	34	78
24	32	0.050	0.188	1.613	4.307	87	1085	0.985	2.185	53	119
25	24	0.038	0.282	1.669	4.456	83	945	0.765	1.86	28	67
26	46	0.072	0.226	1.636	4.368	87	1025	0.985	2.185	73	161
✓27	44	0.069	0.283	1.670	4.459	86	945	0.92	2.10	60	137
28	14	0.022	0.104	1.562	4.171	89	1250	1.115	2.36	31	65
29	23	0.036	0.172	1.603	4.280	68	1125	0.23	0.90	9	36
D 1	35	0.055	0.106	1.564	4.178	82	1250	0.71	1.78	48	122

SUMMARY OF HYDROLOGIC COMPUTATIONS-DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN		AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
		Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
D	2	10	0.016	0.075	1.545	4.125	86	1260	0.92	2.10	19	42
	3	28	0.044	0.189	1.613	4.308	77	1090	0.505	1.43	24	69
E	1	152	0.238	0.150	1.590	4.245	62	1165	0.11	0.62	19	108
	2	67	0.105	0.154	1.592	4.251	61	1150	0.095	0.575	12	69
	3	78	0.122	0.191	1.615	4.312	60	1085	0.08	0.53	11	70
	4	38	0.059	0.203	1.622	4.330	60	1060	0.08	0.53	5	33
	5	67	0.105	0.201	1.621	4.327	79	1060	0.58	1.57	65	175
	6	59	0.092	0.161	1.597	4.263	72	1145	0.34	1.12	36	118
	7	158	0.247	0.151	1.591	4.248	60	1155	0.08	0.53	22	151
	8	90	0.141	0.136	1.582	4.224	75	1195	0.435	1.30	73	219
	9	35	0.055	0.092	1.555	4.152	72	1260	0.34	1.12	24	78
	10	71	0.111	0.196	1.618	4.320	71	1070	0.31	1.065	37	126

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN		AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
		Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
E	11	86	0.134	0.229	1.637	4.372	70	1020	0.28	1.01	38	138
	12	44	0.069	0.133	1.580	4.219	84	1200	0.82	1.94	68	161
	13	17	0.027	0.123	1.574	4.203	83	1220	0.765	1.86	25	61
	14	74	0.116	0.197	1.618	4.288	90	1070	1.18	2.45	146	304
	15	25	0.039	0.062	1.537	4.104	79	1260	0.58	1.57	29	77
	16	30	0.047	0.112	1.567	4.184	90	1245	1.18	2.45	69	143
	17	26	0.041	0.115	1.569	4.189	89	1240	1.115	2.36	57	120
	18	19	0.030	0.112	1.567	4.184	88	1245	1.05	2.27	39	85
	19	99	0.155	0.132	1.579	4.216	81	1200	0.665	1.71	124	318
F	1	96	0.150	0.284	1.670	4.340	88	940	1.05	2.27	148	320
	2	95	0.148	0.332	1.699	4.536	86	885	0.92	2.10	121	275
	3	74	0.116	0.324	1.694	4.523	88	890	1.05	2.27	108	234

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN	AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
F 4	82	0.128	0.362	1.717	4.585	74	850	0.40	1.24	44	135
5	59	0.092	0.211	1.627	4.344	66	1055	0.18	0.80	17	78
6	44	0.069	0.190	1.614	4.309	90	1085	1.18	2.45	88	183
7	24	0.038	0.177	1.606	4.288	85	1105	0.87	2.02	37	85
8	59	0.092	0.192	1.615	4.312	81	1080	0.665	1.71	66	170
9	57	0.089	0.386	1.732	4.623	60	830	0.08	0.53	6	39
10	21	0.033	0.121	1.573	4.200	67	1225	0.205	0.85	8	34
11	39	0.061	0.241	1.645	4.392	88	1000	1.05	2.27	64	138
12	6	0.009	0.177	1.606	4.288	88	1105	1.05	2.27	10	23
13	42	0.066	0.205	1.623	4.333	80	1055	0.62	1.64	43	114
14	26	0.041	0.196	1.618	4.320	85	1075	0.87	2.02	38	89
15	70	0.109	0.340	1.704	4.550	79	875	0.58	1.57	55	150
16	37	0.058	0.177	1.606	4.211	84	1105	0.82	1.94	53	124

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

SUB BASIN		AREA		Tc (Hr.)	Tpo (Hr.)	Tb (Hr.)	CURVE NUMBER (CN)	PEAK DISCHARGE (CSM/IN.)	RUNOFF (Inches)		PEAK FLOW (c.f.s.)	
		Acres	Sq.Miles						5 YR.	100 YR.	5 YR.	100 YR.
F	17	69	0.108	0.195	1.617	4.317	89	1075	1.115	2.36	129	274
	18	20	0.031	0.099	1.559	4.163	91	1260	1.255	2.545	49	99
	19	32	0.050	0.167	1.600	4.272	78	1130	0.54	1.50	31	85
	20	27	0.042	0.158	1.595	4.258	85	1145	0.87	2.02	42	97
G	1	16	0.025	0.175	1.605	4.285	85	1110	0.87	2.02	24	56
	2	40	0.063	0.249	1.649	4.403	83	995	0.765	1.86	48	117
	3	17	0.027	0.199	1.619	4.324	86	1070	0.92	2.10	27	61
	4	26	0.041	0.132	1.579	4.216	83	1200	0.765	1.86	38	92
	5	70	0.109	0.214	1.628	4.348	85	1045	0.87	2.02	99	230
	6	23	0.036	0.200	1.620	4.325	81	1060	0.665	1.71	25	65
TOTAL BASIN AREA		6588	10.301									

