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UNITED WESTERN ENGINEERS
632-3593 / 1000 W. FILLMORE
COLORADO SPRINGS, COLORADO

CAMP CREEK
DRAINAGE STUDY

for

The City of Colorado Springs,
Colorado

October 22, 1964

Director of Public Works
City of Colorado Springs
Colorado Springs, Colorado

Dear Sir:

Submitted herewith is the Hydrologic Engineering Study of the Camp Creek Drainage Basin.

This report includes a study of the rainfall runoff characteristics and proposed methods of handling this runoff throughout the entire basin.

The various proposals as outlined in this report may be used as a guide for future drainage work as this drainage basin is developed.

Respectfully submitted,

UNITED WESTERN ENGINEERS

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State of Colorado 5076

Reviewed By:

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State of Colorado 2051

HYDROLOGIC ENGINEERING STUDY

OF THE

CAMP CREEK DRAINAGE
BASIN

FOR THE

CITY OF COLORADO SPRINGS, COLORADO

October 22, 1964

UNITED WESTERN ENGINEERS
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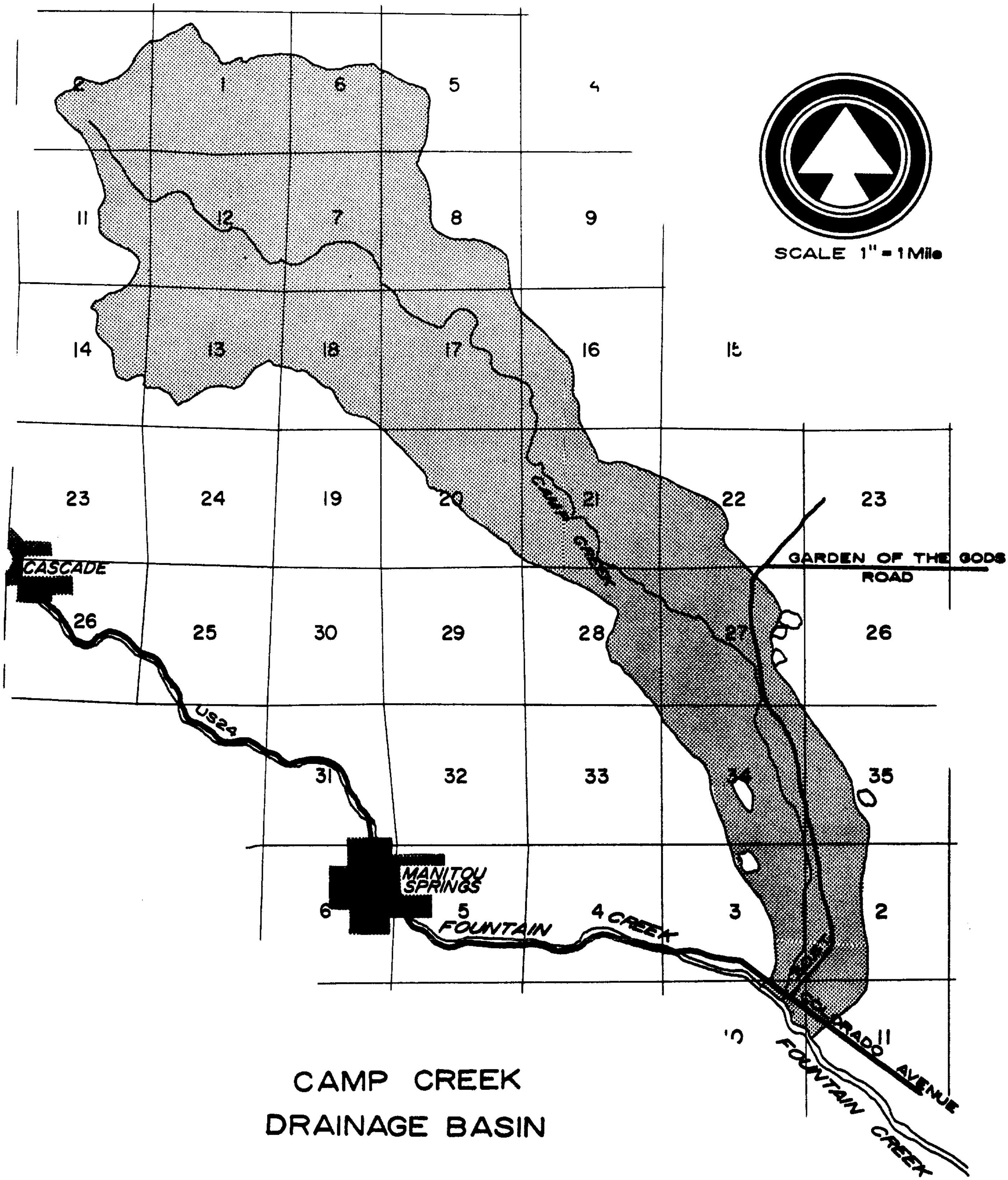

CAMP CREEK
DRAINAGE BASIN

VICINITY MAP

U·W·E·

SCOPE AND PURPOSE:

This report is intended to furnish the basis for an overall plan for placing storm sewers and drainage appurtenances in the Camp Creek Drainage Basin as subdivisions are developed therein and for the installation of drainage facilities in the developed areas. It should be a part of the overall plan for storm water control in the metropolitan area around Colorado Springs.

The intent of this study is not to establish the exact design of a storm sewer, or channel, or drainage appurtenances in a definite area. It does, however, establish the general location of required storm drainage structures and their required general sizes. It points out and establishes those natural channels which should be retained as water carrying channels and those which may be blocked or diverted.

Any study of this type is necessarily general, and such a generalized development plan is faced with the problem that, since the street plan for an area is not known, the exact drainage patterns and required appurtenances may not be computed. This particular Drainage Basin is somewhat different than those major basins previously studied by this office in that the major portion of the land which is suitable for development has already been developed into residential areas. The first step in such a study is, therefore, the laying out of proposed or potential streets in the areas which have not been developed. These streets are positioned so as to best handle storm runoff in the area. The drainage is then computed for these streets. When the area is actually developed, however, it may be found that many of the actual street patterns will not fit those which are proposed in this report for the area. If this is the case, then it is obvious that the drainage plan must be changed to fit the new street plan.

Depending on the circumstances, it is possible that the drainage costs may be reduced by a new street plan, but conversely, they may be increased by the new street plan. This must all be taken into consideration when using a generalized development plan such as this.

It is much easier to locate the major drainage channels (greenbelts) required and to preserve these for future use than it is to locate exactly the storm sewers which will be required. On this drainage plan, we have located the streets in various areas which, we feel, should be constructed in order to facilitate the surface removal of storm water. (If these streets are not constructed as shown, changes must be made in the drainage plan as mentioned previously.)

The salvage of existing channels now being used for drainage purposes and not allowing developments to encroach upon these channels, is one of the major drainage problems facing the City of Colorado Springs. Existing natural channels, if blocked or diverted, can lead to flooding of major proportions. This flooding, in turn, necessitates the installation of large quantities of storm sewers and other drainage works. If the natural channels can be saved, part, at least, of these installations may be avoided.

It should be noted that a ditch will carry runoff water much more readily and economically than a pipe system. The ditch, generally being more economical than the pipe system, is therefore, in many cases, preferable. It is not always possible, or desirable, however, to use ditches, and in such cases, other means must be found to remove runoff water. Wherever it was found possible and desirable during the course of this study, ditches were used to remove the water, and the proposals included herein reflect this.

The study of a partially undeveloped basin such as this provides the basis for a logical overall storm drainage design prior to the time of the remaining subdivision development. In this manner, storm drainage structures may be constructed to proper size as the subdivisions are developed, helping to control costs and avoiding potential storm damage. It is felt that in this way, major construction problems caused by the existance of inadequate structures or streets over the drainage area may be avoided. In this drainage basin several inadequate structures do exist, however, and will be discussed more thoroughly later in this report.

BASIN DESCRIPTION:

The Camp Creek Basin is approximately 11.2 square miles in area and lies generally northwest of the City of Colorado Springs. Camp Creek drains the Basin in this study and outfalls into Fountain Creek.

In the drainage basin, approximately 8.4 square miles lie within the boundary of the Pike National Forest. This area, being under the jurisdiction of the Federal Government, was considered to be undevelopable as far as subdivision development is concerned. The storm drainage generated within the National Forest area is, therefore, rather small for the area involved.

An additional 0.9 square mile lies within the boundary of The Garden of the Gods, owned by the City of Colorado Springs, and Glen Eyrie, owned by The Navigators of Colorado. This area was also considered to be undevelopable insofar as regular subdivision development is concerned.

This leaves approximately 1.9 square miles of land available for subdivision development of which 0.7 square mile has already been developed. Thus there is about 1.2 square miles of area left in this drainage basin to be developed.

At least a low flow of water can be found in the main stream during most parts of the year. However, as shown by the data accompanying this report, the future potential for a large flood peak does exist. The fact that large quantities of storm runoff have previously existed in this basin may be seen from existing channels and the sizes of previously constructed drainage facilities.

The topography of the major portion of the basin is definitely mountainous in the westerly portion with a relatively narrow, gently sloping valley along the Camp Creek streambed from Glen Eyrie southerly. In general, the basin has quite steep slopes everywhere except in the immediate vicinity of the actual stream channels and the streambed valley as mentioned above.

GEOLOGIC FORMATION, SOILS TYPES:

The valley of Camp Creek is one of the more broken up basins in El Paso County. The upper section, known as Queen's Canon, is carved from the Pikes Peak Granite. This material is found in both sound and decomposed states. In general, sands and gravels cover the sound granite in very thin layers. The bed of the creek is composed mainly of the sands, but even here this sand layer is thin.

The slopes are extremely steep in the canon and the gradient of the stream is also steep. Even so, the infiltration is high and the runoff relatively low.

At the east end of Queen's Canon, the creek disgorges onto a wider and much less steep valley, and turns to the south. This is the area of the Front Range fault, and is one of the more interesting geologic features of the region. Due to the presence of this fault zone, many formations came to the surface in a banded pattern. The harder rock forms long ridges and hogbacks, with the softer material forming valleys. A few gaps in the hard rock allow Camp Creek through the fault zone.

Soil types change rapidly and drastically in this fault zone. In some formations, infiltration is rapid and in others, almost non-existant. To allow any sort of determination in this area, infiltration rates of the formations have been averaged. The average arrived at shows an infiltration rate of a Type "B" soil with relatively rapid runoff.

At the point at which Camp Creek turns to the south, the basic soil type is that of the Pierre Shale. At some time in the past, the shale has been scoured clean by the creek. Then the flow decreased and the stream commenced depositing miscellaneous sediments into the valley. At the present time, these sediments average about 20' in thickness and consist of silts and sands of various formations.

The presence of the shale bed covered with permeable sediments allows a large amount of subsurface water to seep south down the valley. The water table is thus high, which cuts the value of the infiltration to some extent. This will also be an area of paved streets and houses which lowers infiltration of storm water further.

The typical Trellis pattern of the stream affects the basin in several ways. The stream has very few tributaries and long unbroken reaches. This allows a relatively stable regime to develop in the lower stream bed. Such tributaries as exist on either a permanent or intermittant basis are allowed through the fault zone at well defined and isolated gaps only. This pattern will tend to concentrate flows into the main valley, increasing both the flow and runoff time.

