UNIVERSITY OF COLORADO
AT
COLORADO SPRINGS

PRELIMINARY ENGINEERING REPORT

FIRE LANE/STORM DRAINAGE
IMPROVEMENTS PROJECT

MARCH 1985

Prepared For

Planning and Construction Office
University of Colorado, Colorado Springs

Prepared By

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Formerly MSM Consultants, Inc.

A Greiner Engineering, Inc. Company

March 26, 1985

Ms. Gail Chamley, Director
Office of Planning and Construction
University of Colorado at Colorado Springs
Colorado Springs, Colorado

Re: Fire Lane/Storm Drainage Improvements Project

Dear Ms. Chamley:

In accordance with the Phase I terms of our agreement dated February 5, 1985, Greiner Engineering Sciences, Inc. is pleased to submit herewith our report titled "Preliminary Engineering Report, Fire Lane/Storm Drainage Improvements Project."

This report presents our findings of existing conditions, design criteria, recommendations, and cost estimates for proposed improvements to eliminate the storm drainage and fire access problems on the UCCS campus.

During the preparation of this report, we discussed our findings and recommendations with Mr. Bill English of the Colorado Springs Fire Department Fire Prevention Bureau and Mr. Chris Smith of the Drainage Division of the City Engineering Department. We recommend a copy of this report be forwarded to each of these agencies for their review and approval.

We appreciate this opportunity to provide our services. We are available to assist you in any manner possible in implementing the recommendations outlined in this report.

Very truly yours,

GREINER ENGINEERING SCIENCES, INC.

Joseph R. Peters

Joseph R. Peters, P.E.
Project Engineer

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Thomas E. Jedlinsky, P.E.
Project Manager

Enclosure -
As Stated

TEJ/JRP/law

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1.0 EXECUTIVE SUMMARY

Documented Fire Lane and Storm Draiage deficiencies at the University of Colorado at Colordo Springs campus indicate that improvements are necessary to upgrade both facilities. The Colorado Springs Fire Department has pinpointed several key areas of concern regarding fire fighting equipment accessibility. The University has identified the need for a comprehensive drainage study which incorporates the existing campus and provides for continued University development. This report identifies these concerns and offers specific recommendations to develop an adequate fire lane system and integrated storm drainage system.

Major recommended improvements are as follows:

1. Construct a new western access road/fire lane from Austin Bluffs Parkway to the new Engineering Building.

2. Construct a new fire lane from the Engineering Building to Dwire Hall.

3. Construct a sedimentation basin east of the Engineering Building to trap sediment, facilitate maintenance and minimize downstream siltation.

4. Upgrade the fire loop on the east side of the campus by installing asphalt pavement and realigning the present roadway at existing problem areas.

5. Widen existing walkways on campus to also serve as emergency fire lanes.

6. Construct a detention pond on the west end of the campus to avoid potential flooding of Austin Bluffs Parkway during the 100-year storm event.

7. Install miscellaneous ditches, catch basins, storm sewers, and drains throughout the campus to alleviate existing flooding problems.

8. Install landscaping and vegetation to minimize erosion due to storm water runoff.

The estimated costs for the project total $669,700.00. A detailed cost breakdown is included in Section 6.

2.0 INTRODUCTION

The University of Colorado - Colorado Springs (UCCS) is located in portions of Sections 28 and 29, Township 13 South, Range 66 West of the 6th Principal Meridian in the City of Colorado Springs, County of El Paso, State of Colorado (see Appendix, Figure 1). The campus area under study consists of approximately 122 acres of which approximately 40 acres are developed. The campus is bordered on the south and west by the existing Austin Bluffs Parkway, on the east by residential/commercial land and on the north by undeveloped land.

The land slopes generally from northeast to southwest. The upper portion of the drainage basin is very steep and rocky with average slopes of 40 to 50%. The lower portion of the drainage basin is moderately sloped sandy clay with average slopes of approximately 10%. Due to the relatively steep topography, several problem areas have surfaced as a result of storm water runoff and ensuing sediment accumulations.

In addition to drainage concerns, the need to upgrade existing fire lanes throughout the campus has been documented. The Colorado Springs Fire Department has requested several modifications to existing fire lanes as well as construction of additional access roads to allow them proper access to new facilities in the event of an emergency. A new entrance road which will double as a fire lane is planned to provide a new western access to the campus from Austin Bluffs Parkway. This new road, coupled with a variety of improvements throughout the UCCS campus, will greatly improve the Fire Department's ability to respond in the event of an emergency.

3.0 PURPOSE

The purpose of this study is to analyze the existing campus drainage and road system and recommend improvements to each. Since roadway and drainage improvements lend themselves to a simultaneous solution, this plan will integrate the fire lane improvements with the overall drainage plan. Every effort will be made to incorporate drainage and fire lane improvements that are compatible with the natural setting of the University. This comprehensive study will encompass the entire campus and allow for orderly growth and expansion of the University facilities.

4.0 BACKGROUND

Site Characteristics

Topographically, the campus lies at the base of a sizable sandstone bluff. Site drainage is to the southwest where water ultimately reaches Monument and Fountain Creeks, which are tributary to the Arkansas River.

Vegetation on the site consists of grama grasses, yucca, cacti, small shrubs and bushes of various species, and weeds. Annual precipitation is approximately 16 inches per year, occurring mainly as short, violent thunderstorms in the summer and scattered, light snow in the winter.

Geologically, the site is underlaid by an alluvial fan which has been transformed to an andesitic sandstone member of the Dawson Formation which was deposited some 60 million years ago. Andesite tends to be susceptible to a fairly rapid weathering process in which the feldspar and glass are converted to clay minerals by the action of groundwater and time. Thus, we have the phenomenon of a sandstone that weathers to a clay due to the chemical breakdown of the sand grains themselves. As a result, portions of the andesitic Dawson near the surface are commonly weathered to clays or sandy clays which often have dramatic expansive properties. This soil condition is predominant over the majority of the campus.

Project History

The City of Colorado Springs carries an Insurance Service Office (ISO) rating of 3. The ratings vary from 1 to 10 with the most desirable rating being 1. These ratings have a direct correlation to the insurance rates municipalities must pay for fire protection coverage. Since UCCS is within the city limits, the Colorado Springs Fire Department is committed to upgrading facilities to maintain their current ISO rating. This project addresses areas of concern and suggests improvements to minimize the risks associated with a fire emergency.

Reference is made to the May 1984 Program Plan for the Campus Fire Lane/Storm Drainage Construction and Utilities Planning prepared by the UCCS Planning and Construction Office. A copy of this plan is contained in the Appendix of this report. This document summarized all the main elements requiring improvements into five identifiable areas, labeled Item A through Item E. During the course of the project, several additional drainage and roadway problem areas identified, and recommendations for these areas are included as well. A description of the five key areas and any additional work required in the same vicinity follows. Refer to the Recommended Roadway/Fire Lane Improvements Drawing (Appendix, Drawing P2) for locations of improvements.

4.1 Item A

Item A work includes developing a fire/service road and associated drainage facilities from Dwire Hall to the Engineering/Applied Science Building currently under construction. This new connector road is necessary to provide fire lane access to the new Engineering building and the proposed expansion of the Student Center. This road would also serve as a service loop for University vehicles.

In addition, the new road will have a roadside drainage ditch to intercept runoff from the major drainage area to the north. This area is of particular concern since the courtyard behind the existing University Center has experienced serious flooding as recently as August 1984. By intercepting the water further uphill, the majority of the water could be safely channeled around the problem area.

4.2 Item B

Item B includes upgrading the existing fire/service road which loops around the eastern end of the campus. This road starts at the southeastern parking lot and travels past the garage, behind Main Hall, along the east side of Dwire Hall, and down the existing fire lane east of the Science Building. This loop contains several deficiencies which impede the ability of fire fighting equipment to adequately respond to an emergency. Among the existing problems are sub-standard road widths and curve radii, limited sight distances and physical obstructions, such as building corners, light poles, rock retaining walls, and landscaping. Many of these obstructions are of a permanent nature, and it would not be cost effective or practical to attempt their relocation. There are, however, several improvements which could be undertaken at a reasonable cost which would greatly improve accessibility around this loop.

In addition, the area between Dwire Hall and Main Hall was investigated to determine if a turnaround is warranted. Given the existing conditions, this area appears to be restrictive for fire fighting equipment to maneuver. However, since this is a main student walkway and a focal point of the campus, alternatives to a full size turnaround are recommended.

4.3 Item C

Work included under Item C involves the improvement of the existing walkway/fire lane directly north of the Science Building. This walkway provides access to the rear of the Science Building, Library, Student Center, and eventually the proposed Student Center Expansion. The existing walkway is approximately 12 feet wide and is constructed of asphaltic concrete. Improvements will include upgrading the walkway to meet the Fire Department's criteria as well as investigating the potential to construct a turnaround near the northwest corner of the Science Building.

4.4 Item D

This item requires a comprehensive study of existing storm drainage facilities on the UCCS campus as well as recommendations for the west end of the campus to accommodate future expansion. Existing drainage studies which cover this area include the University of Colorado, Storm Drainage Study, Colorado Springs Campus, by Swanson-Rink and Associates, 1975, and The Preliminary Drainage Study for Applied Sciences/Engineering Building at The University of Colorado, Colorado Springs, Colorado, by KKBNA, Inc., 1983.