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6a. SUB-BASIN RUNOFF

POINT NUMBER	AREA		Tc (Hr.)	COMMENTS	COMPOSITE CURVE NUMBER (CN)	PEAK DISCHARGE (CSM / IN.)	RUNOFF (In.)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles					5 YR.	100 YR.	5 YR.	100 YR.
H-1A	335	0.523	0.185	North Fork enters City from Pikeview A-3 & A-4	71.4	1095	0.322	1.087	184	623
H-2A	242	0.378	0.202	Oak Valley N. Property Line A-1, A-2, A-5, A-6, A-7	63.4	1060	0.131	0.683	53	274
H-3A	671	1.048	0.219	Oak Valley Junction A-1 Thru A-8 & A-10	69.5	1040	0.2675	0.9825	292	1071
H-4A	99	0.155	0.165	Oak Valley N. Property Line A-9	78	1130	0.54	1.50	95	263
H-5A	822	1.284	0.242	Oak Valley Junction A-1 Thru A-11	71.1	1005	0.313	1.0705	404	1381
H-1B	1064	1.663	0.518	Main Fork Enters City Limits B-1 & B-2	67.2	715	0.210	0.860	250	1023
H-2B	2200	3.438	0.579	Junction Main & N. Branch A-1 Thru A-12 & B-1 Thru B-5	69.5	675	0.2675	0.9825	621	2280
H-3B	2344	3.663	0.598	Main Fork @ Wilson Rd. A-1 Thru A-14 & B-1 Thru B-5	70.7	665	0.301	1.0485	733	2554
H-1C	256	0.400	0.269	Mtn. Shadows Road C-1 Thru C-3	60.5	955	0.0875	0.5525	33	211
H-2C	2734	4.272	0.617	Wilson Ranch/Pinon A-1 Thru A-14 (A's) B-1 Thru B-5 (B's) C-1 Thru C-5	70.4	655	0.292	1.032	817	2888
H-3C	2861	4.470	0.629	Pinon Valley A, B, & C-1 Thru C-6, & C-10	70.8	645	0.304	1.054	877	3039

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6b. ACCUMULATIVE RUNOFF

POINT NUMBER	AREA		Tc (Hr.)	COMMENTS	COMPOSITE CURVE NUMBER (CN)	PEAK DISCHARGE (CSM / IN.)	RUNOFF (In.)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles					5 YR.	100 YR.	5 YR.	100 YR.
H-4C	3058	4.778	0.647	Pinon Valley A, B, C-1 Thru C-7 & C-10 Thru C-11	71.2	635	0.316	1.076	959	3265
H-5C	3219	5.030	0.666	Erie Dr. A, B, C-1 Thru C-8 & C-10 Thru C-12	71.7	630	0.331	1.104	1049	3499
H-6C	3373	5.270	0.681	Garden of the Gods Ind. A, B, C-1 Thru C-13	72.4	620	0.352	1.144	1150	3738
H-7C	3542	5.534	0.709	Garden of the Gods Rd. A, B, & C-1 Thru C-15	73.0	605	0.370	1.18	1240	3951
H-8C	3670	5.734	0.728	Chestnut A, B, C-1 Thru C-17 & C-19 Thru C-20	73.9	595	0.397	1.234	1355	4210
H-9C	3835	5.992	0.744	I-25 A,B,C-1 Thru C-21	74.2	590	0.470	1.252	1439	4426
H-10C	3935	6.148	0.757	D&RGW RR A,B,C-1 Thru C-21&C-26 & Flow Split (C-23 & C-24)	74.5	580	0.418	1.270	1491	4540
H-11C	3979	6.217	0.769	Monument Creek A,B, C-1 Thru C-21&C-26& C-28 & Flow Split (C-23 & C-24)	74.6	575	0.421	1.276	1505	4561
H-12C(East)	81	0.127	0.325	Gard.of the Gods Rd.@ D&RGW Flow Split- E. thru from W.C-22 Only	83	890	0.765	1.86	86	210
H-12C (South)	54	0.084	0.300	Gard.of the Gods Rd.@ D&RGW Flow Split-S. thru from N.C-23& C-24	86.6	920	0.959	2.151	74	167
H-13C	78	0.122	0.374	Gard.of the Gods Rd. @ Monument Creek C-23 thru C-25	85.5	840	0.895	2.060	92	211

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6b. ACCUMULATIVE RUNOFF

POINT NUMBER	AREA		Tc (Hr.)	COMMENTS	COMPOSITE CURVE NUMBER (CN)	PEAK DISCHARGE (CSM / IN.)	RUNOFF (In.)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles					5 YR.	100 YR.	5 YR.	100 YR.
H-1E	219	0.342	0.152	City Limits near Chuck Wagon E-1 & E-2	61.4	1155	0.101	0.593	40	234
H-2E	402	0.628	0.202	Near Main Intersection E-1 Thru E-5	63.5	1060	0.1325	0.6875	88	458
H-3E	283	0.442	0.216	Hole-in-Wall-Lower E-7 thru E-9	64.6	1045	0.152	0.737	70	340
H-4E	901	1.408	0.248	Mtn. Shadows @ Junction E-1 thru E-11	65.6	1005	0.172	0.782	243	1107
H-5E	962	1.503	0.253	Mtn. Shadows @ Wilson E-1 Thru E-11 & E-13	66.8	985	0.200	0.840	296	1244
H-6E	129	0.202	0.079	Wilson from Hole-in-Wall E-14 thru E-16	87.9	1260	1.0435	2.2615	266	576
H-7E	1117	1.745	0.265	Gard. of the Gods E-1 thru E-11 and E-13 thru E-17	69.7	965	0.2725	0.9935	459	1673
H-8E	1235	1.930	0.278	Main Chan. Hill Property above Mostek E-1 thru	70.9	945	0.307	1.0595	560	1932
				E-11 & E-13 thru E-19						
H-1F	1546	2.416	0.333	Main Channel Below Mostek E, F-1&F-3 thru F-5	72.8	875	0.364	1.168	770	2469
H-2F	1846	2.884	0.345	Centennial E & F-1 thru F-10	73.8	865	0.394	1.228	983	3063
H-3F	1959	3.061	0.357	Holland Park E & F-1 thru F-14	74.4	855	0.414	1.264	1084	3308
H-4F	2155	3.367	0.391	Chestnut St. E & F-1 thru F-18	75.3	825	0.4455	1.318	1238	3661