PREVIOUS DRAINAGE WORKS IN THE BASIN:

Numerous runoff control measures have been taken throughout the basin prior to this time. Several reservoirs have been constructed, however, these were probably intended to be used for water storage rather than for flood control purposes. It is proposed to retain all of these reservoirs and use them insofar as possible for detention reservoirs.

The first of these reservoirs is Palmer Reservoir located at Point 3 on the basin drainage map. This is an earthfill dam with a concrete and masonry spillway. This reservoir may reduce the peak flow somewhat, but for purposes of this report it has been assumed that the reservoir was full at the beginning of the rainfall. The reservoir is used for water storage and thus cannot be considered solely as a detention reservoir. The spillway, however, has sufficient capacity to pass the peak flow without damage to the dam.

The second reservoir is a very small concrete and masonry dam located above Glen Eyrie in Queen's Canon. This reservoir is used as the intake for the Glen Eyrie water system and is too small to be considered as a flood control structure.

The two remaining reservoirs are located along the easterly boundary of The Garden of The Gods at Points 58 and 62 on the basin drainage map, and are known as Valley Reservoir No. 1 and Valley Reservoir No. 2 respectively. These two reservoirs are of definite value as detention reservoirs and are discussed in more detail later in this report.

A large concrete lined channel has been constructed as a median channel on 31st Street from Dent Street southerly to Bijou Street. This channel is large enough to handle the expected peak flow. However, the three streets which cross 31st Street (Water Street, Fontanero Street and Bijou Street) all have culvert installations which are too small to carry the peak flow. These culverts will carry less than one-half of the computed peak flow. These three culvert installations will also be discussed further in the recommendations of this report.

This concrete lined channel is in essence a greenbelt through the subdivided area. In the preliminary planning for the future development of Westmoor Park, the planners have anticipated the necessity of continuing this concrete lined channel as a greenbelt along the existing stream channel and have incorporated this facility with their development plan. This greenbelt system follows the same alignment as proposed for the greenbelt in this report.

Storm sewers have been installed in 28th Street and in Kiowa Street from 30th Street to the existing Camp Creek stream bed. These existing storm sewers are shown on the drainage basin map.

A preliminary report for "STORM SEWER REQUIREMENTS" at 28th Street and Kiowa Street was submitted to the City of Colorado Springs in

January, 1962 by Henningson, Durham & Richardson. The area covered by their report lies in the extreme southeasterly corner of the Camp Creek Drainage Basin. It will be noted that the recommendations for this same area in this report do not correspond with the recommendations of the Henningson, Durham & Richardson report. However, it must also be understood that their report is based on a five (5) year storm frequency with a one hour intensity of slightly over 1.0 inches. This report is based on a fifty (50) year frequency, one hour duration, two inch intensity rain storm.

RAINFALL PATTERN:

Average annual rainfall in the Camp Creek Basin is low, being only about 14.6 inches per year. The major portions of this annual rainfall usually occur during the months of May, June, July and August. Both mountain type storms and plains type storms fall on this Basin. Storms of record in the Basin fall into two general categories:

1. Short intense storms lasting up to two hours and usually local in nature.

2. Long term storms lasting 6 hours or more and being spread over a large area.

The long term storms last a relatively long period of time, allow high infiltration and produce a great volume of runoff. However, they do produce a relatively low flood peak. The short duration storms produce less runoff water, but being intense, have a very high flood peak. Following development of an area, the peak flow naturally becomes even higher.

The 50-year frequency, 1-hour duration, 2-inch intensity rain storm has been adopted by the City of Colorado Springs as their design criterion, and has been used in this report.

The 50-year occurance mentioned above is something of a misnomer. It is true that a storm of this intensity can be expected to cover the entire area of the basin an average of once every 50 years. It is also true, however, that a storm of this intensity may be expected on an extremely local basis (i.e. not covering the entire basin) about once every three years. For design purposes, therefore, it is not considered safe to consider a storm of any lesser rainfall than the one used in this report.

Snowstorms can be severe and may be a local problem in the basin. However, the actual amount of moisture in a snowfall is usually not high enough to lead to excessive runoff. For this reason, snowfalls have not been considered in this report.

RUNOFF PATTERN:

Measured runoff data does not exist for this basin. Such measured data would be very desirable and should be obtained in the future. A continuation of the City's rain gage system would be very desirable. A stream gage could be installed at the proposed culvert under U.S. Highway 24 (Colorado Avenue). This stream gage would gather valuable data for future drainage works.

If such data were now available, some refinement in design would be possible, and such drainage work would be more accurate. In the absence of measured data, the available data by the Soil Conservation Service must be used. Runoff was estimated by the system developed by the Soil Conservation Service and improved somewhat by the Bureau of Reclamation. An analysis of the land within the basin was made to determine the usable portions and the most likely portions to remain unsubdivided. Aerial photos and on the spot observations completed this general survey.

The Camp Creek Basin was then subdivided into sub-basins which are noted by letters "A, B, C, etc." These sub-basins were then divided into minor basins which are indicated by numbers (C3, etc.). An outfall point was then assigned to each minor basin, and the peak runoff computed for these minor basins.

The peak flow of each minor basin was then combined on a time scale so that the combined hydrographs could be constructed for succeeding points as the peak flow proceeds downstream.

The combined hydrographs give a graphical picture of the flow down Camp Creek and its various tributaries. As it takes some amount of time for a flood crest to travel from point to point, and since the length of the various tributaries is relatively great, it was found that the peak time of the combined hydrograph gradually increases as the crest moves downstream. The hydrographs shown in this report are based on the assumptions that the lower valley area has been developed into residential tracts, the steeper hillsides have been developed into acreage tracts and that the forest and park areas will remain undeveloped. Due to the location of this basin, this development is a probable occurance within the very near future.

The hydrographs shown are all synthetic hydrographs and some adjustments will be necessary if, and when, actual stream runoff measurements can be made. These adjustments should be minor, but will be desirable.

MAIN CHANNELS-GREENBELTS:

Previous studies commissioned by the City of Colorado Springs have recommended a greenbelt drainage system in all basins so studied. This is desirable as it is the most economical method of removing flood runoff from any developed area. The cost of open ditches or drainage channels is much lower and the ditches are generally easier to maintain and clean than pipe.

In some developed areas, however, these greenbelt systems are impractical due to the fact that insufficient space has been left for the development of properly sized ditches or control works. This is, at least to some degree, the situation in the lower end of this basin (i.e. from Bijou Street to the Camp Creek outfall at Fountain Creek). The existing streambed through this area meanders through trees, around homes, and through various small culverts. It is being proposed in this report to continue the concrete lined channel southerly from Bijou Street along 31st Street and to cross Colorado Avenue at its intersection with the Midland Expressway. This not only gives the shortest structure length for crossing Colorado Boulevard, but also the least expensive route from the right of way standpoint. In comparing the two routes it is $ 70,600.00 more expensive to follow the existing streambed than to continue southerly on 31st Street. In the developed portion of the basin, adequate greenbelt drainage facilities have been, or are being, constructed so this problem does not exist on the main greenbelt except for the previously mentioned culverts in the 31st Street channel and the small culverts below Bijou Street. The proposed greenbelt system consists of strips of land reserved for drainage flow and for certain drainage structures. This land should be reserved for the ditches and should be planted in grass, where possible, and riprapped where necessary.

Some concrete control structures will be required.

New subdivisions should be planned around these greenbelts so that there is no interference with runoff, and so the road crossings can be held to a minimum. Bridges, culverts, and pedestrian crossings will be required along the stream channel, but care should be taken so that the stream flow is neither impeded nor diverted.

It will be found upon examination of the accompanying map that the greenbelts tend to follow the natural stream channels and do not interfere excessively with land good for subdividing. Required greenbelt widths are shown in the appendix and on the development map. In general, the channels were designed to be wide and shallow. This not only reduces the danger to children, but reduces the water velocity and decreases the amount of required channel stabilization. It also allows the use of the greenbelt as a strip of park, if desired. The use of such greenbelt strips as a park can be made since actual water flow along these ditches would only be periodic and not continuous. It is felt that any wide points could be used as playgrounds or parks with the narrow strips acting as pedestrian walkways or as local playgrounds.

One note of caution should be given in the establishment and use of these greenbelts. It is felt that the greenbelts should be controlled by the City and not allowed to exist merely as an easement across the rear of lots. If this cannot be done, the ordinances should specifically restrict the building of chain link or other structural type fences across the channels. The construction of this type of fence across a greenbelt can be very serious. The chain link fences tend to collect trash and debris during times of flow and, in effect, act as a small dam. The backing up of water as a result of such an impediment can be dangerous, not only to surrounding adjacent property owners, but downstream structures as well may be endangered.

RESERVOIRS:

There are a total of four reservoirs involved in this report. Two of these reservoirs are located on property owned by The Navigators of Colorado and have been previously discussed in this report. The larger of these two, Palmer Reservoir, may be of some value as a flood control structure but cannot be considered as such for the reason previously noted.

Valley Reservoir No. 1, located at Point 58, has been constructed as a water storage reservoir and has a relatively small contributary area. The area which does drain into this reservoir is primarily in The Garden of The Gods and contributes a peak flow of approximately 143 cubic feet per second. The reservoir has a small masonry and mortar spillway. It is proposed to utilize this existing reservoir as a detention reservoir. The storage volume required to impound the entire peak flow at this point (58) is approximately 10 acre feet. Valley Reservoir No. 1 is easily capable of providing this storage volume and will require no modification to be used as a flood control structure.

Valley Reservoir No. 2 has also been constructed for storage purposes but can be used as a detention reservoir without modification. The area draining into this reservoir is approximately 69 acres which creates a peak flow of 121 cubic feet per second. The storage volume required to impound this entire flow is 9 acre feet which is easily provided by Valley Reservoir No. 2. The existing spillway for this reservoir is located at the westerly end of the dam. The spillway has no erosion protection; however, it is not felt that such protection will be necessary.

INDIVIDUAL IMPROVEMENTS:

Attention is directed to that portion of the appendix which shows the individual improvement map. This map shows the recommended improvements to greater advantage than any discussion.

After designing the main channel and reservoirs, the individual basins were studied using the minor basin hydrographs previously described. Waterflow at various points in the basin was compared to street capacity and distribution. In some cases, it was found that the specification of location of a certain size street will be sufficient to distribute runoff properly. In other cases, this will not be sufficient and storm sewers or drainage ditches will be required. This particular basin lends itself very well to the control of runoff with street design in the area remaining to be developed because the developable area is located in a relatively narrow valley along the Camp Creek streambed. As shown on the improvement map, no storm sewer is required in the remaining developable area if street design is such that water may be split between several streets carrying it directly to dropouts and then into the greenbelts.

The street locations shown do not necessarily have to be followed, but would certainly be desirable for drainage purposes. For example, in some basins a total of two, or possibly three, streets will easily carry the water to the greenbelt. If, for some reason, the area is planned so that only one street exists to carry the water to the greenbelt, then a storm sewer may be necessary. Thus, whenever it is possible to distribute storm runoff to several streets, the flow can be handled readily, whereas one street may not be capable of handling the same amount of water.