The information contained in this report is intended to replace the previous studies for this area. A drainage study was prepared by Nelson, Haley, Patterson, and Quirk for the design of the drainage facilities within Austin Bluffs Parkway. We conducted an extensive search for this report but were unable to locate it. The basis for the flow rates entering Austin Bluffs Parkway storm sewer system was based upon the land use shown in the Storm Drainage Study by Swanson-Rink and Associates, 1975.

The existing drainage facilities in the developed area of the campus consist of a combination of underground drain pipes, culverts and drainage swales. Austin Bluffs Parkway has inlets and reinforced concrete pipe storm drains along the entire length adjacent to UCCS. All known existing drainage facilities are shown on the Recommended Drainage Improvements Drawing (Appendix, Drawing P1).

Problems which have been experienced are primarily local with point concentrations of overland flow due to the steep slopes existing in the upper watershed areas (40% and more), the resultant erosion due to high overland velocities and the plugging of existing pipe systems and catch basins. The primary problem area of this nature is in Drainage Basin "D" above the University Center and Library.

4.5 Item E

The requirements for Item E include developing a new fire/service road and associated drainage facilities to link the west end of the campus to the existing west Austin Bluffs Parkway curb cut. Primarily, this will provide a quicker route for emergency vehicles to access the west end of the campus and relieve traffic congestion at the existing southern entrances. This will be particularly beneficial upon the completion of the Engineering/Applied Science Building when traffic will generally increase on the west end of the campus.

In addition, development of a new road on this end of the campus will be the initial step in further expansion to the west. Addressing this area early will allow advanced planning with respect to fire lane access, drainage requirements, traffic movements, and will set the groundwork for new facilities in the future.

5.0 DESIGN CRITERIA

5.1 Storm Drainage

The basis for the design of new drainage facilities is the "City of Colorado Springs - Determination of Storm Runoff Criteria," 1977. The 5-year and 100-year frequency runoff rates were calculated using the Modified Soil Conservation Service (SCS) Method. The input data used in this method includes soil type (Appendix, Figure 2) and associated Runoff Curve Number (Appendix, Figure 3), the runoff depth in inches, (Appendix, Figure 4), the Type IIA, 6-hour storm duration (Appendix, Figure 5), and the time of concentration (Appendix, Figure 6).

The peak runoff from an area is basically determined as follows:

1. The soil type is identified from the Soil Conservation Services Soil Survey for the area (Appendix, Figure 2). For UCCS, the soils are identified as No. 94 and No. 97. These soils fall under the Hydrologic Soil Group "D" which indicates very slow infiltration rates and therefore high runoff potential.

2. A runoff curve number is selected from Figure 3 in the Appendix depending on the ground cover in the given area.

3. Based on the runoff curve number, the runoff depth in inches is determined for the 5-year and 100-year storm from Figure 4 in the Appendix.

4. The area of the drainage basin is calculated in square miles.

5. The time of concentration (tc) is determined for the drainage basin based on the length of the longest watercourse in miles and the maximum elevation difference in feet.

6. The peak discharge is then determined from Figure 5 in the Appendix using this time of concentration.

7. The storm runoff for a given area is then determined by the formula:

$$Q_p = AQ_q$$

where Q_p = Peak Discharge (cfs)
A = Area of Basin (mi^2)
Q = Runoff Depth (in.)
q = Peak Discharge $\frac{cfs/mi^2}{inch}$

This procedure is used for each drainage basin to arrive at peak discharge and evaluate storm sewer requirements.

The capacity of the existing campus storm drain facilities and the Austin Bluffs Parkway system were determined using Manning's Equation. The roughness coefficients, or "n" values, used in this report are listed in the following table. An "n" value is a measure of a pipe or channel lining's ability to enhance water flow. The smoother the pipe or channel, the lower the "n" value.

TABLE 5.1

UCCS Storm Drainage "n" Values

Description	Manning's Equation "n" Values
Reinforced Concrete Pipe (RCP)	0.013
Corrugated Metal Pipe (CMP)	0.024
Grass Lined Channels	0.032
Rock Rip-Rap Lined Channels	0.045

5.2 Roadways/Fire Lanes

The City of Colorado Springs Fire Department has adopted minimum criteria for fire lane access roads from the Uniform Fire Code. This code requires all fire lanes to be a minimum of 20 feet wide with adequate turnarounds at dead-ends. If the road surface is composed of a material other than concrete or asphalt paving, i.e., paving block or brick, the desired width is 24 feet. The roadway section must be able to withstand 5100 pounds per square foot (psf) across its entire width. Preliminary designs from our Soils Engineer indicate that typical roadway sections will be 2" or 3" of asphalt over 4" or 6" of base. Test borings will be drilled at various locations to adequately determine roadway section requirements during the final design phase of this project. Existing walkways will also be checked to insure adequate structural strength.

Curve radii shall be a minimum of 33 feet for the inside returns and 45 feet for the outside. Road grades shall be 10% maximum, with a limit of 8% preferred.

The western access road from Austin Bluffs Parkway was chosen to be 36 feet wide with roadside drainage ditches where necessary. This width will provide adequate capacity to accommodate future University traffic resulting from expansion to the west. The road will not contain curb and gutter since the locations of future facilities are unknown, and locating curb cuts would not be practical at this time.

6.0 RECOMMENDATIONS AND COST ESTIMATES

The specific locations for the improvements outlined in this section are shown on the Recommended Drainage Improvements (Drawing P1) and the Recommended Roadway/Fire Lane Improvements (Drawing P2) included in the Appendix. References to specific locations (Example: Area B-5, Area C-1, etc.) refer to areas that are called out on these drawings. Items A, B, C, and E work are typically shown on Drawing P2. Item D improvements are shown on Drawing P1.

6.1 Item A

The new access road/fire lane between Dwire Hall and the Engineering Building will be a 20 foot wide roadway constructed of asphalt. It will contain a roadside ditch to collect runoff from the slopes above and channel the water to the proposed sedimentation basin. This road will start at the existing parking area behind Dwire Hall and match the new access road behind the Engineering Building. In addition, it will provide access for University vehicles to the rear of the proposed Student Center Expansion.

Runoff water generated below the new road will be collected in two locations. An existing ditch traverses across the slope in a southwesterly direction and stops near a stand of scrub oak north of the Library. Included in the Engineering Building contract is the installation of a catch basin at this location to collect the runoff. In addition, the existing rip-rap ditch along the northern edge of the walkway behind the Library will be upgraded and drain to this new catch basin as well. Care should be exercised to set the catch basin sufficiently low to intercept all the runoff. These improvements, coupled with additional seeding of these slopes by the University, will alleviate the flooding problems in the courtyard behind the Library.

When the proposed expansion of the Student Center is undertaken, it will be necessary to install a catch basin at the east side of the building to collect runoff from the lower rip-rap ditch. This water should be piped under the new building with a permanent material, such as ductile iron pipe, and tied into the new catch basin near the existing scrub oak on the downstream side. This appears to be the obvious solution, however, other alternatives should be evaluated during final design.

6.2 Item B

The following recommendations would improve accessibility around the existing fire loop on the east end of the campus:

a) Install asphaltic paving on the existing portions of the loop that are not already hard surfaced. This work would consist of shaping the existing road base, installing a leveling course of aggregate base, applying a prime coat, and placing a 2-inch layer of asphaltic concrete. Desired roadway width is 20 feet, however, in some areas, this width will not be attainable due to existing restrictions. There are areas behind Main Hall where an existing stone retaining wall borders the road to the north, and a stone curb is on the south. The road width varies from 15 feet to 17 feet. In these instances, the roadway will be paved as wide as possible from wall to curb. "No Parking - Fire Lane" signs should be posted along the entire roadway portions of this loop.

b) The existing intersection at Area B-1 is somewhat restrictive for fire fighting equipment to negotiate. To improve the situation, the existing curb on the east side of the area which juts out into the intersection should be removed to make the turn more negotiable. This curve could then be graded smooth back to the existing trees to give equipment ample room to make the turn. An existing CMP culvert will need to be extended approximately 15 feet to maintain the flow of runoff water in existing swales.

c) Additional asphalt paving should be installed in the vicinity of the existing garage to maximize the outside lane turning radius (Area B-2). "No Parking - Fire Lane" signs should be installed west of the garage to minimize the possibility of conflicts with parked cars at that location in the event of an emergency.

Immediately uphill from the garage, a portion of the existing rock retaining wall on the north side of the road has collapsed. Material behind the wall is sloughing off onto the road impeding the usable width of the road. The damaged wall should be repaired to match the existing portions of wall using rock and mortar for materials. Gravel drain rock should be placed behind the wall with sufficient weep holes to adequately drain any water buildup behind the wall.

d) The existing "S" curve between cottages C and D should be straightened out to provide increased sight distances and reduce the curve radii (Area B-3). To accomplish this, several scrub oak trees will need to be removed, and one parking space will be lost due to the realignment. A new catch basin and storm sewer will be constructed to carry runoff water under the new road alignment.