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6b. ACCUMULATIVE RUNOFF

POINT NUMBER	AREA		Tc (Hr.)	COMMENTS	COMPOSITE CURVE NUMBER (CN)	PEAK DISCHARGE (CSM / IN.)	RUNOFF (In.)		PEAK FLOW (c.f.s.)	
	Acres	Sq.Miles					5 YR.	100 YR.	5 YR.	100 YR.
H-5F	2214	3.459	0.414	Monument Creek South Fork E & F-1 thru F-20	75.5	800	0.4525	1.330	1252	3680
H-1G	126	0.197	0.125	Monument Creek Below Railroad G-1 G-2 & G-5	84.4	1210	0.840	1.972	200	470

SUMMARY OF HYDROLOGIC COMPUTATIONS - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6b. ACCUMULATIVE RUNOFF

POINT	ACCUMULATIVE FLOW - 100 YR. - C.F.S.				COMMENTS
	1981	1974	OTHER	SOURCE	
H-1A	623	-			
H-2A	274	104			
H-3A	1071	-	1020	GJW	
H-4A	263	240			
H-5A	1381	-	1271	GJW	
H-1B	1023	770	681	GJW	
H-2B	2280	-			
H-3B	2554	1880	2280	GJW	Wilson Road (+ 36%)
H-1C	211	235	243	GJW	
H-2C	2888	-	2181	Pinon Valley	
H-3C	3039	2387	2406	Pinon Valley	
H-4C	3265	2828	2702	Pinon Valley	
H-5C	3499	2962	2802	Pinon Valley	Erie Drive
H-6C	3738	3245	3057	Garden of the Gods Ind. & Pinon Valley	
H-7C	3951	-	3223 3398	Garden of the Gods Indust. Oaks	Garden of the Gods Road
H-8C	4210	3523	4500 3523	Spgs. Business Pk. Oaks	Chestnut Street

SUMMARY OF HYDROLOGIC COMPUTATIONS
DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6c. TABULATION OF ACCUMULATIVE FLOWS

POINT	ACCUMULATIVE FLOW - 100 YR. - C.F.S.				COMMENTS
	1981	1974	OTHER	SOURCE	
H-9C	4426	3541	4900	Springs Business Park	I-25 (25%)
H-10C	4540	3605			
H-11C	4561	3687			Outfall (+ 24%)
H-12C	87(5)210(E) 74(5)167(S)	85 (5 YR.)			
H-13C	211 (92) 5 YR.	92 (5 YR.)			
H-1E	234	220	195	GJW	
H-2E	458	316	440	GJW	
H-3E	340	266	337	GJW	
H-4E	1107	-			
H-5E	1244	-	1261	Mountain Shad. Filing No. 1	
H-6E	576	-	530	Mountain Shad. Filing No. 1	
H-7E	1673	-	1630	GJW	Garden of the Gods Road
H-8E	1932	1446	2300	Mostek	Below Garden of the Gods (+ 34%)
H-1F	2469	2196	2600	Mostek	

SUMMARY OF HYDROLOGIC COMPUTATIONS
DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6c. TABULATION OF ACCUMULATIVE FLOWS

POINT	ACCUMULATIVE FLOW - 100 YR. - C.F.S.				COMMENTS
	1981	1974	OTHER	SOURCE	
H-2F	3063	2503	2500	Holland Park North	Centennial
H-3F	3308	-	952	Holland Park North	
H-4F	3661	2797	3634	Holland Park North	Chestnut
H-5F	3680	2893			Outfall (+ 27%)

SUMMARY OF HYDROLOGIC COMPUTATIONS
DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 6c. TABULATION OF ACCUMULATIVE FLOWS

TABLE NO. 1

Runoff curve numbers for selected agricultural, suburban, and urban land use. (Antecedent moisture condition II, and $I_a = 0.25$)

Land Use Description	Hydrologic Soil Group A	B	C	D
Cultivated land[1]: without conservation treatment	72	81	88	91
: with conservation treatment	62	71	78	81
Pasture or range land: Poor condition	68	79	86	89
: Good condition	39	61	74	80
Meadow: Good condition	30	58	71	78
Wood or Forest land: thin stand, poor cover, no mulch	45	66	77	83
: good cover[2]	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.				
good condition: grass cover on 75% or more of the area	39	61	74	80
fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial districts (72% impervious).	81	88	91	93
Residential:[3]				
Average lot size / Average % Impervious[4]				
1/8 acre or less / 65	77	85	90	92
1/4 acre / 38	61	75	83	87
1/3 acre / 30	57	72	81	86
1/2 acre / 25	54	70	80	85
1 acre / 20	51	68	79	84
Paved parking lots, roofs, driveways, etc.-	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers-	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89

For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, August 1972.