In minor basins G-12 and G-13 it has been necessary to install three storm sewer systems in order to adequately drain the various areas.

The storm sewer system shown as No. 1 is necessary because Fontmore Road drains a relatively large area for a single street and the street becomes overloaded before it reaches the greenbelt.

Storm sewer systems No. 2 and No. 3 are located in the older developed areas with narrow streets and flat street grades. Thus, the streets have a very small capacity and the storm sewers are required.

The three streets which cross the 31st Street channel (Water Street, Fontanero Street and Bijou Street) have been previously discussed and it was noted that the existing structures will not handle the expected peak flow. These three installations will cause flooding in these areas and, therefore, to conform to the basic criteria of this report, should be replaced with structures of sufficient size to carry the peak flow. In view of the fact that it is being recommended to continue the concrete channel southerly along 31st Street from Bijou Street to Fountain Creek, it becomes immediately imperative that the crossing at Bijou Street be enlarged. If flooding should occur at this location after the channel has been extended southerly it is most likely that this flooding would follow the existing streambed and could cause considerable damage in that area.

It is felt that the existing structures on the natural channel of Camp Creek below Bijou Street should be left in place to handle the small amount of drainage from the immediate area since these structures are all located at low points in the streets.

A channel change is also shown on the improvement drainage map in minor basin E-18. This channel change will eliminate two road crossing structures.

Two special intersection design locations are shown on the improvement map. At the intersection of King Street and Crown Ridge Drive provision must be made to assure the turning of all drainage to flow down King Street. The intersection of King Street and Castle Road is very badly in need of repair. It is felt that when the repair project is undertaken that the intersection could be reconstructed and improved, not only to handle the drainage in a more satisfactory manner, but also to improve it from a safety standpoint.

Numerous dropout structures have also been shown on the improvement map. These consist of a concrete structure carrying water directly from a street into a ditch or, possibly, into the greenbelt itself. These dropout structures should be individually designed for the conditions at each location. This is simply due to the fact that water conditions will vary in almost any basin.

Inlet problems can be very difficult, especially in the case of streets with steep grades. Such problems must be worked out as each area is designed, since the street designs of the subdivisions, as previously mentioned, will alter the sewer design somewhat. The nature of hydraulic structures does not lend itself generally to standardized design.

A single greenbelt has been used throughout this basin. This is possible due to the fact that the Camp Creek Valley is relatively narrow and therefore drainage runoff can be carried to the single greenbelt by streets and storm sewers as shown on the improvement map. The greenbelt follows the existing streambed of Camp Creek.

Throughout the basin, the water which is being carried in the streets is conducted to the greenbelts through dropouts and small ditches. This has been incorporated into this study as a general basin design. Pipe culverts could be substituted for the ditches if desired, but are much more expensive and do not carry the water as well. Also, with pipe culverts, inlet problems will be magnified.

For the most part, these small ditches are designed as grass or sodded ditches. The slopes are generally low enough for sod to conduct the water without undue erosion. Concrete lining can be used in these ditches and will solve some maintenance problems for the City. In this area, however, lining of ditches with concrete is more expensive than is normal in other areas. The grass lined ditches are, therefore, deemed more desirable.

SUMMARY AND RECOMMENDATIONS:

Experience in and around the City of Colorado Springs has shown the futility of trying to control storm runoff with street drainage alone. Streets will carry large quantities of water under favorable conditions, but will not contain the high flood peaks common during the intense local storms in the area.

A study such as this should be made for each major basin within the region in which subdivision development is contemplated. In this manner, channels, ditches, reservoir sites and ponding areas may be preserved. Houses and commercial structures can be kept out of dangerous areas. Within limits, the size and cost of the drainage structures required in these areas would be known much in advance.

The use of streets as a drainage flow structure can certainly be tolerated up to a point. It is recommended that streets be used as drainage ways insofar as possible. There is a point, however, at which a street is simply unable to carry the water and must have help. For this purpose the storm sewers and greenbelts as shown on the improvement map are being recommended in this report.

The preliminary study of drainage basins by the City of Colorado Springs has, in the past, generally had the effect of changing the design of subdivisions in these areas. Subdivision planners have now adjusted their planning to incorporate these drainage facilities and subdivision planning now reflects the presence of greenbelts, the necessity of keeping crossings of these greenbelts to a minimum, and the necessity of not overloading streets. It is felt that this is a step in the right direction and should be continued for all the drainage basins around the City.

A point already mentioned in this report, but one which cannot be overstressed, is the point that the greenbelts within the drainage basin must be kept open and clear. Permanent structures such as chain link fences should not, and indeed must not, be tolerated within the greenbelt area. The potential for future damage possessed by a chain link fence across a drainage way is almost incalculable. Therefore, for the safety of all residences and commercial ventures along these greenbelts, chain link fences must not be allowed.

It is further recommended that the existing concrete channel along 31st Street be cleaned (i.e. all silt removed) to its original depth. This channel must be kept clean and any silting removed if it is to operate effectively. The City should, therefore, include this work in their regular maintenance operations.

The same is true for any existing culverts and storm sewers. All structures must be checked periodically to be certain they are in operating condition.

The recommendation of this study is that the design features shown in appendix "B" of this report be followed, in general terms at least, and that the cost thereof be prorated as outlined in the attached cost estimate.

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ESTIMATE OF COST

FOR THE

CAMP CREEK DRAINAGE COMPLEX

GREENBELTS:			
Land	17.3 Acres	$58,900.00	
Construction		55,686.00	
Total			$114,586.00
STORM SEWERS AND APPURTENANCES:			
Line No. 1		54,440.00	
Line No. 2		116,670.00	
Line No. 3		111,290.00	
Total			282,400.00
MISCELLANEOUS DITCHES AND APPURTENANCES:			
Total			13,254.00
CULVERTS:			
Total			241,142.00
TOTAL COST OF DRAINAGE APPURTENANCES			$ 651,382.00

This figure is the total cost of all drainage facilities recommended in this Report for the Camp Creek Drainage Basin. However, it is not felt that this total cost can, or should, be borne by the portion of the basin which remains to be developed. That portion of the drainage facilities which lies in the area to be developed appears to be the only cost which this developable area should reasonably be expected to bear. The following estimate reflects this portion of the total basin expenditure.

(See Page -2- "Estimate of Cost")

GREENBELTS:		
Land, 16.5 Acres	$49,500.00	
Construction	39,638.00	
Total		$89,138.00
STORM SEWERS AND APPURTENANCES:		
Total		0.00
MISCELLANEOUS DITCHES AND APPURTENANCES:		
Total		13,254.00
CULVERTS:		
Total		70,466.00
Total Cost of Drainage appurtenances In Developable Area		$ 172,858.00
Developable Area in Basin	751 Acres	
COST PER ACRE		$ 230.17

This leaves a total of $478,524.00 which must be paid for by other means.

The structure crossing Colorado Avenue (U.S. Highway 24) should be a joint project between the City and the Colorado Highway Department. The portion to be paid by each would necessarily be worked out between the City and State. The estimated cost of the culvert installation is $91,711.00.

This leaves a total of $386,813.00 for the remaining installations which must be borne solely by the City of Colorado Springs.

APPENDIX A:

GENERAL MAP OF

CAMP CREEK DRAINAGE BASIN

EL PASO COUNTY, COLORADO

AS IT EXISTS

October, 1964

1. Entire basin

2. Developable portion of the basin

APPENDIX B:

GENERAL MAP OF

CAMP CREEK DRAINAGE BASIN

EL PASO COUNTY, COLORADO

SHOWING

OVERALL PROPOSED REQUIRED IMPROVEMENTS

APPENDIX C:

STANDARD AND TYPICAL DRAWINGS

FOR

CAMP CREEK DRAINAGE BASIN

EL PASO COUNTY, COLORADO

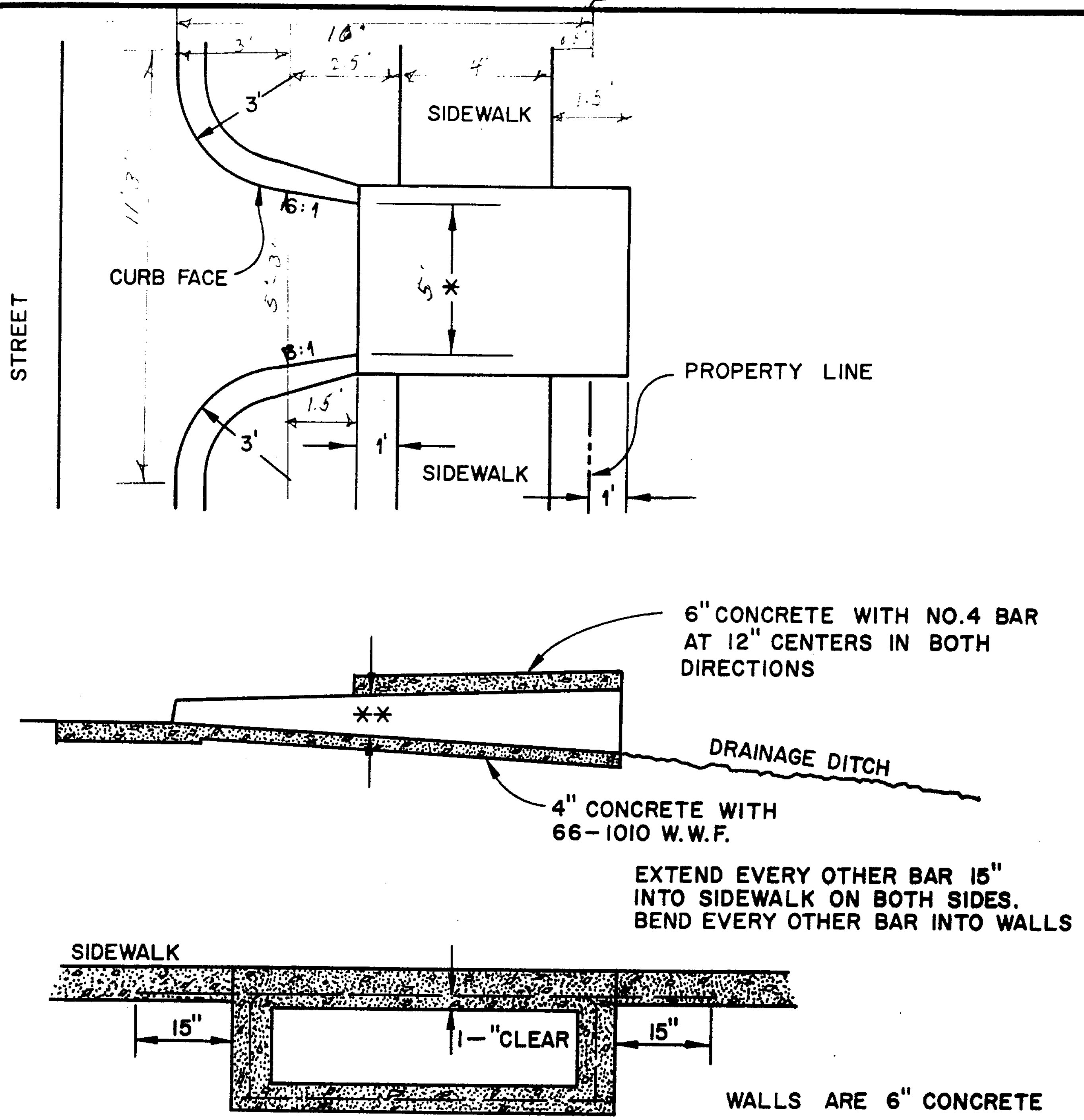
CURB INLET

CURB OUTLET

TYPICAL DITCH SECTIONS

REQUIRED GREENBELT WIDTHS

INFILTRATION CURVES



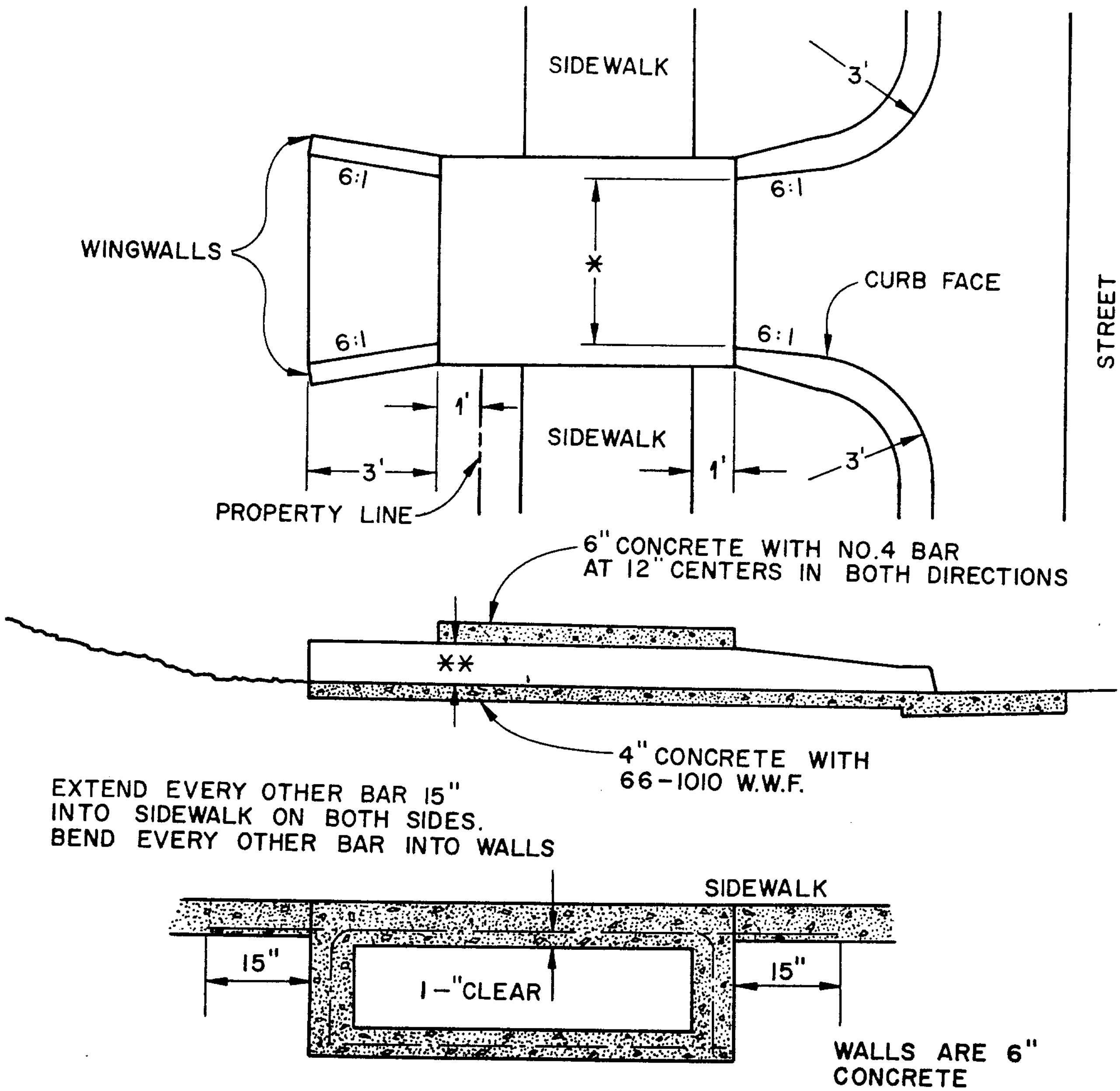
NOTES:

1 SIDEWALK MAY BE PLACED ANYWHERE FROM CURB TO PROPERTY LINE BY EXTENDING THE TOP SLAB TO MATCH THE POSITION OF THE SIDEWOLK

2 * VARIABLE DEPENDING ON QUANTITY OF WATER. MINIMUM 4'
** VARIABLE DEPENDING ON QUANTITY OF WATER. MINIMUM 1'

CURB INLET

U·W·E·



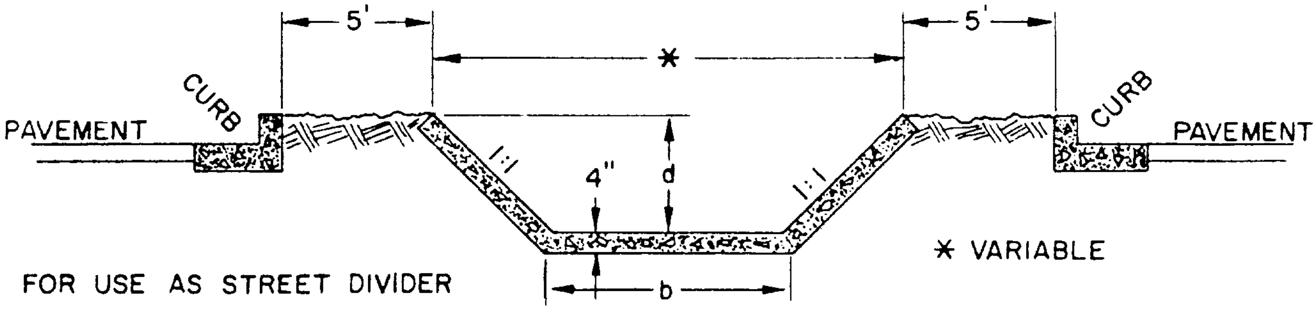
NOTES:

1 SIDEWALK MAY BE PLACED ANYWHERE FROM CURB TO PROPERTY LINE BY EXTENDING THE TOP SLAB TO MATCH THE POSITION OF THE SIDEWALK

2 * VARIABLE DEPENDING ON QUANTITY OF WATER. MINIMUM 4'
** VARIABLE DEPENDING ON QUANTITY OF WATER. MINIMUM 1'

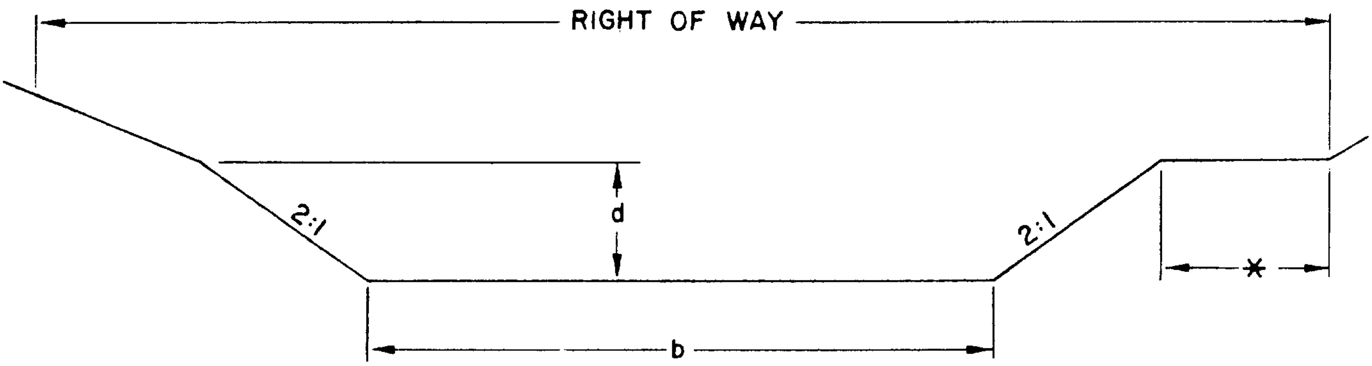
CURB OUTLET

U·W·E·



FOR USE AS STREET DIVIDER

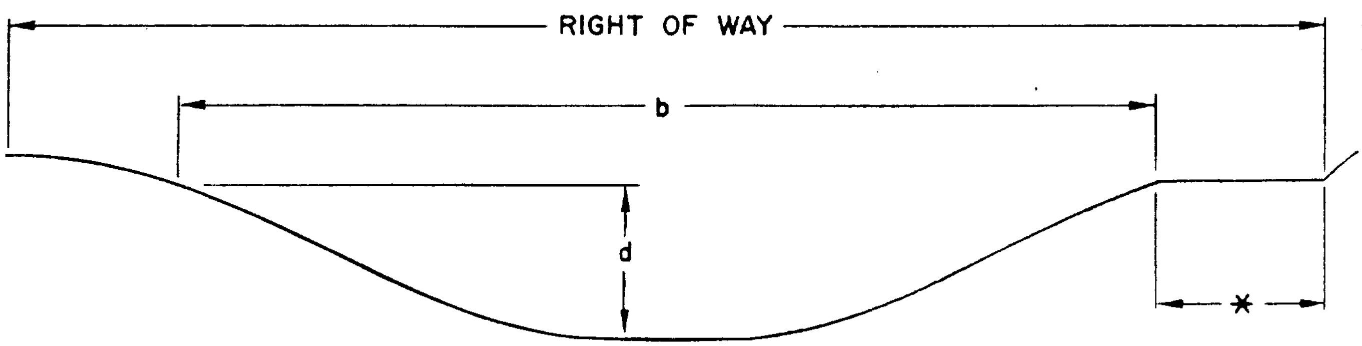
TYPE NO. 1



FOR USE AS STREET DIVIDER OR HIGH CAPACITY DITCH.

* 16' ROADWAY FOR MAINTENANCE

TYPE NO. 2



FOR USE AS PARK STRIP, PLAYGROUND STRIP, OR LOW CAPACITY RESIDENTIAL DITCH.