The western entrance to the parking lot in this area is proposed to be eliminated to correct a local drainage problem. Runoff water from the jeep trail north of this entrance flows down the hill, crosses the road and enters the parking area. To keep this water away from the parking lot, we recommend building a 1 foot high stone curb across the existing entrance which matches the existing stone curb on the south side of the road. This curb will channel the runoff water down the road to the west where it would be collected downstream in a new slotted drain (see Section 6.2, e) and enter the underground storm sewer system.

e) The following recommendations are made to improve the drainage characteristics at the four-way intersection between Dwire Hall and Main Hall (Area B-4). A new concrete swale is proposed to be constructed down the centerline of the upper road to the east. A slotted drain will be installed at the intersection to catch the water which is channeled down this road. Also, a new catch basin is proposed to be installed on the northern edge of the road near the existing embankment. This catch basin will collect runoff water from both the rip-rap ditch behind Dwire Hall and a small tributary which is currently scouring the embankment below the power pole on the hillside. Both the slotted drain and the new catch basin will be tied into the existing catch basin at the base of the concrete retaining wall east of Dwire Hall.

In addition, the embankment below the power pole which is badly scoured due to runoff water should be repaired to eliminate the erosion problem. The solution would consist of installing fill material to dress up the slope, placing filter fabric to stabilize, and rock rip-rap for slope protection.

This area was also studied to determine if accessibility could be improved for fire fighting equipment. In particular, the existing rock wall east of the intersection restricts traffic flow from that direction. To alter or remove this wall would necessitate reworking the entire area, and several mature trees would be lost. As an alternative, the new fire lane between the Engineering Building and Dwire Hall will provide access from the west and, as a result, will improve the ability to negotiate this intersection. Although the area will still be tight, there appears to be ample room to negotiate the turn.

f) Based on discussions with the Colorado Springs Fire Department, a turnaround at the sidewalk area between Dwire Hall and Main Hall will not be necessary (Area B-5). The existing asphalt walkway east of the Science Building (Area B-6) will be adequately upgraded to provide drive-through capability for fire equipment, thereby eliminating the need for a standard turnaround. This walkway currently varies from 12 feet to 15 feet in width. It would be widened to approximately 20 feet by use of a concrete paving block system (i.e., Grasscrete, Hastings Checker Block or similar product). These blocks are of a checkerboard pattern with alternating rows of concrete and voids which enable grass to grow up through the openings. This material is acceptable to the Fire Department as a traveling surface and is more aesthetically pleasing from an environmental standpoint. Use of this material would save the peripheral trees along the walkway and minimize the impact on existing conditions. The Fire Department has approved a 20 foot width for this fire lane in order to avoid removing the existing trees which line the walkway.

The widening of this walkway will necessitate the reworking of some existing drainage facilities near the southern end of the walkway (Area B-8). The work will entail realigning an existing drainage swale, relocating a catch basin and extending approximately 10 lineal feet of storm sewer.

g) At the southeast corner of the Science Building, there is a localized drainage problem (Area B-7). Runoff water from the north follows a path around the east side of the building and is supposed to be collected by an existing catch basin in the grass near the building's southeast corner. There is, however, a low spot in the asphalt accessway to the building entrance at this corner. The water ponds at this location and has entered the building on occasion causing minor flood damage.

To alleviate this problem, we propose adding a slotted drain across the entrance door to the building to collect the water, and sufficient new pipe to tie into the existing catch basin and the underground storm sewer system. In addition, approximately 40 square yards of asphalt should be removed and replaced with sufficient slope to drain to the new slotted drain.

h) The area west of the main campus entrance across from Meadow Lane (Area B-9) contains a rip-rap lined swale in need of repair. This area apparently has a steady trickle of water which passes through on a year-round basis. This moisture has caused a maintenance problem with this swale in that much of the rip-rap has been grown over by grass or settled into the wet soil. Maintenance crews are unable to mow this area with lawn mowers and must trim between the rocks by hand.

Our recommendation is to remove the remnants of the existing rip-rap and install a 4 foot wide concrete trickle channel at the bottom of the swale. This would eliminate the soggy conditions and enable ground maintenance crews to easily care for the lawn in the area.

6.3 Item C

Improvements to the existing walkway north of the Science Building would consist of widening the walkway with asphalt to a width of 20 feet. The additional width will be constructed to the north as much as possible to avoid any further steepening of the existing slopes on the southern edge of the pavement. A 20 foot width can be accomplished without relocating the existing light poles, however, the existing rip-rap ditch will be relocated to the new northern edge of the walkway.

The area northwest of the Science Building was studied as a potential site for a fire truck turnaround (Area C-2). A new turnaround at this location would be both costly and disruptive to the existing campus setting. The existing slope of the land would necessitate a large (16 to 18 feet tall) retaining wall to accommodate an acceptable turnaround. A large wall of this nature at this central location on campus would be unsightly and unsafe.

As an alternative, there appears to be sufficient turnaround room on the existing concrete walkway directly west of the Science Building and the asphalt area north of the University Center (Area C-3). A fire truck traveling in a westerly direction can drive past this concrete walkway, back onto the walkway and successfully turn around. To better accommodate fire trucks in this area, and facilitate drainage as well, we recommend removing and replacing the existing asphalt directly behind the University Center and the existing asphalt walkway which leads toward the Engineering Building (Area C-4). The walkway needs to be upgraded to 20 feet to serve as a fire lane and is currently in very poor condition. The paving for this project will interface with the fire lane from the Engineering Building at the northwest corner of the existing wall north of the Library.

The proposed expansion of the Student Center will eventually cut off this fire lane, however, the Fire Department has indicated the fire lane from the west may dead-end at the proposed building without a turnaround, provided they have access around the east side of the Engineering Building to the new connector road (Area A-1). The turnaround area east of the proposed expansion should remain adequate if it is incorporated into the final design of that building.

6.4 Item D

For study purposes, the campus was divided into seven major drainage basins, as shown on the Recommended Drainage Improvements Drawing (Appendix, Drawing P1). The area designations and total acreages are as follows:

Drainage Area Designation	Area (Acres)	Corresponding Developed Runoff (cfs)	
		5 Yr. Storm	100 Yr. Storm
(A)	14.3	31.3	66.0
(B)	40.5	88.5	186.5
(C)	14.4*	35.4	71.4
(D)	25.5	66.2	131.4
(E)	18.7	34.6	66.1
(F)	5.1	12.7	25.6
(G)	2.5	6.5	12.9
(H)	1.2	2.8	5.8
	122.2	278.0	565.7

* Includes Bennett Property

Typically, underground storm sewers are sized for the 5-year storm event. This is apparently the case for the drainage facilities on the campus as well as the Austin Bluffs Parkway drainage system. From the data developed from University as-built records, the capacities of existing drainage systems appear to be adequate for the 5-year event. The existing capacities are shown on Drawing P1.

Part of the proposed improvements to the campus is a new access road which will run from west to east in a location which will intercept the flows from the steep slopes of the upper watershed. This water will be collected in a rip-rap ditch on the upslope side of the road and directed to one of two new culverts under the road. All culverts have been sized with capacity for the 100-year flood with headwater up to the shoulder of the access road. After passing under the road, the water will be diverted into one channel which then follows the existing natural drainage paths to be collected in catch basins near Austin Bluffs Parkway.

Since the existing drainage characteristics will be altered somewhat due to the new access road, a detention pond should be considered west of the Bennett Property near the low point in Austin Bluffs Parkway. During the 100-year storm, runoff water from the University will ultimately collect at this location (Area D-2) when the City underground storm sewer system reaches capacity. To keep the water on-site and to avoid subsequent flooding in Austin Bluffs Parkway, a detention pond should be constructed with sufficient capacity to detain the difference between the 100-year developed flow and the 5-year historic flow.

Preliminary design indicates a detention pond with a maximum storage capacity of 12-1/2 acre-feet is required. The unit hydrographs for the 5-year and 100-year storms are included in the computations section of the Appendix. These hydrographs were developed from the computer program titled "Computer Program for Project Formulation-Hydrology" distributed by the Soil Conservation Service, Technical Release No. 20 (SCS-TR-20). Storage requirements are determined using these hydrographs and the outflow conditions from the detention pond.

We propose a pond with 3:1 side slopes for maintenance accessibility. The surface area required would be approximately 69,000 feet^2 with a water depth of 10 feet. Two outlet pipes will be provided to tie directly into two separate existing inlet structures to contain all runoff either in an underground system or in the detention pond.

Other ancillary improvements, as shown on the Recommended Drainage Improvements Drawing include cross-culverts at points of concentrated flow, new catch basins, slotted drains, concrete swales, and a sedimentation basin (Area D-1) to trap high velocity flows and allow quiescent settling of eroded material before allowing flows to continue into the underground collection system.

The paved parking lot directly east of the Bennett Property has a localized drainage problem requiring attention (Area D-3). Sediment from the unpaved parking lot above is deposited at this corner during storms causing a maintenance problem in the roadway. To divert the sediment away from the road, we propose a 4 foot curb cut at this location and the installation of a concrete apron to direct the flow into existing drainage channels. The sediment will then be deposited off the roadway and can be maintained at regular intervals by University personnel.

A swale has been designed along the west side of the existing Library to convey the developed 100-year runoff. If the proposed Library expansion occurs, the proposed swale and existing storm sewer system could be relocated around the expansion. This alternate would be somewhat costly (approximately $20,000) in that the flow of water would have to make a 90 degree turn to avoid the Library expansion, then turn another 90 degrees to return to natural drainage channels. This option would require a large ditch with heavy rip-rap to prevent the water from escaping the channel and is not necessarily a permanent solution. Depending on future University expansion, the channel may have to be diverted again to contend with the layout of new buildings.