EXHIBIT 6d. TABLE NO. 1
RUNOFF NOS./SELECTED USE

TABLE NO. 2

Determination of Runoff Depth in inches for selected CN's and rainfall amounts (Q)

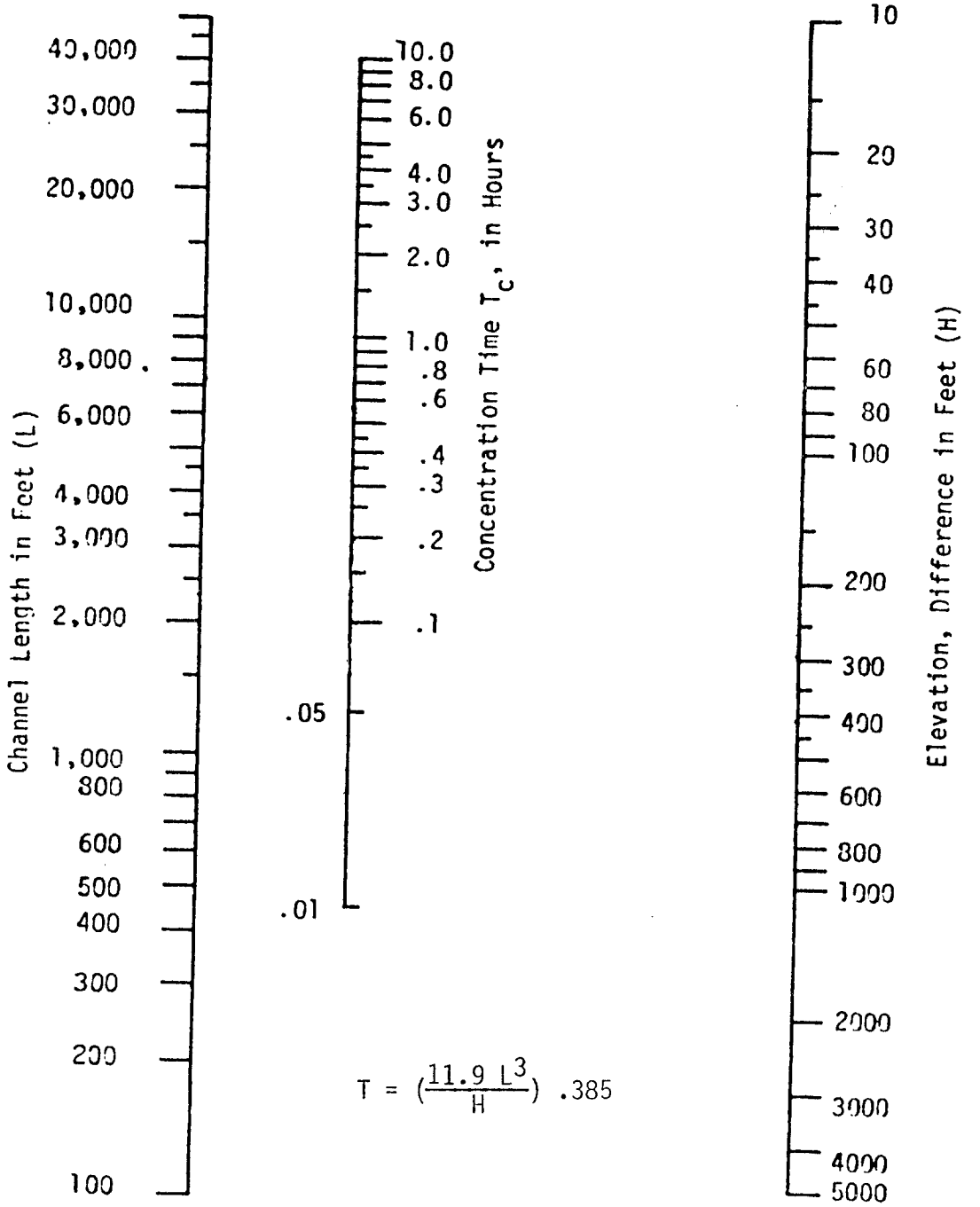
Curve Number [1]	(P) Rainfall (Inches) 2.10	3.50
56	0.03	0.38
58	0.05	0.45
60	0.08	0.53
62	0.11	0.62
64	0.14	0.71
66	0.18	0.80
68	0.23	0.90
70	0.28	1.01
72	0.34	1.12
74	0.40	1.24
76	0.47	1.36
78	0.54	1.50
80	0.62	1.64
82	0.71	1.78
84	0.82	1.94
86	0.92	2.10
88	1.05	2.27
90	1.18	2.45
92	1.33	2.64
94	1.49	2.84
96	1.67	3.04
98	1.87	3.27

1/ To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use arithmetic interpolation or:

$$Q = \frac{CN\,(P + 2)^2 - 400\,(P+2 - \frac{100}{CN})}{CN\,(P - 8) + 800}$$

EXHIBIT 6d. TABLE NO. 2
RUNOFF DEPTH / CN & Q

TABLE NO. 3



Estimating Tc from Lengths and Slopes of Natural Channels

T = Tc in hours
L = Length of longest water course in miles
H = Elevation difference in feet

EXHIBIT 6d. TABLE NO. 3
Tc / LENGTH-SLOPE CHANS.