* 16' ROADWAY FOR MAINTENANCE

TYPE NO. 3

TYPICAL DITCH SECTIONS

U·W·E·

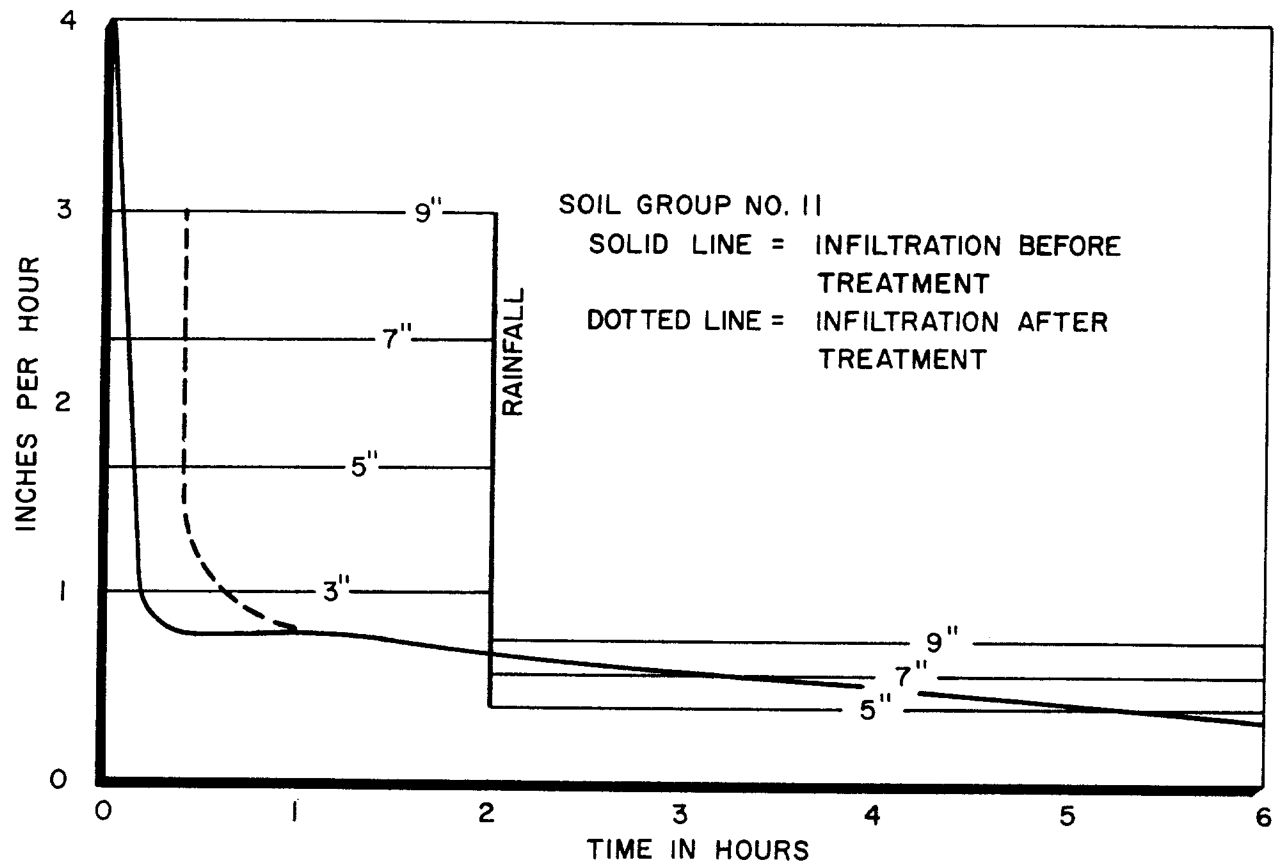
CAMP CREEK GREENBELT SYSTEM

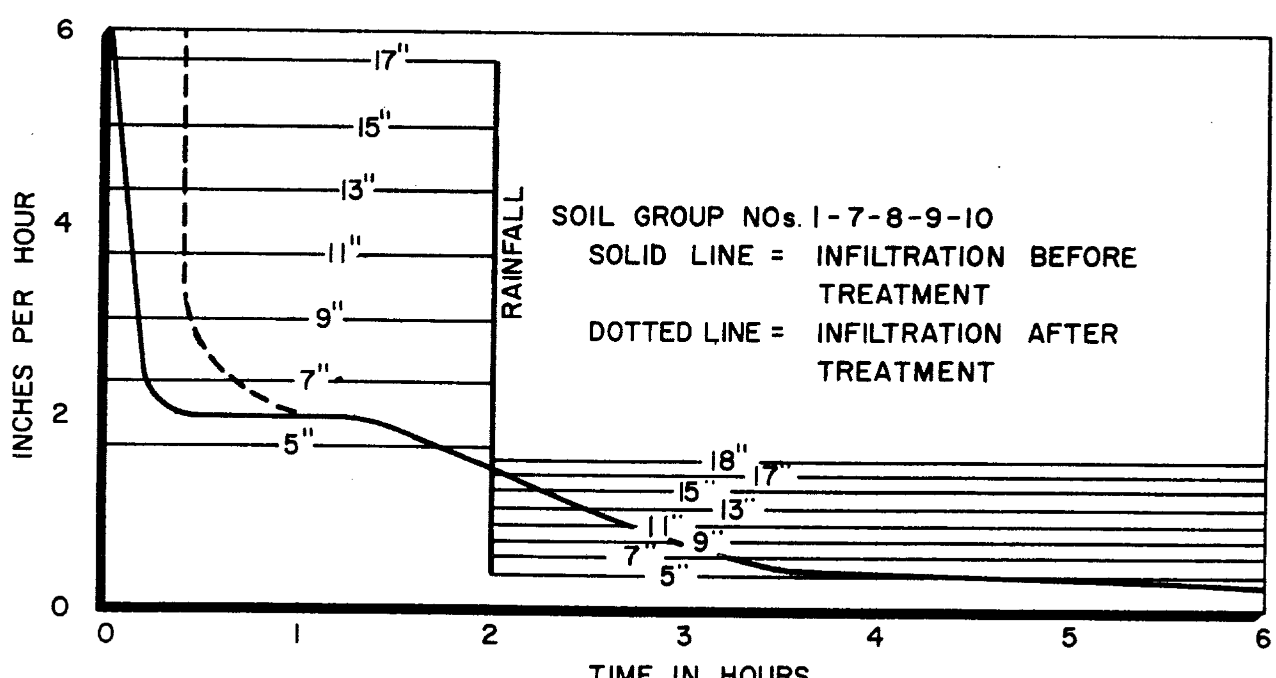
REQUIRED GREENBELT WIDTHS

LOCATION		GREENBELT WIDTH
From Point	To Point	Feet
49	52	90
52	54	100
54	59	40
59	66	Existing
66	Fountain Creek	40

NOTE: The greenbelt widths as shown above include a sixteen (16) foot right of way for maintenance road purposes.

INFILTRATION CURVES ESTIMATED FROM RAINMAKER TESTS BY SCS PROJECTS 1936





U·W·E·

APPENDIX D:

HYDROGRAPHS

FOR

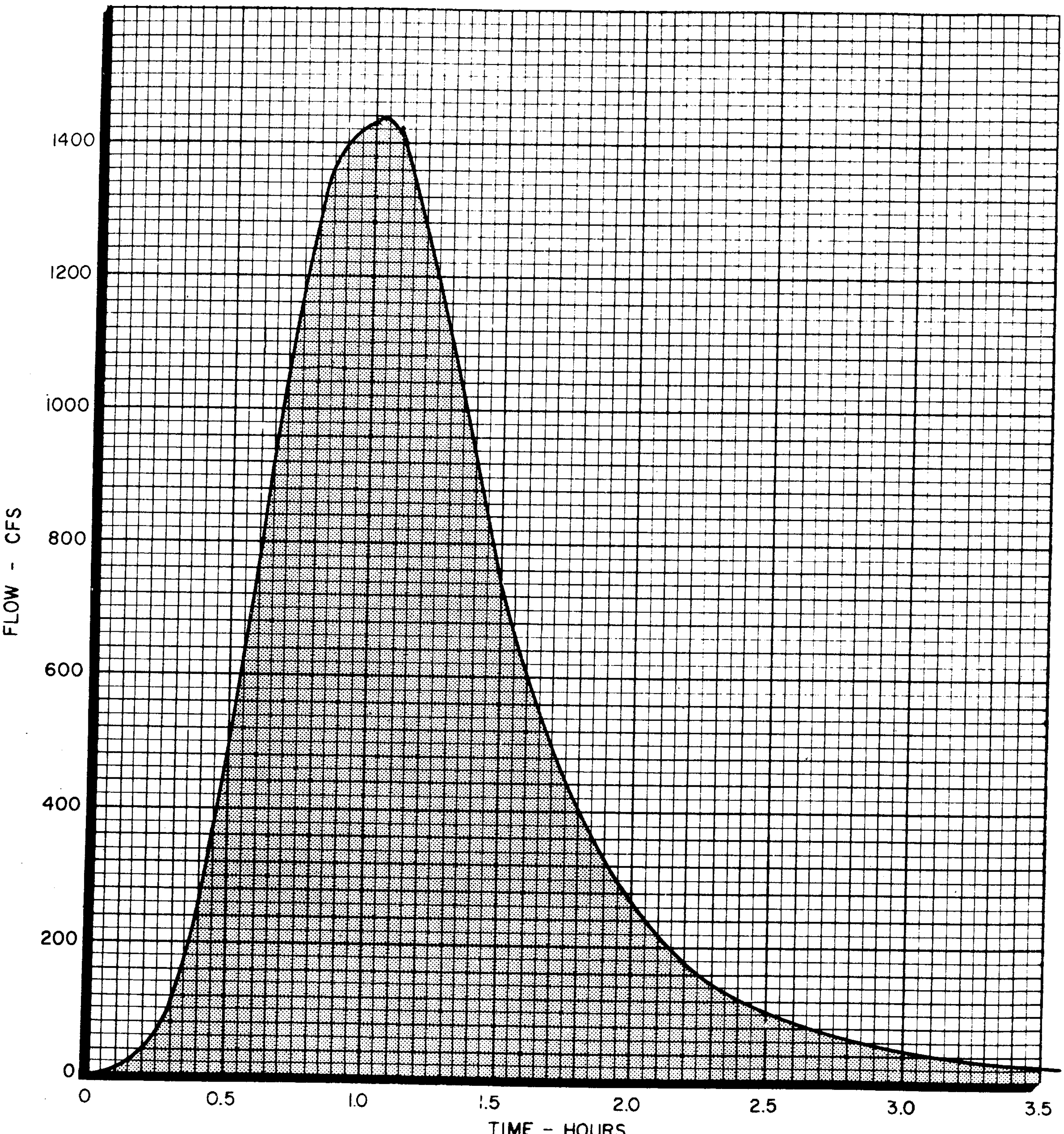
CAMP CREEK DRAINAGE BASIN

EL PASO COUNTY, COLORADO

A hydrograph is a graphic "picture" of runoff. The area of the graph equals the total amount of runoff in Acre Feet. The peak and entire upper limit of the hydrograph represents the amount of runoff at any given instant of time. In the case of all the following hydrographs, the 0 Point on the time scale represents the beginning of rainfall.

To be plotted and calculated, a point in the subject basin must be arbitrarily selected, and the hydrograph constructed in relation to that point.