A suitable alternative is to provide an open walkway between the buildings which is adequate to allow the 100-year runoff to pass west of the existing Library and to allow maintenance access to the existing storm sewer system. If the expansion is proposed to attach to the existing Library, the connection could possibly be made on the second floor instead of ground level. That way, the area between the buildings on the first floor could remain open so the 100-year storm runoff would flow between the buildings without any abrupt changes in direction. This would be a permanent solution that should not be affected by future growth unless a building is constructed south of the Library in the existing parking lot. A cross-section of this swale is shown on the Recommended Drainage Improvements drawing.

We propose a sedimentation basin with 1 on 2.5 side slopes so that maintenance and access may be easily accomplished. Slopes can be grassed and landscaped for visual attractiveness.

We propose five feet of bottom depth to trap sediment. Trapped sediment may be removed annually with a small, rubber-tired front end loader. The sediment thus removed should be disposed of in a location where it will not be transported again by runoff to a channel or inlet structure.

We have provided a 12-inch bleeder pipe so that the basin may fully drain. The bleeder pipe will require periodic rodding in order to maintain its capacity.

The results of the preliminary drainage improvements are shown on Drawing P1 and the Computation Sheets in the Appendix enclosed with this report.

6.5 Item E

Four alternate routes were considered for the alignment of the new western access road off Austin Bluffs Parkway. Simply stated, one was the existing gravel road alignment on the south, two were in the intermediate area north from this existing road to our recommended route, and one was as high as is practically possible at the base of the hills to the north (Area E-1). The recommended alternate was selected based on current economic considerations, drainage requirements and future University concerns. The selected route is the shortest of the four alternates, thereby minimizing total project costs. The road is located as far north as is practical to intercept runoff water from the steep slopes above and to maximize future University expansion area to the south.

An existing curb cut is located on the east side of Austin Bluffs Parkway where the new road will intersect. An existing right turn lane is provided on Austin Bluffs Parkway for northbound traffic access, and the median is already open for southbound access. Austin Bluffs Parkway also contains existing sidewalks from both directions to the new intersection. No sidewalks are anticipated at this time for the new access road.

The new road will be 36 feet wide from Austin Bluffs Parkway to a point beyond the parking area for the Engineering Building. It will then taper down to 20 feet and serve as a fire lane which continues behind the Engineering Building. Two access points are anticipated to accommodate traffic from the existing graveled parking lot located just south of the new Engineering Building (Area E-2). These access points will be spaced as far apart as possible to minimize interference during peak traffic flow.

Horizontal and vertical alignment of this proposed road will be well within the design criteria of both the City of Colorado Springs and the Fire Department (see Appendix, Item 8.0). Runoff water from the slopes to the north will be channeled to two new culverts under the road. Likewise, runoff water contained in roadside ditches will be diverted to the culverts.

6.6 Construction Cost Estimates

The construction costs presented herein are preliminary only. This means they are subject to change after detail working drawings have been developed. The costs are based on current area construction costs, taking into account the requisite prevailing state wage rates. A contingency has been added for each item to cover the cost of unforeseen conditions. Appropriate escalation factors will be required for construction performed in years other than 1985. The total cost estimate is consistent with other previous estimates, namely an estimated project cost of $669,700.

Item A

Description	Quantity	Unit Price	Total
Mobilization	L.S.	$ 3,000.00	$ 3,000.00
Clearing and Grubbing	L.S.	2,000.00	2,000.00
Excavation	1,500 C.Y.	2.50	3,750.00
Embankment, Compacted	4,000 C.Y.	3.00	12,000.00
4" Aggregate Base	1,470 S.Y.	5.00	7,350.00
2" Bituminous Paving	1,333 S.Y.	6.50	8,665.00
48" CMP Culvert	35 L.F.	150.00	5,250.00
12" CMP Culvert	45 L.F.	25.00	1,125.00
Rip-Rap D_{50} = 9"	100 C.Y.	50.00	5,000.00
Bedding -- Type II	44 C.Y.	16.00	704.00
Filter Fabric	300 S.Y.	5.00	1,500.00
Seeding & Landscaping	2,000 S.F.	.50	1,000.00
Subtotal			51,344.00
Contingency (15%)			7,700.00
TOTAL - Item A			$59,044.00

Complete with figures

Item B

	Description	Quantity	Unit Price	Total
	Mobilization (All Item B Work)	L.S.	$ 5,000.00	$ 5,000.00
East Loop	Shape, Grade, Compact	1,950 S.Y.	3.50	6,825.00
	3" Aggregate Base	1,950 S.Y.	4.00	7,800.00
	2" Bituminous Paving	1,950 S.Y.	6.50	12,675.00
	2' Concrete Swale	300 L.F.	8.00	2,400.00
B-1	Remove Curb	20 L.F.	25.00	500.00
	Extend 24" CMP	15 L.F.	35.00	525.00
	Grading	L.S.	300.00	300.00
B-2	4' Rock Retaining Wall	100 L.F.	150.00	? 15,000.00
	"No Parking" Signs	5 Each	150.00	750.00
B-3	Remove Scrub Oak	20 Each	30.00	600.00
	Embankment, Compacted	200 C.Y.	3.00	600.00
	4" Aggregate Base	500 S.Y.	5.00	2,500.00
	2" Bituminous Paving	450 S.Y.	6.50	2,925.00
	Catch Basin	1 Each	1,200.00	1,200.00
	21" CMP	30 L.F.	33.00	990.00
	1' Tall Rock Curb	20 L.F.	40.00	800.00
B-4	15" Diameter CMP in Slotted Drain	20 L.F.	30.00	600.00
	48" Diameter Manhole	1 Each	1,200.00	1,200.00
	Catch Basin	1 Each	1,200.00	1,200.00
	15" Diameter CMP Storm Sewer	105 L.F.	25.00	2,625.00
	Asphalt Pavement Removal	220 S.Y.	3.00	660.00
	Asphalt Pavement Replacement	220 S.Y.	12.00	2,640.00
	Embankment, Compacted	80 C.Y.	3.00	240.00
	Filter Fabric	55 S.Y.	5.00	275.00
	Rip-Rap Slope	15 C.Y.	40.00	600.00
B-5 & B-6	Remove Shrubs	L.S.	200.00	200.00
	Asphalt Pavement (Curb Return)	14 S.Y.	12.00	168.00
	Paving Block with Reinforcing & Seeding	330 S.Y.	32.50	10,725.00

Item B (cont.)

	Description	Quantity	Unit Price	Total
B-7	15" Diameter CMP with Slotted Drain	25 L.F.	$ 30.00	$ 750.00
	15" Diameter CMP	20 L.F.	25.00	500.00
	Asphalt Pavement Removal	40 S.Y.	3.00	120.00
	Asphalt Pavement Replacement	40 S.Y.	12.00	480.00
B-8	Catch Basin	1 Each	1,200.00	1,200.00
	18" Storm Sewer	10 L.F.	30.00	300.00
	Grading	L.S.	300.00	300.00
B-9	Remove Rip-Rap	L.S.	2,000.00	2,000.00
	4' Concrete Trickle Channel	200 L.F.	15.00	3,000.00
	Subtotal			91,173.00
	Contingency (15%)			13,695.00
	TOTAL - Item B			$104,868.00

Item C

Description	Quantity	Unit Price	Total
Mobilization	L.S.	$ 1,000.00	$ 1,000.00
Asphalt Pavement Removal	800 S.Y.	3.00	2,400.00
Asphalt Pavement Replacement	1,600 S.Y.	12.00	19,200.00
Relocate Rip-Rap Ditch	50 C.Y.	50.00	2,500.00
Bedding -- Type II	33 C.Y.	16.00	528.00
Filter Fabric	220 S.Y.	5.00	1,100.00
Subtotal			26,728.00
Contingency (15%)			4,000.00
TOTAL - Item C			$30,728.00

Item D

Description	Quantity	Unit Price	Total
Mobilization	L.S.	$ 3,000.00	$ 3,000.00
30" CMP Culvert	60 L.F.	75.00	4,500.00
48" CMP Culvert	60 L.F.	150.00	9,000.00
30" Flared End Sections	2 Each	450.00	900.00
48" Flared End Sections	2 Each	750.00	1,500.00
Roadside Ditch Excavation	3,000 C.Y.	2.50	7,500.00
Rip-Rap	1,300 C.Y.	50.00	65,000.00
Bedding -- Type II	550 C.Y.	16.00	8,800.00
Diversion Ditch Excavation	300 C.Y.	2.50	750.00
Diversion Ditch Embankment	300 C.Y.	3.00	900.00
Detention Pond Excavation	7,000 C.Y.	2.50	17,500.00
Detention Pond Embankment	7,000 C.Y.	3.00	21,000.00
Seeding	3,000 S.F.	.50	1,500.00
Filter Fabric	3,800 S.Y.	5.00	19,000.00
Remove Existing Concrete Curb	4 L.F.	25.00	100.00
Install Concrete Apron	4 C.Y.	100.00	400.00
Subtotal			161,350.00
Contingency (15%)			24,200.00
TOTAL - Item D			$185,550.00