TABLE NO. 4

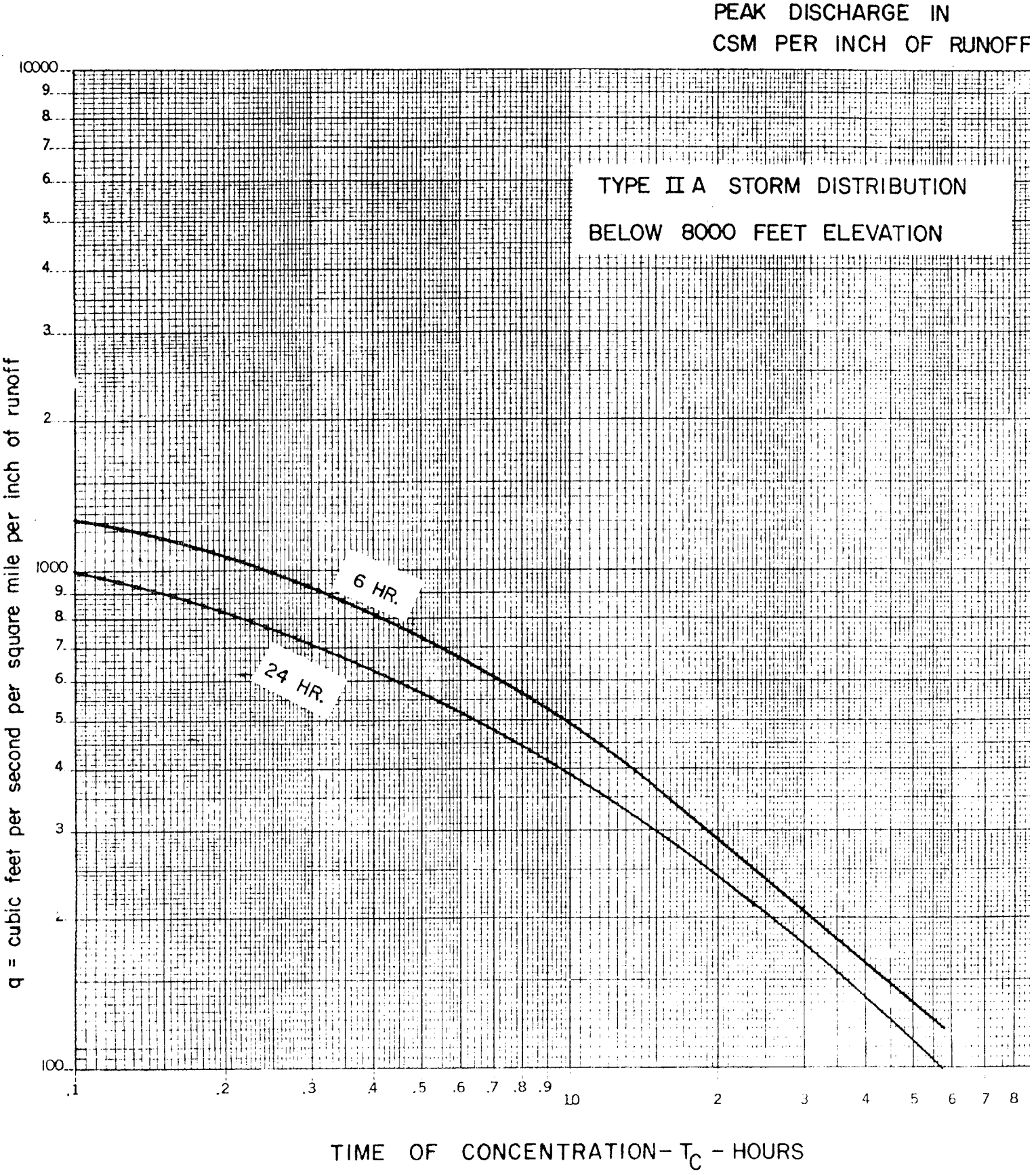


EXHIBIT 6d. TABLE NO. 4
PEAK DISCHARGE (CSM/IN. RUNOFF)

SUMMARY OF HYDRAULICS

EXHIBIT 7

NOTE: Under the "Construction Responsibility" heading the number in parenthesis (40') is recommended right-of-way width

FROM	TO	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR	LENGTH (FT.)	AVERAGE SLOPE (%)	EXISTING FACILITY	REQUIRED FACILITY	ESTIMATED COST	CONSTRUCTION RESPONSIBILITY	COMMENTS
Basin Boundary	West Limits Pikeview Quarry	53	236	4500	33	Natural Channel	None	-	-	Pike National Forest
West Limit Pikeview Quarry	H-1A	76	296	2000	18	Unimproved Channel	Rock Riprap Chan. B=8' D=3' 2:1 Sides @18% V=18 fps 24" Rock 36" Thick	$125,000	Developer (50')	Out of City Not Incl. in Fee
H-1A	A-8/ A-10 Bdry.	185	622	1300	10	Small Unimproved Channel-Alluvial Fan	Rock Riprap Chan. B=8' D=4' 2:1Sides @10% V=16 fps 18"Rock 27"Thick	$ 67,000	Developer (50')	Remove Pond
A-8/ A-10 Bndry	H-3A	246	786	1300	8	Small Unimproved Channel-Alluvial Fan	Conc.Chan.B=8' D=3.5'1½:1 Sides @4% V=29 fps-4' Drops @100' Intervals	$ 90,000	Developer (40')	Possible Rock Riprap Alternate
H-3A	H-5A	303	1102	1600	5	Well Defined Natural Channel	Conc.Chan. B=8' D=4'1½:1 Sides@3.5% V=29fps-3' Drops @ 200' Intervals	$114,000 +$ 20,000to Adj.Water Line	Developer (40')	24"Exist. Waterline Conflicts with Chan.
H-5A	H-2B	481	1576	3000	3.5	Diversion from Historical Routing Proposed	Conc.Chan.B=8' D=5'1½:1 Sides @ 2.75% V=30fps-3' Drops @400'Intervals Guardrail one side	$243,000 +$ 36,000 Guardrail	Developer (45')	Re-routing Natural Channel
Basin Bdry.	H-1B	198	822	17000	15	Natural Channel	Rock Riprap Check Dams @100'Intervals W=3 D=6'x50' Long V= 15fps 18"Rock	$ 9,000	Developer	Lower 1000' in City Limits but prob.Park Bal=Pike Forest
H-1B	H-2B	305	1196	4400	6	Natural Channel	Conc.Chan.B=8'D=4' 1½:1 Sides @4%V=31 fps-2' Drops @100' Intervals	$325,000 +$ 20,000to Adj.Waterline	Developer (40')	Remove Pond
H-2B	H-3B	621	2280	1400	3.5	Natural Channel	Conc.Chan.B=10' D=6.25'1½:1 Sides @ 2.0% V=29fps-3' Drops@200'Intervals	$140,000	Developer (50')	Wilson Rd. Crossing-Culvert Inventory
H-3B	H-2C	749	2586	2300	2	Small Meandering Natural Channel Not well defined	Conc.Chan. B=10' D=7.25' 1½:1Sides @1% V=25fps-3'Drop @400' Intervals	$259,000	Developer (55')	Remove Pond No Master Plan Available
H-2C	H-3C	835	2921	1450	2.5	Well Defined But Small Channel Re-routing Proposed	Conc.Chan.B=10' D=7.75'1½:1 Sides @1% V=26fps-2.5' Drops@200' Intervals	$131,000	Developer (55')	Pinon Valley 2181 CFS Master
H-3C	H-4C	898	3099	2100	2.2	Well Defined But Small Chan.Re-routing Proposed	Conc.Chan.B=10' D=8'1½:1 Sides @ 1.2% V=26fps-4' Drops@400'Intervals	$239,000	Developer (55')	Pinon Valley 2486 CFS-Much Smaller Chan. w/Higher Veloc.