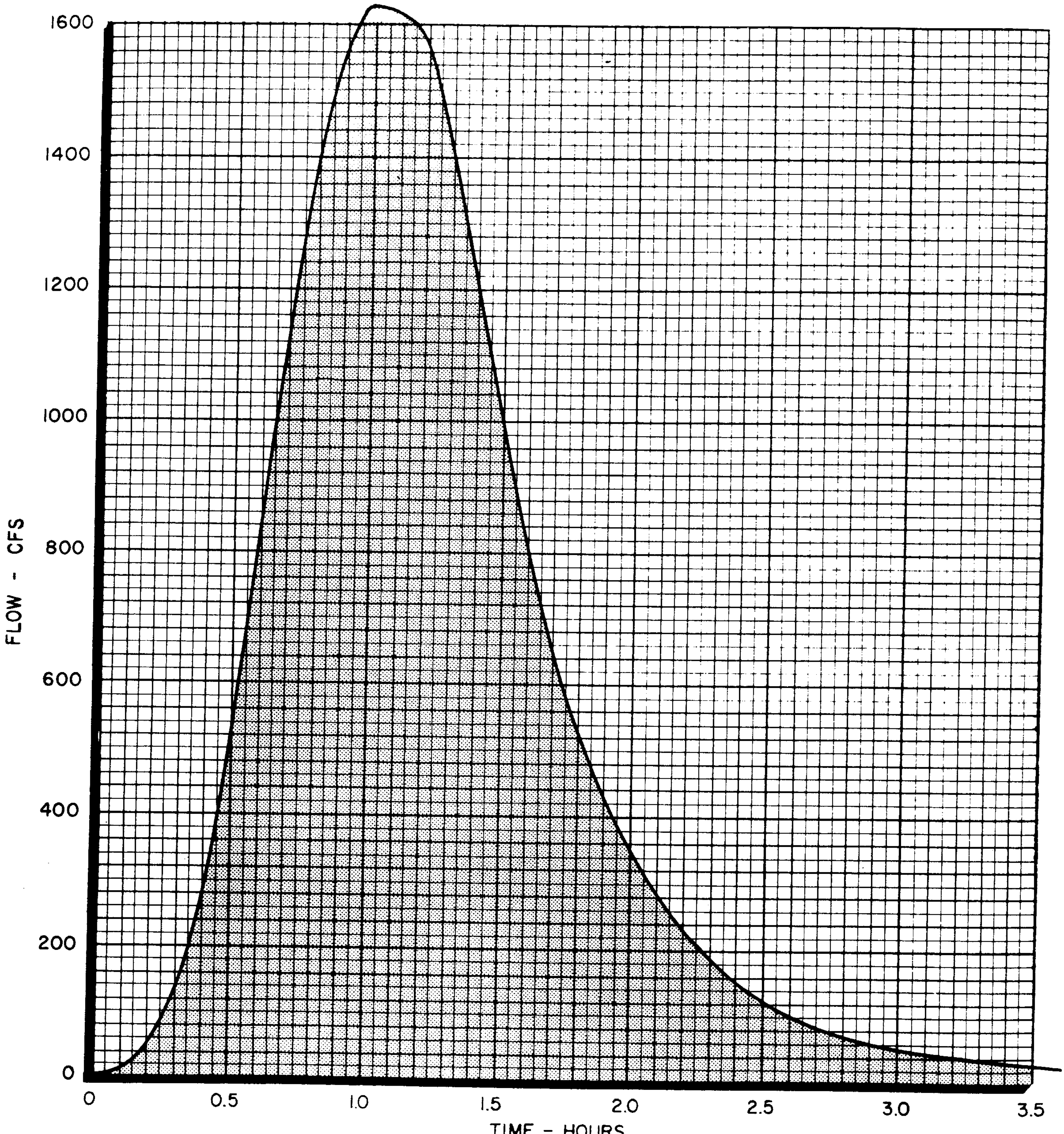
In the cases in this Appendix, numbered key points were selected along the existing channels for these computations. Those points are shown on the basin drainage map by Roman numerals.



Tp = 1.027 hr
Qp = 1431 cfs

POINT 1

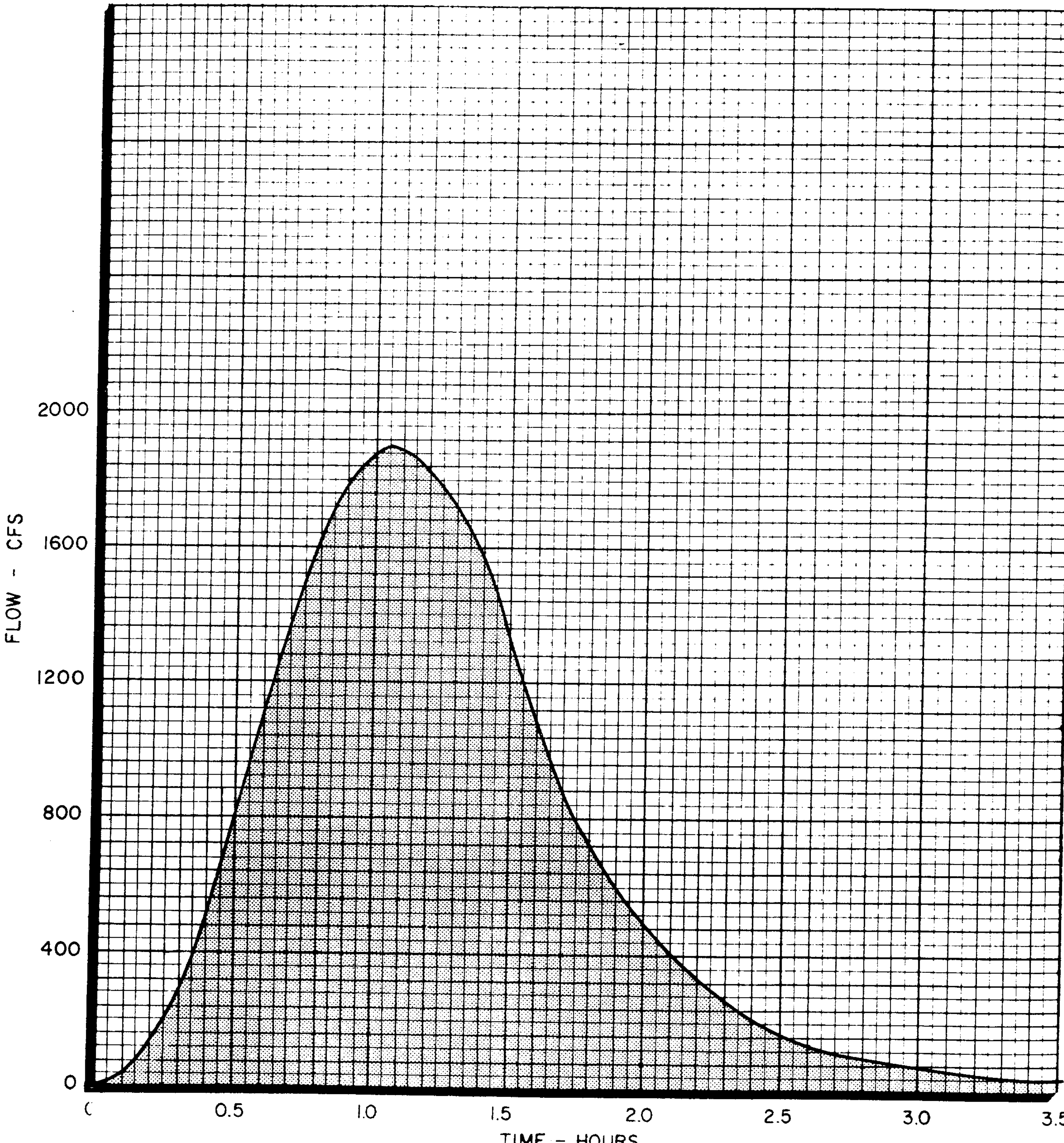
UWE
UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado



Tp = 1.000 hr
Qp = 1620 cfs

POINT 11

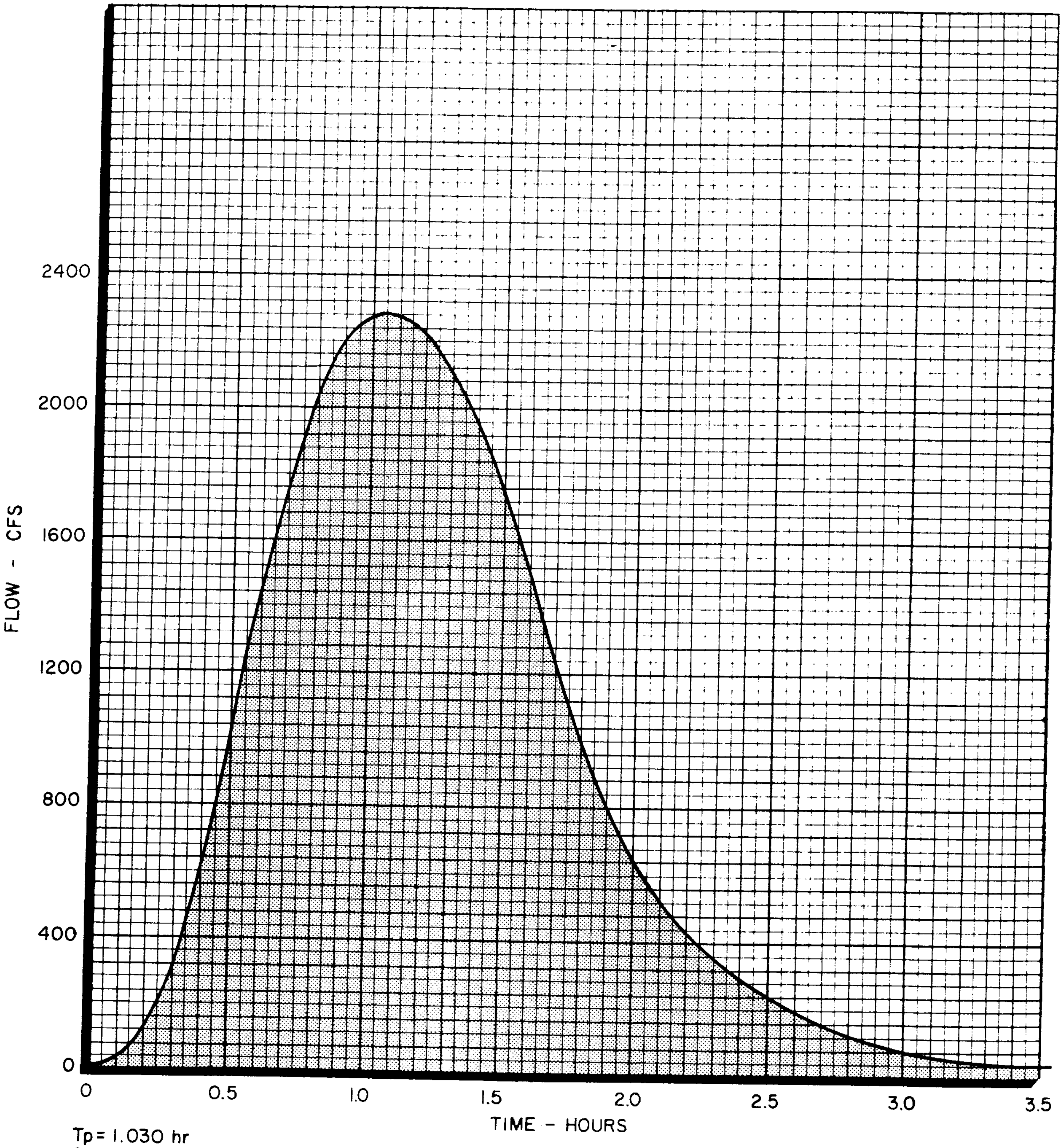
U·W·E·
UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado



Tp= 1.070 hr
Qp= 1935 cfs

POINT III

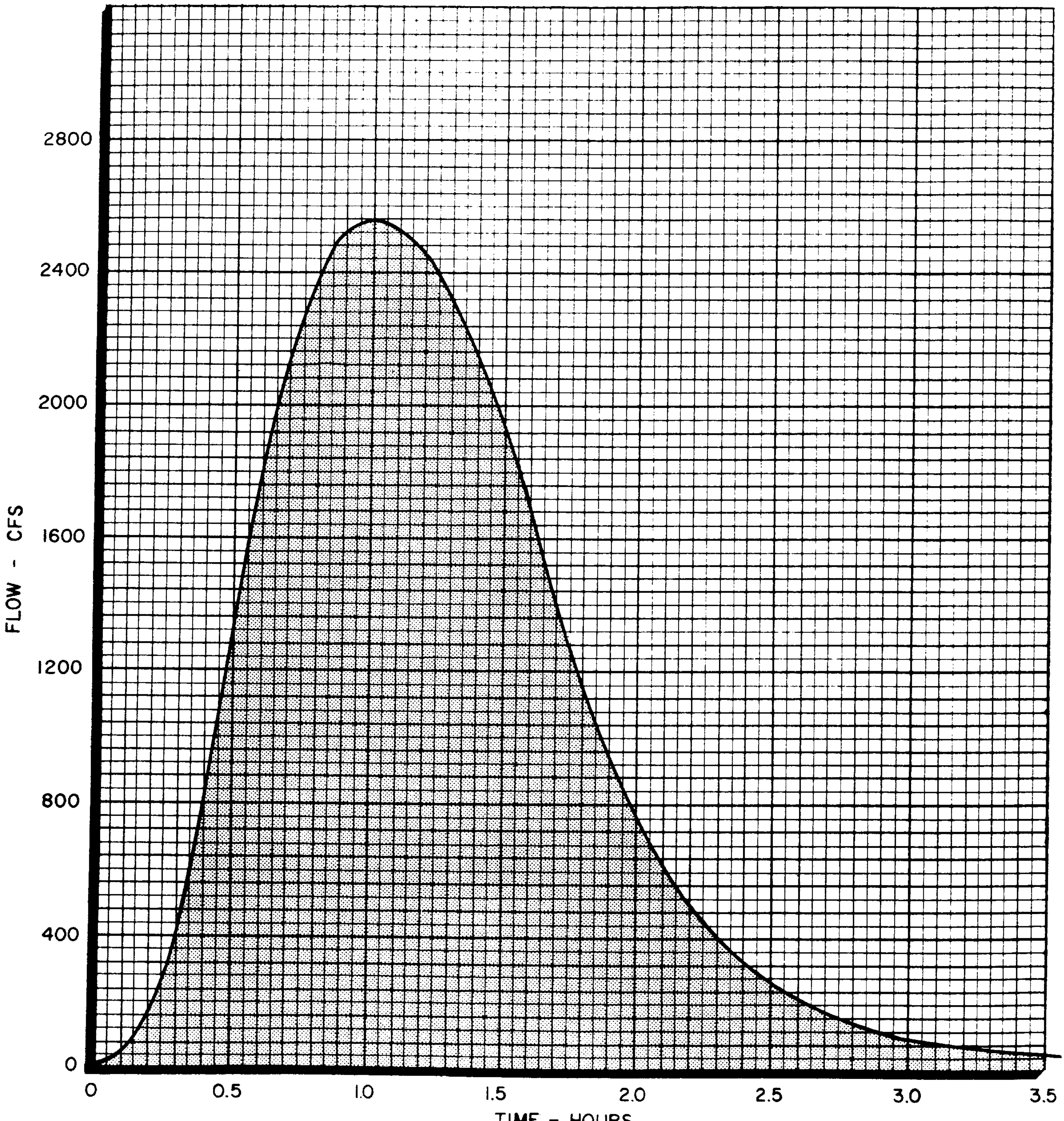
U·W·E·
UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado



Tp= 1.030 hr
Qp= 2275 cfs

POINT IV

U·W·E·
UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado



Tp = 1.000 hr
Qp = 2540 cfs

POINT V

UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado

APPENDIX E:

BASIC DATA FOR

CAMP CREEK DRAINAGE BASIN

EL PASO COUNTY, COLORADO

Street Runoff Assumed:

For the purposes of this report, it has been assumed that the amount of runoff to be carried in a street may be as much as one-half of the full capacity on that street. Any water over this point must be carried in a ditch or pipe. It is assumed in all cases that standard curb (8-inches high) will be used on major drainage streets.

MAJOR BASIN	SUB BASIN	AREA ACRE	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	V CN	TPO	FLOW Q	FLOW qp	Tb
A	1	125.57	.196	3875	200	.220			70	0.632	0.25	37.6	
	2	82.64	.129	3100	285	.150				0.590	0.25	26.5	
	3	105.94	.166	4125	660	.148				0.589	0.25	34.2	
	4	31.74	.050	1750	255	.080				0.548	0.25	11.1	
	5	106.69	.167	3500	370	.154				0.593	0.25	34.2	
	6	90.22	.141	3750	370	.166				0.600	0.25	28.5	
	7	130.45	.204	3600	370	.163				0.598	0.25	41.4	
	8	55.50	.087	2750	255	.135				0.581	0.25	18.1	
	9	68.24	.107	3500	370	.152				0.591	0.25	21.9	
B	1	62.27	.097	3300	315	.151				0.591	0.25	19.9	
	2	53.43	.083	4500	450	.190				0.614	0.25	16.4	
	3	56.18	.088	2150	480	.078				0.547	0.25	19.5	
	4	87.75	.137	4200	530	.161				0.597	0.25	27.8	
	5	90.22	.141	3750	410	.160				0.596	0.25	28.7	
	6	91.54	.143	1800	610	.058				0.535	0.25	32.4	
	7	64.22	.100	2200	1010	.060				0.536	0.25	22.6	

HYDROLOGIC COMPUTATION — BASIC DATA

SHEET 1 OF 7

U·W·E·

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Colorado Springs, Colorado

MAJOR BASIN	SUB BASIN	AREA ACRE	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	V Cb	TPO	FLOW Q	FLOW qp	Tb
B	8	38.22	.060	3250	1060	.091			70	0.555	0.25	13.1	
	9	79.37	.124	3250	1125	.089				0.553	0.25	27.2	
	10	55.96	.087	2500	725	.080				0.548	0.25	19.2	
	11	60.26	.094	3500	670	.121				0.573	0.25	19.9	
	12	94.87	.148	4200	750	.145				0.587	0.25	30.6	
	13	94.64	.148	3050	430	.123				0.574	0.25	31.3	
	14	40.29	.063	3600	660	.128				0.577	0.25	13.2	
	15	10.73	.017	2250	495	.081				0.549	0.25	3.8	
	16	12.86	.020	3000	660	.100				0.560	0.25	4.3	
	17	63.53	.099	4200	800	.140				0.584	0.25	20.6	
	18	53.77	.084	3400	820	.107				0.564	0.25	18.1	
	19	115.18	.180	4200	1210	.118				0.571	0.25	38.2	
	20	64.45	.101	3350	1100	.092				0.555	0.25	22.0	
	21	130.56	.204	4250	1430	.111				0.567	0.25	43.5	
	22	104.39	.163	3800	1360	.099				0.560	0.25	35.3	
	23	55.50	.087	2100	1005	.057				0.534	0.25	19.8	

HYDROLOGIC COMPUTATION — BASIC DATA

SHEET 2 OF 7

U·W·E·

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MAJOR BASIN	SUB BASIN	AREA ACRE	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	V cl	TPO	FLOW Q	FLOW qp	Tb
B	24	108.18	.169	3600	1130	.100			70	0.560	0.25	36.6	
	25	71.85	.112	2950	815	.091				0.555	0.25	24.4	
C	1	43.10	.067	4625	790	.158				0.595	0.25	13.7	
	2	29.96	.047	3200	510	.121				0.573	0.25	10.0	
	3	74.09	.116	2500	790	.076				0.546	0.25	25.8	
	4	49.53	.077	1875	560	.063				0.538	0.25	17.4	
	5	76.39	.119	2150	360	.087				0.552	0.25	26.1	
	6	69.61	.109	3450	400	.148				0.598	0.25	22.4	
	7	17.45	.027	3100	415	.130				0.578	0.25	5.7	
	8	32.77	.051	3750	665	.131				0.579	0.25	10.7	
	9	55.84	.087	3850	785	.129				0.578	0.25	18.3	
	10	62.27	.097	4125	770	.140				0.584	0.25	20.1	
	11	91.42	.143	4250	980	.130				0.578	0.25	30.0	
	12	92.57	.145	3750	1245	.101				0.561	0.25	31.3	
	13	84.42	.132	2500	1250	.064				0.538	0.25	29.8	
	14	58.31	.091	2800	1350	.071				0.543	0.25	20.3	

HYDROLOGIC COMPUTATION – BASIC DATA

SHEET 3 OF 7

U·W·E·

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Colorado Springs, Colorado

MAJOR BASIN	SUB BASIN	AREA ACRE	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	V Cb	TPO	FLOW Q	FLOW qp	Tb
C	15	79.66	.124	3875	1230	.108			70	0.565	0.25	26.6	
	16	64.45	.101	2700	855	.081				0.549	0.25	22.3	
	17	22.61	.035	1500	580	.048				0.529	0.25	8.1	
	18	36.44	.057	2800	650	.093				0.556	0.25	12.4	
D	1	63.30	.099	1875	290	.082				0.549	0.25	21.9	
	2	63.82	.100	2750	500	.100				0.560	0.25	21.6	
	3	44.48	.070	1800	430	.067				0.540	0.25	15.7	
	4	43.10	.067	2875	810	.088				0.553	0.25	14.7	
	5	78.68	.123	3050	960	.089				0.553	0.25	27.0	
	6	59.63	.093	3750	1130	.109				0.565	0.25	19.9	
	7	67.49	.105	2000	845	.057				0.534	0.25	23.9	
	8	52.28	.082	4150	1165	.120				0.572	0.25	17.4	
	9	54.58	.085	3800	1120	.109				0.565	0.25	18.2	
	10	27.83	.043	3100	805	.095				0.557	0.25	9.4	
	11	35.24	.055	3750	815	.122				0.573	0.25	11.6	
	12	108.24	.169	3950	1265	.110				0.566	0.25	36.2	

HYDROLOGIC COMPUTATION – BASIC DATA

U·W·E·
UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado

MAJOR BASIN	SUB BASIN	AREA ACRE	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	V CN	TPO	FLOW Q	FLOW qp	Tb
D	13	44.08	.069	2225	930	.062			70	0.537	0.25	15.6	
	14	31.97	.050	2300	710	.073				0.544	0.25	11.1	
	15	22.73	.036	2750	910	.080				0.548	0.25	8.0	
	16	28.06	.044	3125	675	.106				0.564	0.25	9.5	
	17	83.90	.131	3750	1245	.100				0.560	0.25	28.4	
E	1	61.01	.095	2725	970	.078				0.547	0.25	21.0	
	2	24.33	.038	1525	630	.048				0.529	0.25	8.7	
	3	66.23	.103	2550	910	.074				0.544	0.25	23.0	
	4	74.84	.117	4000	1080	.119				0.571	0.25	24.8	
	5	77.82	.122	2950	930	.087				0.552	0.25	26.8	
	6	11.76	.018	2000	530	.070				0.542	0.25	4.1	
	7	44.08	.069	1850	875	.052				0.531	0.25	15.7	
	8	52.74	.082	3075	1040	.085				0.551	0.25	18.0	
	9	56.53	.088	4100	910	.131				0.579	0.25	18.4	
	10	45.68	.071	3750	1150	.107				0.564	0.25	15.3	
	11	55.90	.087	2975	910	.089				0.553	0.25	19.1	