Item E

Description	Quantity	Unit Price	Total
Mobilization	L.S.	$ 3,000.00	$ 3,000.00
Clearing and Grubbing	L.S.	10,000.00	10,000.00
Excavation	26,000 C.Y.	1.85	48,100.00
Embankment, Compacted	3,800 C.Y.	1.00	3,800.00
6" Aggregate Base	7,310 S.Y.	6.00	43,860.00
3" Bituminous Paving	6,950 S.Y.	7.00	48,650.00
Seed & Landscaping	30,000 S.F.	.50	15,000.00
Filter Fabric	1,000 S.Y.	5.00	5,000.00
Road Signs, Striping	L.S.	5,000.00	5,000.00
Subtotal			182,410.00
Contingency (15%)			27,400.00
TOTAL - Item E			$209,810.00

Project Cost Summary

ITEM	
A	$ 59,044.00
B	104,868.00
C	30,728.00
D	185,550.00
E	209,810.00
Construction Subtotal	590,000.00
Percentage for Art	5,900.00
Surveys and Site Work	11,000.00
Engineering	46,000.00
Contingencies	16,800.00
TOTAL ESTIMATED PROJECT COSTS	$669,700.00

A P P E N D I X

PROGRAM PLAN

for the

CAMPUS FIRE LANE/STORM DRAINAGE CONSTRUCTION AND UTILITIES PLANNING

May 1984

Prepared by

Gail Chamley
Planning & Construction Office
University of Colorado, Colorado Springs

TABLE OF CONTENTS

ABSTRACT

Program Plan

for the

Campus Fire Lane/Storm Drainage
Construction and Utilities Planning

SCOPE: This project calls for a campus fire lane and related storm drainage study and construction with utilities planning a part of the engineering study. There are five areas of concern:

- o Complete and implement a drainage plan of the area south of the Engineering Building, providing for the continued development (drainage & utilities)of the west end of the UCCS campus.
- o A fire lane and related drainage channel between the back of Dwire Hall and the Engineering Building.
- o Complete fire/service loop from the Engineering Building to the west curb-cut on Austin Bluffs Parkway.
- o Improve transition between the back of Dwire Hall and the upper access road to Colorado Springs Fire Department standards.
- o Improve the firetruck turn-around in front of Dwire Hall and the existing fire lane from Dwire to the Library and proposed Student Center Expansion.

BACKGROUND AND PURPOSE Because of its topography, the UCCS campus development requires carefully engineered drainage complimenting the natural setting and required site improvements. The study is required to provide a plan for fire lanes and related drainage improvements, to improve existing fire lanes and to complete the east-west fire loop with the construction of a west campus road. The construction of this fire lane/storm drainage improvements are in separate sections of campus, but all work toegether as a complete fire lane system and integrated drainage system.

BUDGET AND SCHEDULE

A.	Professional Services		$ 60,500
B.	Land Acquisition		-0-
C.	Construction/Sitework		
	1. Sitework	$ 605,000	
	2. Percentage for Art	6,050	
	3. Contingencies	18,150	
	Total Construction Costs		$ 629,200
D.	Movable Equipment		-0-
TOTAL PROJECT COST			$ 689,700
Completion of Program Planning			May 1984
Bid Date			October 1985
Completion			July 1986

UCCS

CAMPUS FIRE LANE/STORM DRAINAGE
CONSTRUCTION AND UTILITIES PLANNING

1.0 POLICY REQUIREMENTS

1.1 Physical Operations to Accommodated

The present UCCS Campus is located at the southwestern base of the Austin Bluffs, north of the center of Colorado Springs. The campus site changes 400 to 500 feet in elevation, sloping southwesterly. The UCCS Campus contains many early 1900 facilities donated by the Cragmor Foundation in 1965. Most of the runoff was naturally directed to drainages washes which controlled heavy rainfall, but as the campus has developed mechanical drainage has been required. Some of the existing fire lanes were part of the original service roads for the Cragmor Sanitarium. These roads will be a base for the improved fire lane loop.

1.2 Institutional Policies

In 1975 a campus Storm Drainage Study was completed, part of which was implemented in September 1979, (Appendix Item 3). The University has enhanced the present drainage systems by landscape design and plantings. This study needs to be revised for current and projected facilities expansion and revisions to the Colorado Springs Fire Department requirements for fire access.

1.3 Program Plan Objectives

This project calls for a study of the drainage from the back of Dwire Hall westward, the existing drainage system east of the Engineering Building down the west side of the Library, the drainage as it is dumped south/southwest of the Engineering Building and its flows around the future development of this area of the UCCS Campus.

This project would complete the upper fire lane loop from east to west giving the highest location for fire trucks to reach the backs of the Art & Photography Cottage, Main Hall, Dwire Hall, Library, the Engineering Building and the proposed Student Center Expansion. The existing fire lanes to be upgraded would access the east end, back and roof of the Science Building, the front of Dwire, the roof/plaza of the Student Center, back of the Art Gallery, back of the Library and the front of the proposed Student Center Expansion. The fire lanes would be used to facilitate the drainage by means of uphill rip-rap channels wherever possible.

1.4 Program Plan Process

This program plan will be submitted for approval to the University of Colorado Board of Regents and then forwarded to the Colorado Commission on Higher Education. Capital Construction Schedule 9 and 9A are in the Appendix, Item 5.

2.0 PROGRAM REQUIREMENTS

Because of the UCCS Campus topography, drainage considerations have been a concern and priority in campus planning. The lack of a specific drainage plan that unifies the surface and sub-surface systems has created several maintenance problems for the Grounds Department staff(silt build-up in catch basins and erosion of seeded areas). There has been some uneasiness about the possibility of our drainage flowing on to adjacent private property during a heavy rainfall.

The Colorado Springs Fire Department has been very co-operative with the UCCS Campus and our efforts to meet fire standards not only in buildings but on the fire access. We have expressed our intent to meet their standards with our road systems

This project would produce a plan for the storm drainage system expansion. It is understood that the fire lane system and surface drainage systems could work compatibly in several parts of the developed campus. This plan will give us a drainage system around the anticipated expansion of the Library, Student Center and Engineering Building.

All planning documents and construction specifications will be in accordance with the Colorado Springs Fire Department requirements and current civil engineering standards.

3.0 FACILITY REQUIREMENTS

The Colorado Springs Fire Department has requested the upgrading of the existing fire lane east of the Science Building and enlarging the turn-around in front of Dwire Hall. The fire access behind Dwire needs to be expanded as a road west connecting with the fire/service road behind the new Engineering Building. This fire road could also accommodate another uphill drainage channel needed to direct run-off from the proposed expansion of the Student Center. This proposed expansion has also been discussed with the University Design Review Board and agree a drainage system in this area is needed. This fire road extension could not only serve for a fire truck access but as a service loop.

Between the east end of Dwire and the west end of the upper road behind Main Hall the grades will need to be minimized for the fire trucks. The slope and dip are too severe and some fill will be needed to create a smooth transition from asphalt area to upper road. Continuing eastward the upper road will need to be widened and several sharp curves straightened. There is one wash area that will require a culvert. These details have not been defined but should be a part of the campus drainage/road study.

The extension of the road to the west Parkway curb-cut would not only serve as a fire lane/service loop but to alleviate the chaotic traffic congestion at the Library entrance. With the construction of the Engineering Building vehicular traffic at the west end of the campus is expected to greatly increase.

A summary of the requirements of this program plan are as follows: (See also Appendix, Item 4)

- Complete drainage plan and construction of the west end of the developing campus to accommodate the drainage from the Engineering Building drainage, Item D.
- Develop a fire/service road associated drainage systems from Dwire Hall to the Engineering Building, Item A.
- Complete fire/service road from campus to west Austin Bluffs Parkway curb cut, alleviating major traffice bottlenecks, Item E.
- Upgrading upper campus road behind Main Hall to a fire lane and extend down existing fire land east of the Science Building, Item B.
- Develop an acceptable fire truck turn-around in front of Dwire Hall to access the back of the Science Building, Library, Student Center and the front of the proposed Student Center Expansion, Item C.

4.0 ALTERNATE SOLUTIONS

Until a comprehensive study of both the fire lane system and the storm drainage system is complete, no alternate solutions are known.

Two areas of this program are considered "urgent current need".

- o Complete drainage plan and construction of the west end of campus drainage system, providing for the development of the area of campus. (Item D on Appendix Item 4)

Consequences: The existing campus storm drainage system surface and sub-surface ends at the east end of the Engineering Building site. Drainage from the severe slope behind this site has been rounted around the building but not directed into a drainage system. The runoff will drain through the gravel parking lot and possibly onto adjacent private property. During heavy rains gravel, vegetation and loose dirt will be washed onto the asphalt lot and clog the main sub-surface manhole off the northwest corner of the Library. There is concern that eventually the 36" existing sub-surface drainage will be blocked, possibly flooding a low area in the Library/Student Center northwest corner. The current silt accummalating in this catchbasin is 120 cubic yards a year and it is believed, by our campus grounds supervisor, will be increased by the construction of the Engineering Building. The present sub-surface drainage systems parallels the west side of the existing library. When the library is expanded this system will need to be relocated. Rather than piecemeal a campus drainage plan building by building, a comprehensive drainage study should be considered. This sutdy could avoid duplicating consultants' time and construction.