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 7a. MAJOR CHANNEL NORTH

NOTE: Under the "Construction Responsibility" heading the number in parenthesis (40') is recommended right-of-way width.

FROM	TO	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR.	LENGTH (FT.)	AVERAGE SLOPE (%)	EXISTING FACILITY	REQUIRED FACILITY	ESTIMATED COST	CONSTRUCTION RESPONSIBILITY	COMMENTS
H-4C	H-5C	1014	3422	2200	2.5	Conc.Chan.B=10' D=5' 1½:1 Sides Capacity @2.8% w/ no Freeboard is	Remove E.Side Exist.Conc.Chan.Add 10'of Btm&New E. WallB=20' D=5'@2.5%	$135,000	Developer ?	Design Flow Pinon Valley 2702cfs Slope 2.8% High
						3098cfs V=35.4fps	V=31fps Widen Box			Vel.
H-5C	H-6C	1059	3529	1700	2	Unimproved Chan. w/Lining Proposed Some Earth Work Completed	Energy Dissipator & Conc.Chan.B=12' D-8'1½:1Sides @1%-4' Drops@400' Int.	$206,000 +$ 35,000 Energy Dissipator	Developer (60')	G.of G.Ind. & Pinon Valley 2802cfs Consider
							V=27 fps			Super.
H-6C	H-7C	1168	3781	3250	2.5	Unimp.Chan. w/Lin. Proposed. Some Earthwork Complete	Conc.Chan.B-12' D=8.25' 1½:1 Sides @1.25% V=28fps 2.5 Drops @200'Inter-	$410,000	Developer (60')	Chan.Length may allow chan.smaller @ upper end.
							val Curve Protection req'd. Cost incl. in Chan.			Consider Super.
H-7C	H-8C	1298	4081	2600	2.5	Conc.Chan. B=8' D=7.5' 1:1 Sides Des.3.75% Actual 2.75% Flow Depth	Add 1.5' to both sides Chan.@ lower curve N.Side Asphalt pave park-	$126,000	Developer	Correct upstream curve in new G.of G. Bridge
						6.9' V=40 fps F.B.=0.6'	lot to new top chan. S.Side Remove S.Wall & Construct Vert. Wall @ Curve			Str.Freeboard 0.6'
H-8C	H-9C	1439	4426	1550	3	Conc.Chan. B=13' D=8'9" 2:1 Sides@ 1%W/6-4' Drops V= 25 fps	None	-	-	Channel Oversized Slightly
H-9C	H-10C	1465	4483	1400	2	Well Defined Nat'l Chan. D Varies-12' Avg. B Varies-20' Avg.	Rock riprap Chan. B=20' D=11' 2:1 Side @2% V=15fps No Drops Required	$252,000	Developer (70')	Rock due to Ground Water Constr.Prob &Cost Effect.
H-10C	H-11C	1498	4551	1250	2.5	Well Defined Nat'l Chan. D Varies	Rock riprap Chan. B=20' D=11' 2:1 Sides @2.5% V=16fps No Drops Req'd.	$232,000	Developer (70')	Incl. Trans. to Monument Creek
							Total Estimated Facility Cost Developer-------	$3,214,000	(No Cont.or	Engr.)

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 7a MAJOR CHANNEL NORTH

NOTE: Under the "Construction Responsibility" heading the number in parenthesis (40') is recommended right-of-way width.