HYDROLOGIC COMPUTATION — BASIC DATA

SHEET 5 OF 7

UWE

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Colorado Springs, Colorado

MAJOR BASIN	SUB BASIN	AREA		BASIN		Tc	DITCH		V	TPO	FLOW		Tb
		ACRE	MILE	LENGTH	HEIGHT		LENGTH	SLOPE			Q	qp	
E	12	61.46	.096	3825	1090	.112			CN 70	0.567	0.25	20.5	
	13	67.83	.106	4550	1060	.138			70	0.583	0.40	35.3	
	14	108.24	.169	3975	1105	.118			77	0.571	0.45	64.5	
	15	59.28	.093	3475	410	.147			82	0.588	0.65	49.8	
	16	23.64	.037	3275	400	.138			82	0.583	0.65	20.0	
	17	77.65	.121	4800	520	.191			80	0.615	0.55	52.4	
	18	58.37	.091	3925	440	.167			70	0.600	0.25	18.4	
	19	59.28	.093	4475	380	.199			87	0.619	0.90	65.5	
	20	108.18	.169	2725	610	.093			70	0.556	0.25	36.8	
	21	42.70	.067	3225	725	.107			-	0.564	0.25	14.4	
	22	80.29	.125	2625	800	.082			-	0.549	0.25	27.6	
F	1	47.58	.074	3250	725	.109			-	0.565	0.25	15.9	
	2	36.56	.057	1500	350	.059			-	0.535	0.25	12.9	
	3	34.78	.054	4000	280	.199			94	0.619	1.40	59.1	
	4	93.43	.146	4100	620	.150			-	0.590	0.25	30.0	
	5	89.36	.140	3600	230	.191			-	0.614	0.25	27.7	

HYDROLOGIC COMPUTATION — BASIC DATA

SHEET 6 OF 7

U·W·E·

UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado

MAJOR BASIN	SUB BASIN	AREA ACRE	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	V	TPO	FLOW Q	FLOW qp	Tb
F	6	68.87	.108	3500	220	.179			94	0.607	1.40	120.5	
G	1	56.13	.088	3750	485	.152			94	0.591	1.40	101.0	
	2	50.45	.079	3750	305	.181			82	0.609	0.65	40.9	
	3	88.09	.138	3800	260	.193			94	0.616	1.40	151.7	
	4	36.79	.057	2500	200	.135			94	0.581	1.40	66.5	
	5	77.07	.120	4750	220	.266			94	0.660	1.40	123.2	
	6	74.61	.117	4150	230	.226			-	0.636	1.40	124.6	
	7	66.23	.103	3950	230	.211			-	0.626	1.40	111.5	
	8	85.68	.134	4100	230	.220			-	0.632	1.40	143.7	
	9	81.03	.127	4700	210	.267			-	0.660	1.40	130.3	
	10	34.95	.055	3500	90	.269			-	0.661	1.40	56.4	
	11	56.24	.088	3000	170	.176			-	0.606	1.40	98.5	
	12	117.31	.183	3750	220	.200			-	0.620	1.40	200.0	
	13	112.31	.175	3000	200	.166			-	0.600	1.40	198.0	

HYDROLOGIC COMPUTATION — BASIC DATA

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Colorado Springs, Colorado

LINE	FROM	TO	BASE qp	BASE Tp	DITCH L	DITCH S	DITCH TIME	Tp at POINT	Tp of NEXT	DIFF	qp	STREET CPY	REMARKS
	1	2	37.6	0.632	2250	8.2	0.065	0.697	0.650		62.8		
	2	3	62.8	0.650	2300	5.0	0.068	0.718					
	4	5	88.0	0.598	2150	3.9	0.064	0.662	0.662		121.1		
	5	3	121.1	0.662	1500	2.0	0.056	0.718	0.718		244.1		
	3	6	244.1	0.718	1050	9.0	0.018	0.736					
	7	6	47.7	0.597	3500	6.0	0.101	0.698	0.736		322.1		
	6	8	322.1	0.736	2200	7.3	0.041	0.777					
	9	10	48.5	0.552	1800	8.9	0.049	0.601	0.596		71.0		
	10	11	71.0	0.596	1700	8.5	0.043	0.639	0.620		123.9		
	11	8	123.9	0.620	2000	5.2	0.054	0.674	0.720		502.5		
	8	12	502.5	0.720	1750	12.0	0.024	0.744	0.744		528.1		
	12	13	528.1	0.744	1450	18.6	0.017	0.761					
	14	13	28.7	0.596	2750	29.4	0.050	0.646	0.761		606.6		
	13	15	606.6	0.761	1400	8.2	0.020	0.781					
	16	17	61.9	0.574	700	10.0	0.017	0.591	0.591		81.7		
	17	18	81.7	0.591	1750	9.7	0.037	0.628	0.628		100.0		

HYDROLOGIC COMPUTATION — ROUTING

U·W·E· UNITED WESTERN ENGINEERS
1000 West Fillmore Street
Colorado Springs, Colorado

LINE	FROM	TO	BASE qp	BASE Tp	DITCH L	DITCH S	DITCH TIME	Tp at POINT	Tp of NEXT	DIFF	qp	STREET CPY	REMARKS
	18	19	100.0	0.628	850	17.6	0.014	0.642	0.642		112.9		
	19	15	112.9	0.642	2000	17.7	0.031	0.673	0.775		736.0		
	15	20	736	0.775	550	10.0	0.008	0.783					
	21	20	38.7	0.584	2750	18.9	0.061	0.645	0.740		816		
	20	22	816	0.740	1050	5.7	0.017	0.757	0.750		840		
	22	23	840	0.750	1450	6.9	0.022	0.772	0.760		873		
	23	24	873	0.760	2100	6.7	0.032	0.792	0.780		926		
	24	25	926	0.780	1500	8.7	0.021	0.801	0.801		956		
	25	26	956	0.801	2025	9.6	0.027	0.828	0.828		983		
	26	27	983	0.828	2300	5.9	0.036	0.864	0.864		1,010		
	27	28	1,010	0.864	2325	4.7	0.040	0.904					
	29	30	21.9	0.549	2500	9.6	0.079	0.628	0.565		58.4		
	30	31	58.4	0.565	2650	19.6	0.051	0.616	0.608		99.0		
	31	32	99.0	0.608	2250	16.0	0.043	0.651	0.635		139.6		
	32	33	139.6	0.635	2525	12.6	0.045	0.680	0.680		172.4		
	33	34	172.4	0.680	2250	12.4	0.038	0.718	0.718		190.6		

HYDROLOGIC COMPUTATION — ROUTING

SHEET 2 OF 5

U·W·E·
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1000 West Fillmore Street
Colorado Springs, Colorado

LINE	FROM	TO	BASE qp	BASE Tp	DITCH L	DITCH S	DITCH TIME	Tp at POINT	Tp of NEXT	DIFF	qp	STREET CPY	REMARKS
	34	35	190.6	0.718	1300	11.5	0.022	0.740					
	36	36B	15.6	0.537	1230	26.0	0.028	0.565					
	36A	36B	36.2	0.566	980	22.5	0.020	0.586	0.586		51.7		
	36B	35	51.7	0.586	840	13.1	0.019	0.605	0.710		257		
	35	37	257	0.710	750	20.7	0.010	0.720	0.720		290		
	37	28	290	0.720	825	10.3	0.013	0.733	0.880		1,286		
	28	38	1,286	0.880	700	2.9	0.014	0.894					
	39	38	21.0	0.547	800	22.5	0.020	0.567	0.894		1,312		
	38	40	1,312	0.894	1300	5.8	0.021	0.915	0.915		1,340		
	40	41	1,340	0.915	1600	2.8	0.032	0.947					
	42	41	26.8	0.552	1375	21.1	0.033	0.585	0.947		1,365		
	41	43	1,365	0.947	1975	10.6	0.025	0.972	0.972		1,392		
	43	44	1,392	0.972	650	7.7	0.009	0.981	0.981		1,392		
	44	45	1,392	0.981	2150	8.3	0.029	1.010	1.010		1,413		
	45	46	1,413	1.010	1025	4.8	0.017	1.027	1.027		1,431		
	46	47	1,431	1.027	550	3.6	0.010	1.037	1.037		1,446		

HYDROLOGIC COMPUTATION — ROUTING
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1000 West Fillmore Street
Colorado Springs, Colorado

LINE	FROM	TO	BASE qp	BASE Tp	DITCH L	DITCH S	DITCH TIME	Tp at POINT	Tp of NEXT	DIFF	qp	STREET CPY	REMARKS
	47	48	1,446	1.037	1745	2.8	0.036	1.073	1.073		1,487		
	48	49	1,487	1.073	1900	2.1	0.042	1.115					
	50	51	64.5	0.571	2525	6.1	0.070	0.641	0.600		132.7		
	51	49	132.7	0.600	3550	4.2	0.094	0.694	1.000		1,620		
	49	52	1,620	1.000	2850	2.6	0.058	1.058	1.030		1,687		
	52	53	1,687	1.030	2400	2.3	0.050	1.080	1.060		1,788		
	53	54	1,788	1.060	1250	1.6	0.030	1.090					
	55	56	15.9	0.565	750	8.0	0.029	0.594	0.585		28.5		
	56	57	28.5	0.585	1900	4.2	0.075	0.660	0.615		57.7		
	57	58	57.7	0.615	2275	3.0	0.083	0.698	0.630		142.5		
	58	54	142.5	0.630	1325	3.7	0.037	0.667	1.070		1,937		
	54	59	1,937	1.070	950	2.1	0.020	1.090	1.090		1,937		
	59	60	1,937	1.090	1550	1.3	0.029	1.119	1.110		1,997		
	60	61	1,997	1.110	1675	1.7	0.027	1.137					
	62	61	120.5	0.607	2275	3.0	0.084	0.691					
	64	65	56.4	0.661	2975	4.8	0.135	0.796	0.670		148.5		

HYDROLOGIC COMPUTATION — ROUTING

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LINE	FROM	TO	BASE qp	BASE Tp	DITCH L	DITCH S	DITCH TIME	Tp at POINT	Tp of NEXT	DIFF	qp	STREET CPY	REMARKS
	65	61	148.5	0.670	1475	3.0	0.052	0.722	1.030		2,275		
	61	63	2,275	1.030	825	3.0	0.010	1.040	1.040		2,275		
	63	66	2,275	1.040	1075	3.2	0.012	1.052	1.010		2,437		
	66	67	2,437	1.010	1525	2.6	0.019	1.029	1.000		2,540		

HYDROLOGIC COMPUTATION — ROUTING

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