- o Complete fire land and associated drainage systems from the back of Dwire Hall to the back of the Engineering Building. (Item A on Appendix Item 4)

Consequences: Because the new Engineering Building will store and use hazardous and flamable materials, two-way access is required to the back of the building, according to Inspector Bill English of the Colorado Springs Fire Department. If the road between Dwire Hall and the Engineering Building is construction without addressing drainage problems the maintenance of the road will be continuous. The resulting drainage problems created by the road construction will increase erosion and run-off to the back of the Science Building, Student Center and Library. When the Student Center is expanded drainage from the slope and road could potentially damage the structure unless drainage is directed around the building. This area currently carries all the surface run-off from the midpoint of the back of Dwire Hall westward.

Three areas of this program are considered "urgent need in immediate future".

- o Complete fire lane from campus to west curb-cut. (Item E on Appendix Item 4)

- o Upgrade upper campus road behind Main to the east and from Main Hall along east end of Science Building. (Item B on Appendix Item 4)
- o Upgrade turn around in front of Dwire and fire land down and in back of the Science Building. (Item C on Appendix Item 4.)

Consequences: The existing fire lanes barely meet the minimum standards for fire vehicle access. For basic maneuverability of large firetrucks, the Colorado Springs Fire Department requires a lower and upper road access to buildings with minimum width of 20 feet with a turning radius of 45 feet.(See Appendix, Item 6) Associated with the campus fire lane plan is the west access road improvement. This access would allow for another campus entrance from Austin Bluffs Parkway. One of the current campus entrances passes thru a heavily used parking lot which could hamper a firefighting crew's ability to reach a potentially disasterous situation.

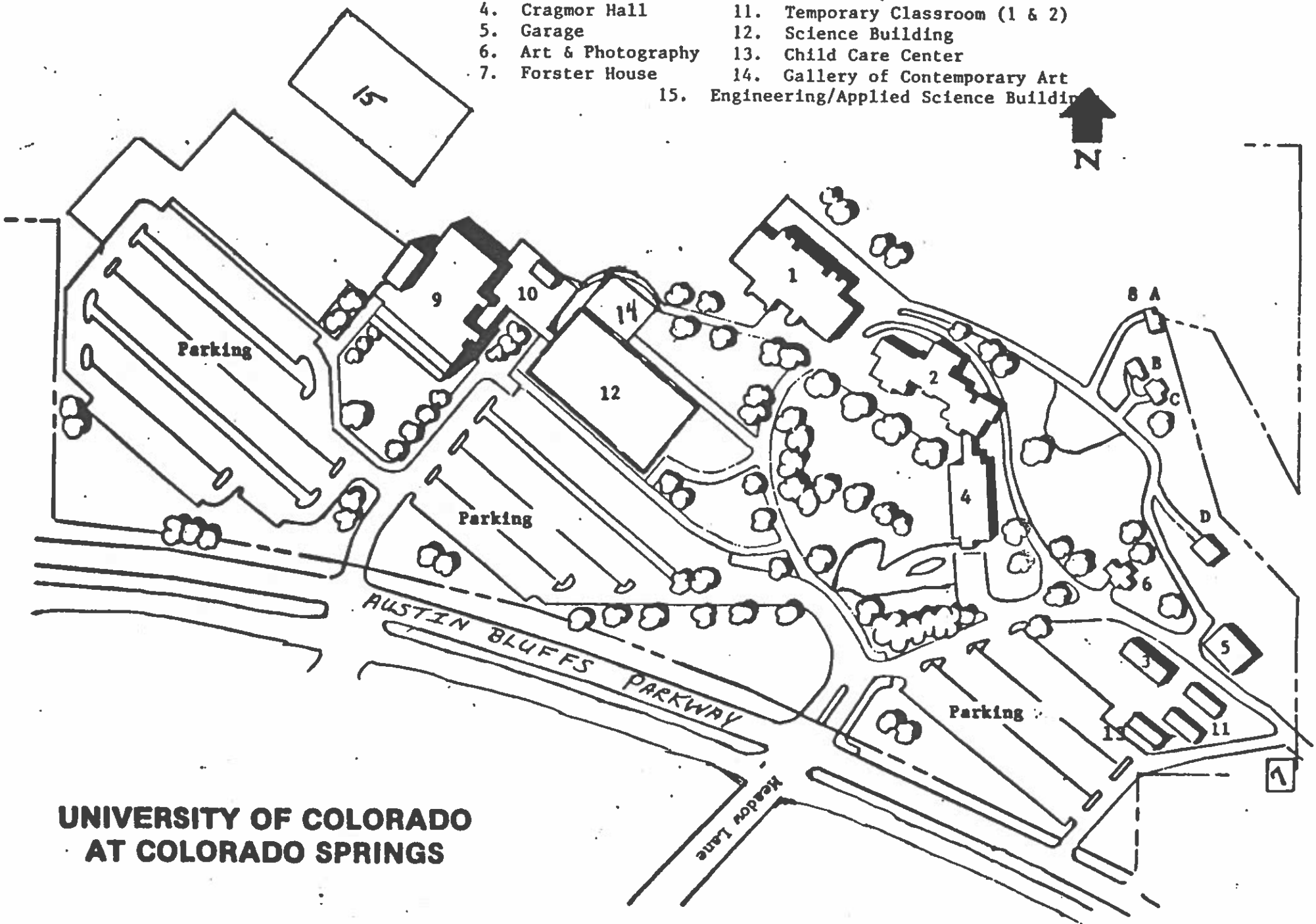
APPENDIX

Item 1

UCCS SITE PLAN

BUILDINGS

1. Dwire Hall
2. Main Hall
3. Art Studio Bldg.
4. Cragmor Hall
5. Garage
6. Art & Photography
7. Forster House
8. Cottages A, B, C, & D
9. Library
10. University Center
11. Temporary Classroom (1 & 2)
12. Science Building
13. Child Care Center
14. Gallery of Contemporary Art
15. Engineering/Applied Science Buildin