FROM	TO	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR.	LENGTH (FT.)	AVERAGE SLOPE (%)	EXISTING FACILITY	REQUIRED FACILITY	ESTIMATED COST	CONSTRUCTION RESPONSIBILITY	COMMENTS
Basin Bdry.	H-1E	19	108	4700	25	Natural Channel	Rock riprap Check Dams @100' Intervals W=3' D=6'x50' Long. V=15fps-18"	$ 9,000	Developer	Upper Part Pike Nat'l For. Lower
							Rock x 1000'			1000' Chuck-Wagon
H-1E	H-2E	88	437	2500	7	Well Defined Natural Channel	Gunite Line Existing Natural Chan. no Earthwork Req'd	$ 98,000	Developer	Maintain as Close to Nat'l Chan. as Possible
H-2E	H-4E	145	664	3800	5.25	Well Defined Nat'l Chan. Upper End	Conc. Chan. B=D=4' 1½:1 Sides @3.75% V=28 fps 3' Drops	$ 238,000	Developer (40')	Long Chan. so smaller size ok near upper end
H-4E	H-5E	296	1244	1250	5	No Defined Chan. Broad Outwash Area	Conc. Chan. B=6' D=4.75' 1½:1 Sides @3.0% V=29fps 4' Drops @ 200' Inter.	$ 93,000	Developer (45')	Strip Park Tract Parallel to 24" Waterline
H-5E	H-7E	406	1480	1300	4	Broad Outwash Area-Small Defined Channel-Stock Pond	Conc. Chan. B=8' D=5' 1½:1 Sides @ 2% V=28 fps 4' Drops @ 200' Inter.	$ 116,000	Developer (45')	Remove Stock Pond. Diversion From Previous Master Plan
H-7E	H-8E	560	1932	1200	4.5	Well Defined Nat'l Chan.-Lower End. Outwash Plain-Upper Area	Conc. Chan. B=12' D=4.75' 1½:1 Sides @2% V=28fps-4' Drops @200' Inter.	$ 110,000	Developer (50')	-
H-8E	Upper End Mostek Channel	602	2039	1000	2	Unimproved, well Defined Natural Channel	Conc. Chan. B=12' 5.5' 1½;1 Sides @ 2% V=29fps No Drops Req'd.	$ 99,000	Developer (50')	-
Upper End Mostek Channel	Lower End Mostek Channel	728	2362	2300	2.3 (1% Act.)	Conc. Chan. B=20' D=8' 1½:1 Sides @ 1% W/6' Drops @ 300' Cap @ D_o = 6.15'	None-Transition In & Out-Costs Incl. in 2 Channels	–	–	Chan. is Oversized as it exists
						of 5400 cfs V=30fps				
Lower End Mostek Channel	H-2F	791	2528	1650	1.6	Unimproved Nat'l Channel-Good Condition	Conc. Chan. B=12' D=6.25' 1½:1 Sides @ 1.6% V=27fps No Drops Required	$ 172,000	Developer (50')	A Detention Pond was at One Time Prop. Here
H-2F	H-3F	1008	3124	1300	1.7	Unimproved Nat'l Chan.(s)-Good Cond.-Some Encroachment	Conc. Chan. B=12' D=7' 1½:1 Sides @ 1.7% V=30fps No Drops Required	$ 143,000	Developer (55')	-

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 7b. MAJOR CHANNEL SOUTH

NOTE: Under the "Construction Responsibility" heading the number in parenthesis (40') is recommended right-of-way width.

FROM	TO	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR.	LENGTH (FT.)	AVERAGE SLOPE (%)	EXISTING FACILITY	REQUIRED FACILITY	ESTIMATED COST	CONSTRUCTION RESPONSIBILITY	COMMENTS
H-3F	H-4F	1161	3485	3400	2.2	Rock Riprap Chan. B=8' D=4' 1½:1 Sides-Lower 800' Chan. Tree Growth	Loose Rock Riprap B=8' D=4' 1½:1 Sides @2% V=10fps 6" Rock Deep.	$41,000 Includes	Developer (Park)	Construction of Pilot Chan.Lining
						Heavy-No Imp. Width Varies	Energy Dissipator Below Box	$20,000 for Energy Dissipator		Diff. Due to Topography
H-4F	H-5F	1249	3676	2000 (Excluding Crossings)	3.1	Very well defined and Established Natural Channel	Rock Riprap Chan. B=20' D=9' 2:1 Sides @3% V=16fps	$350,000	Developer (65')	Incl. Conc. Trans. to & From Exist.
							No Drops Required			Str.-Crosses Chestnut-I-25, Sinton & RR
							Total Estimated Facility Cost Developer--------	$1,469,000	(No Cont. or Engr.)	

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 7b MAJOR CHANNEL SOUTH

APPROXIMATE LOCATION	ARTERIAL STREET	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR.	EXISTING FACILITY	REQUIRED FACILITY	LENGTH	ESTIMATED COST BY	COMMENTS
H-7C	Garden of the Gods Road (North Branch)	1240	3951	CMP Str. Plate Arch, 11'x15', L=84' @50° to ℄. Cond. Very Poor (Support Rods inhibit Flow) Capacity Indeterminent.	RCB Double 10'x 10' @ 1.5% with Transistions Ea. End @ 60° to ℄. V=28fps-Probable Utility Adjustments Req'd. Removal of Exist. Facility Required	R.O.W. 110' Structure 127' on Skew	$ 25,000 Removal $115,000 Structure $ 50,000 Util.Adj. $190,000 Total 72% Bride $136,800 28% City $ 53,200 Developer	Existing OK for Historical Flows if Inlet is Kept in Good Condition. Final Design Should Consider Using Exist.Struc.
H-7E	Garden of the Gods Road (South Branch)	459	1673	None-36" Equiv. CSP Arch Approx. 300' W. of Crossing. 42" Equiv.CSP Arch Approx.400' E.of crossing. Apparently Adequate for Historical Flows	RCB Double 5'x10' @ 2.0% w/Transitions, @ 90° to Road ℄ . V=27 fps Adjust 4" Gas, 8" Gas, Elec. Duct Run.	R.O.W. 110' Structure 110' @ 90°	$62,000 Structure $25,000 Util.Adj. $87,000 Total 72% Bridge $62,640 28% City $24,360 Developer	Located Relative to Exist. 24" Waterline and Easement
H-2F	Centennial Blvd. (South Branch)	791	2528	None-Proposed Centennial Blvd.	RCB Double 7'x10' @1.5% with Transitions, @ 40° to ℄. V=26 fps. No utility Conflicts - Road Proposed	R.O.W. 100' Structure 156' @ 40°	$ 97,000 No Added Cost for Utility Adjustments 85% Bridge $82,450 15% City $14,550 Developer	Most of Increased Flow at This Point is from 54" Pipe Entering Below Box Culvert. Location of Proposed Centennial Blvd.
				Total Estimated Facility Cost	City Arterial Bridge Fund		$ 92,110 $ 281,890	(No Contingency or Engineering)

SUMMARY OF HYDRAULICS (Facilities Inventory) · DOUGLAS CREEK DRAINAGE BASIN

EXHIBIT 7c. BRIDGE INVENTORY

APPROXIMATE LOCATION	CROSSING	DESIGN FLOW		EXISTING FACILITY	REQUIRED FACILITY	LENGTH	ESTIMATED COST BY	COMMENTS
		5 YR.	100 YR.					
NORTH BRANCH DOUGLAS CREEK								
Between H-1A & H-3A	Proposed Street in Oak Valley No Name.	246	786	None-Proposed Road with 84" RCP - Oak Valley 625 cfs	RCB-Single 4'x10'x60' @ 2.75% V=29 fps 90° to Center-line with Transitions.	R.O.W. 60' Structure 60'	$ 18,000 Developer	Alternate RCP OK.
Between H-3A & H-5A Upper Crossing in this Section	Proposed Street in Oak Valley No Name.	303	1102	None-Proposed Road with 6'x11' RCB. Oak Valley 1236 cfs.	RCB-Single 5'x9'x60' @ 3.0% V=32 fps 90° to Center-line with Transitions.	R.O.W. 60' Structure 60'	$ 18,000 Developer	
Between H-3A & H-5A Lower Crossing in this Section.	Proposed Street in Oak Valley No Name.	303	1102	None-Proposed Road with 6'x11' RCB Oak Valley 1415 cfs.	RCB-Single 5'x9'x60' @ 3% V=32 fps 90° to Centerline with Transi-tions.	R.O.W. 60' Structure 60'	$ 18,000 Developer	
Between H-5A & H-2B	Allegheny Drive-Proposed in Oak Valley	481	1576	None-Proposed Road with 6'x13' RCB. Oak Valley 1476 cfs.	RCB-Single 6'x12'x80' @ 2% V=30 fps 90° to Center-line with Transitions.	R.O.W. 80' Structure 80'	$ 33,000 Developer	
Between H-2B & H-3B	Vindicator Extended (Mountain Shadows Rd.) in Mountain Shadows.	621	2280	None-Proposed Road in Mtn. Shadows Development	RCB-Double 6'x12'x80' @ 1.5% V=25 fps @ 90° to Center-line with Transitions	R.O.W. 80' Structure 80'	$ 48,000 Developer	Diversion of Major Flow From Historical Routing is Proposed.

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 7d. CULVERT INVENTORY

APPROXIMATE LOCATION	CROSSING	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR.	EXISTING FACILITY	REQUIRED FACILITY	LENGTH	ESTIMATED COST BY	COMMENTS
NORTH BRANCH DOUGLAS CREEK (CONTINUED)								
H-3B	Wilson Road (North Branch)	733	2554	Stone Bridge with Wingwalls B=8' D=3.3' L=23'. No Bottom Apparent. 36" CMP, L=36" 400'± North.	RCB Double 6'x12' @ 1.5% with Transitions @ 90° to Center-line. V=26 fps.	R.O.W. 80' Structure 80' @ 90° to Road	$60,000 Developer	Existing OK for Historical Flows.
Between H-3B & H-2C	Access into Wilson Ranch and Surrounding Property	749	2586	24" CSP x 25'	RCB-Double 8'x10'x60' @ 1%. V=23 fps. @ 90° to Center-line with Transitions.	R.O.W. 60' Structure 60'	$ 40,000 Developer	The Location of this Crossing is Shown in Its Existing Cond. Could Vary per Development Plans.
Between H-4C & H-5C	Access to Bluffs Area North of Pinon Valley Fil. No. 1	959	3265	None-Proposed Road with 12'x7' RCB. Pinon Valley 2453 cfs.	RCB-Double 8'x12'x60' @ 1% V=24 fps @ 90° to Centerline with Transi-tions.	R.O.W. 60' Structure 60'	$ 49,000 Developer	
H-5C	Eyrie Dr. Extended	1049	3499	RCB-Double 6'x8' @ 2.5% V=40 fps Pinon Valley 2702 cfs.	Add 3rd Barrel on East.	R.O.W. 60' Structure 60'	$ 20,000 Developer	The Added Barrel Req'd at time of Up-stream Channel Widening.
H-8C	Chestnut Street	1355	4210	RCB-5 Cell 8' x 8' @ 1.5% with Entrance and Exit Transi-tions.	None.	R.O.W. 90' Existing Structure 70'	None.	Energy Dissipator in Channel Upstream.

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 7d. CULVERT INVENTORY

APPROXIMATE LOCATION	CROSSING	DESIGN FLOW 5 YR.	DESIGN FLOW 100 YR.	EXISTING FACILITY	REQUIRED FACILITY	LENGTH	ESTIMATED COST BY	COMMENTS
NORTH BRANCH DOUGLAS CREEK (CONTINUED)								
H-9C	Interstate 25 and Frontage Rd.(Sinton Rd.)	1439	4426	RCB-12'x14' @ 2.85% with RCB 17'x26' @ Unknown Grade. Approx.100' N. Used for Rail Spur.	None-Railroad Spur Box on North will Act as Overflow.	Drg. Box Length 377' Railroad Box Length 280' R.O.W. Varies	None	-
H-10C	D&RGW Railroad Tracks	1491	4540	Stone Arch Bridge w/Conc. Bottom. 9.5'x 7.5' w/Top 3' Arched. Wingwalls @ Entr./Exit Approx.Cap.750cfs	RCB-Double 10'x12'x60' @ 1% V=26 fps @ 90° to RR Centerline.	R.O.W. 100' Structure 60' (Exist. is 57' Long)	$ 53,000 Railroad	No cost incl.for Temp.Diversion of RR during Constr. This Str. is Extremely undersized. Should be brought to RR's Attention.
					Total Estimated Facility Cost Developer------	----------	$304,000	(No Contingency or Engineering)
					Total Estimated Facility Cost Railroad------	----------	$ 53,000	

SUMMARY OF HYDRAULICS (Facilities Inventory) - DOUGLAS CREEK DRAINAGE BASIN
EXHIBIT 7d. CULVERT INVENTORY