UNIVERSITY OF COLORADO AT COLORADO SPRINGS

APPENDIX

Item 2

UCCS MASTER PLAN
SLOPES AND DRAINAGE

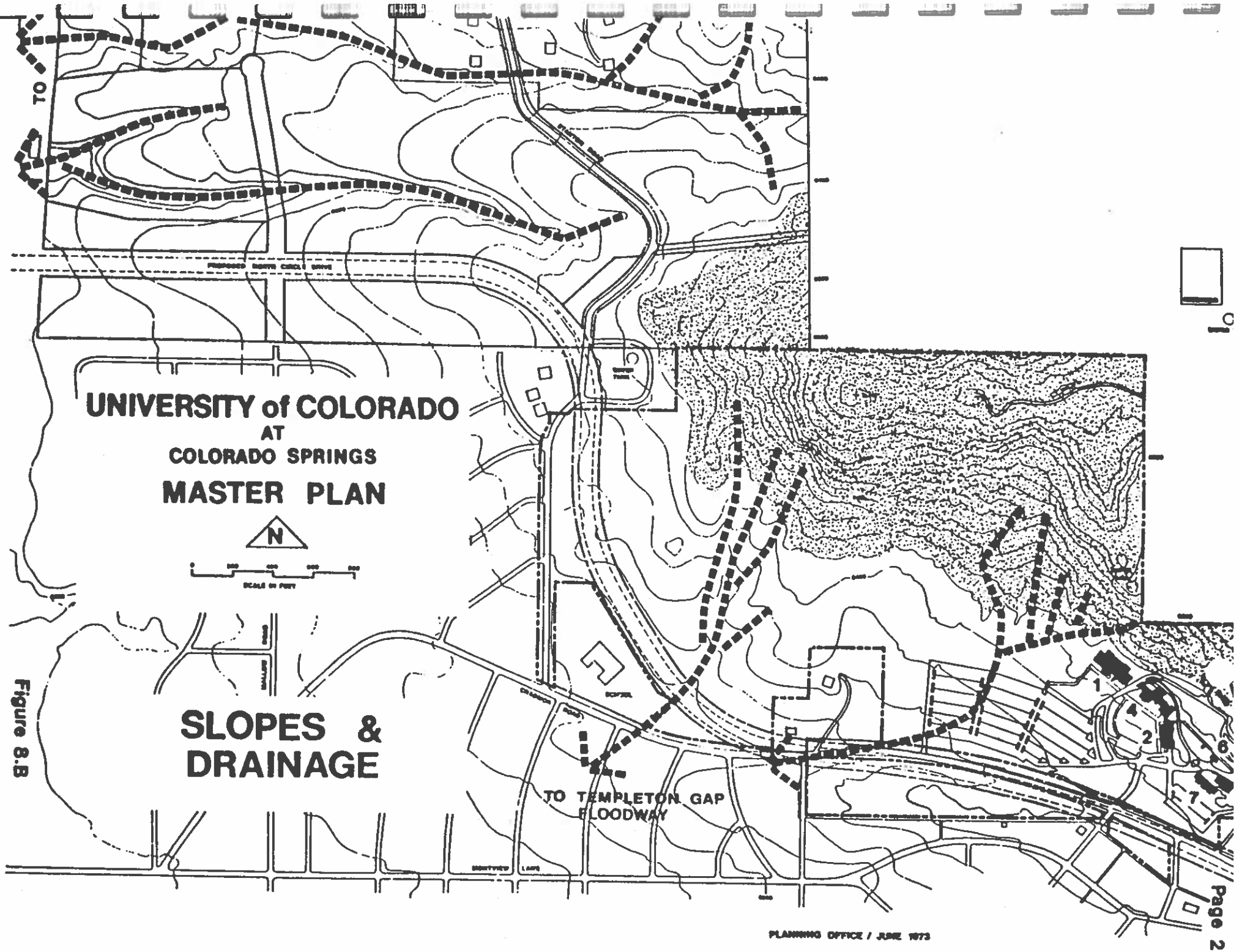


Figure 8.B

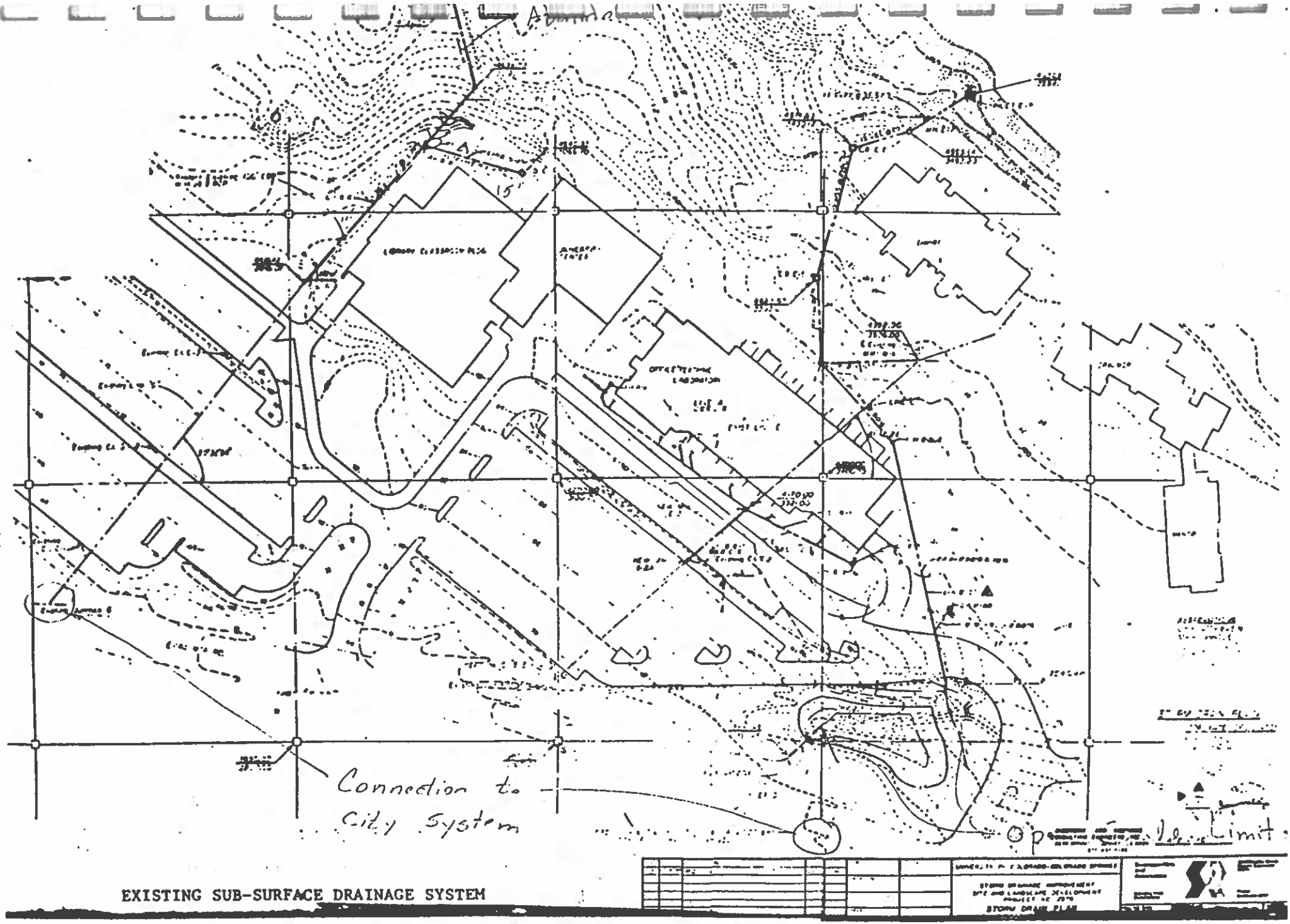
A-12

Page 2

APPENDIX

Item 3

EXISTING SUB-SURFACE DRAINAGE SYSTEM



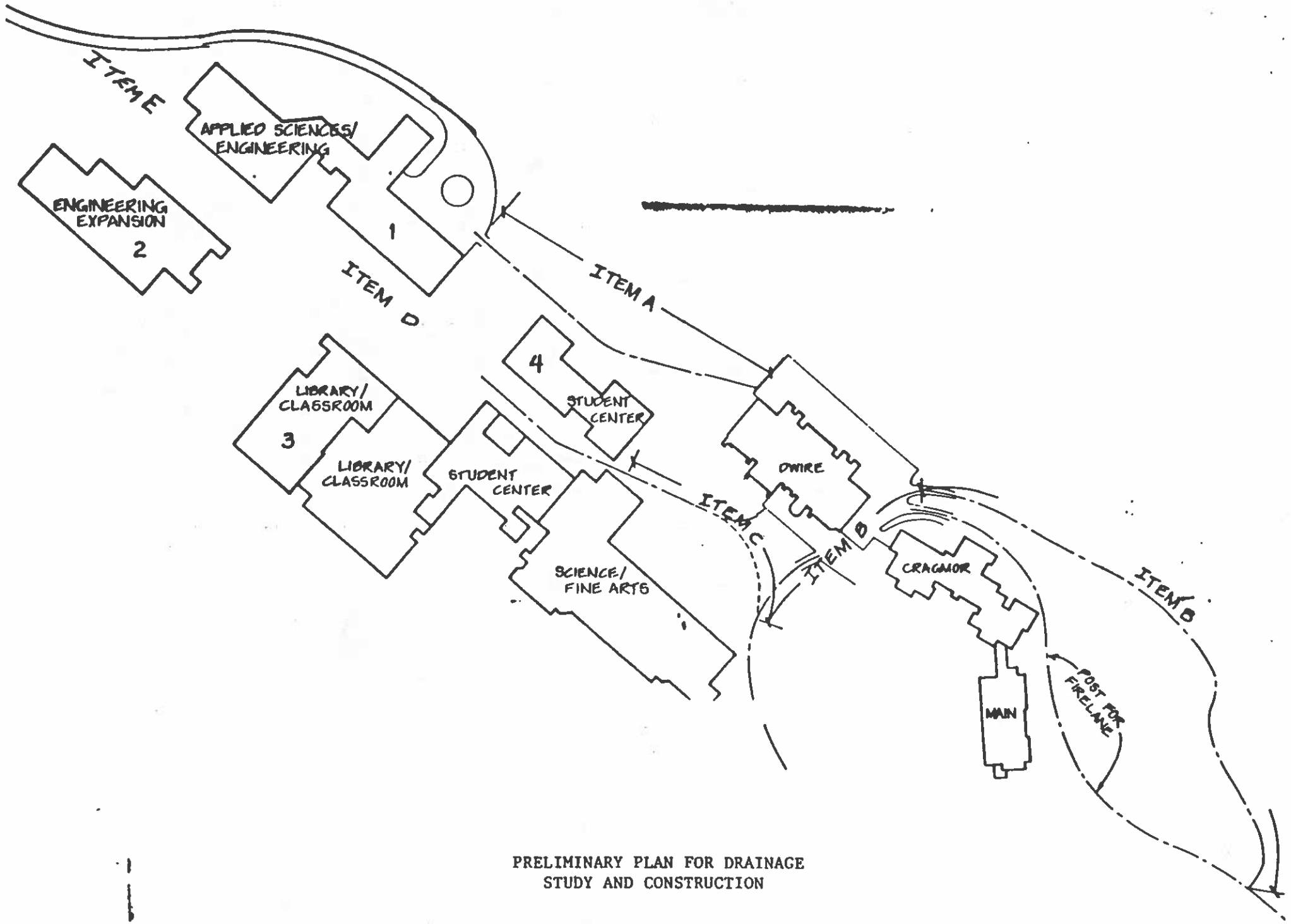
EXISTING SUB-SURFACE DRAINAGE SYSTEM

Funding-FY '84-'85

APPENDIX

Item 4

PRELIMINARY PLAN FOR DRAINAGE
STUDY AND CONSTRUCTION



PRELIMINARY PLAN FOR DRAINAGE
STUDY AND CONSTRUCTION

APPENDIX

Item 6

SUPPORTING DATA

CITY OF COLORADO SPRINGS
COLORADO 80903
FIRE DEPARTMENT
31 SOUTH WEBER ST.

May 17, 1984

University of Colorado
at Colorado Springs
1420 Austin Bluffs Parkway
Colorado Springs, CO 80907

Attn: Ms. Gail Chamley
Physical Plant

Dear Ms. Chamley:

The fire lane situation as it presently exists for emergency vehicle access to structures on the north side of the campus, is not adequate for fire equipment operations. Uniform Fire Code, Section 10.207, requires all fire lanes to be 20 feet wide with an adequate turning radius. If the fire lanes are dead-end drives, the Uniform Fire Code also requires an adequate turnaround for fire vehicles. The fire lanes around Dwyer Hall, Main Hall and Cragmoor Hall do not presently meet these minimum criteria. The extension of the fire lane north of the Science Building, with the construction of the engineering building, will relieve the dead-end problem of that fire access and will also enhance the access to the Library Building. See attachment "A" for turning radius criteria.

An upgrade of the fire access to the buildings adjacent to Main Hall and the extension of the fire lane from the north side of Dwyer Hall to the north side of the engineering building will greatly enhance the Fire Department's ability to effectively attack a fire in those structures Access to fire hydrants will also be improved by this upgrade program allowing us more options for truck placement and operations.

If you need further assistance, please feel free to contact this Division at 578-6040.

Sincerely,

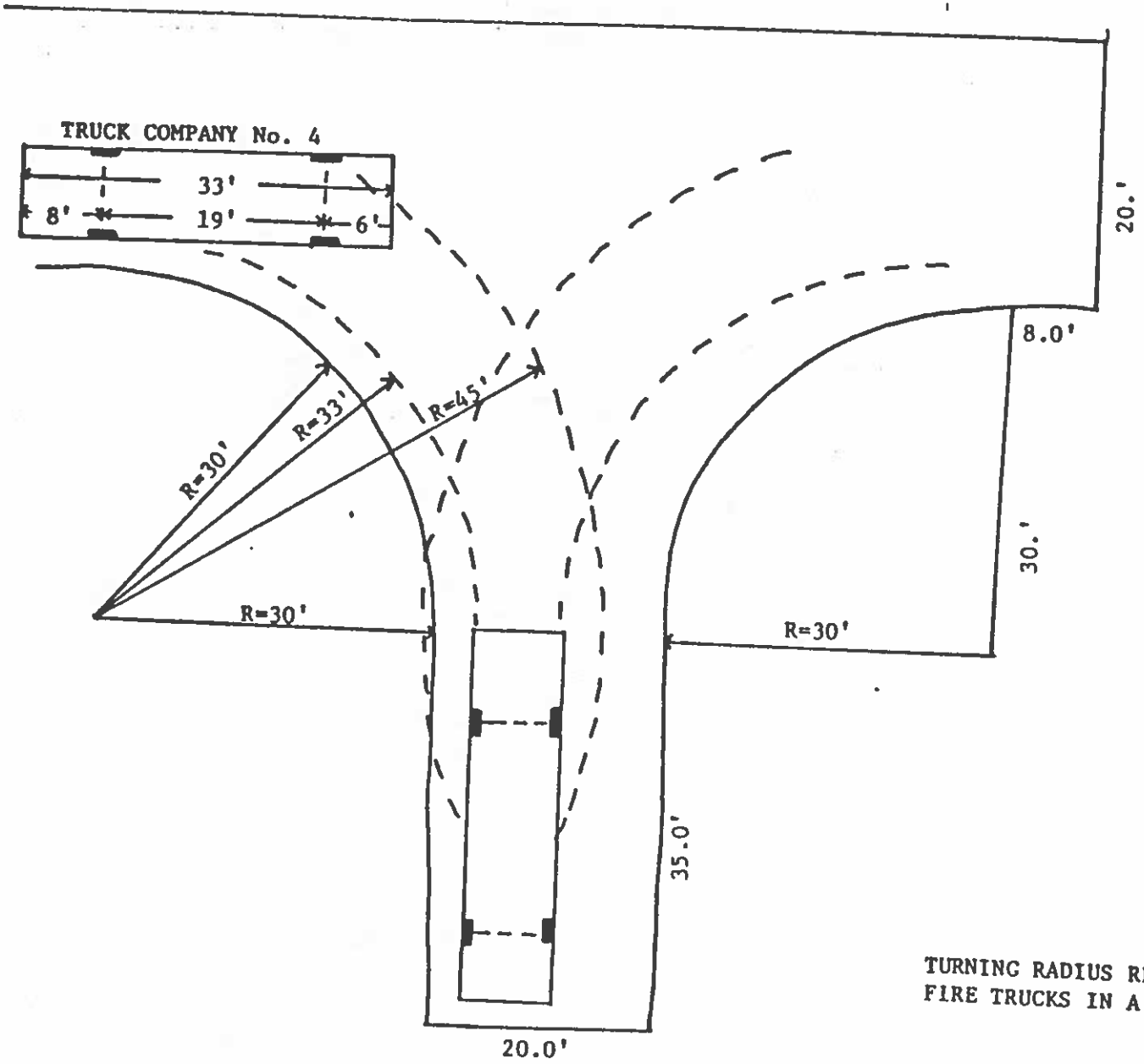
William A English

William A. English
Inspector
Fire Prevention Division

attachments-2

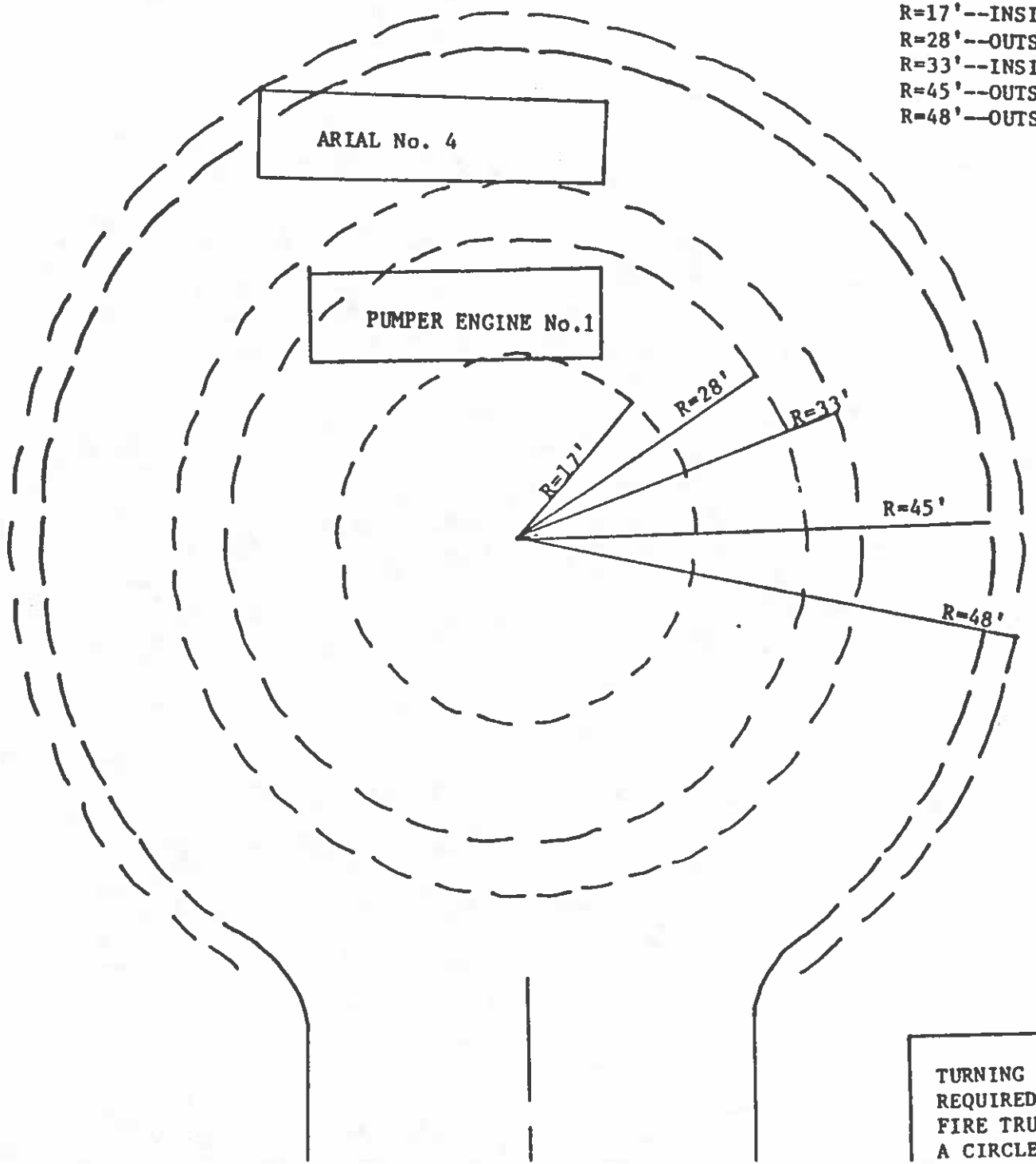
WAE:da

Prevent Fires . . . Save Lives and Property



TURNING RADIUS REQUIRED FOR
FIRE TRUCKS IN A TEE TURNAROUND

R=17'--INSIDE WHEEL PUMPER
R=28'--OUTSIDE WHEEL PUMPER
R=33'--INSIDE WHEEL ARIAL
R=45'--OUTSIDE WHEEL ARIAL
R=48'--OUTSIDE OVERHANG ARIAL



TURNING RADIUS REQUIRED FOR FIRE TRUCKS IN A CIRCLE TURN

CITY OF COLORADO SPRINGS
COLORADO 80901
TRAFFIC ENGINEERING DIVISION
401 WEST FONTANERO P. O. BOX 1575 PHONE 471-6663

January 18, 1982

Mr. Arnold Trujillo, Chief
Police Department
University of Colorado
Austin Bluffs Parkway
Colorado Springs, CO 80907

Dear Arnold:

As per our discussion, this division would review the design of the proposed new roadway to connect the new parking lot and Austin Bluffs Parkway. The details of the intersection with Austin Bluffs Parkway and the needed traffic controls would be determined by this division upon completion and opening of the roadway.

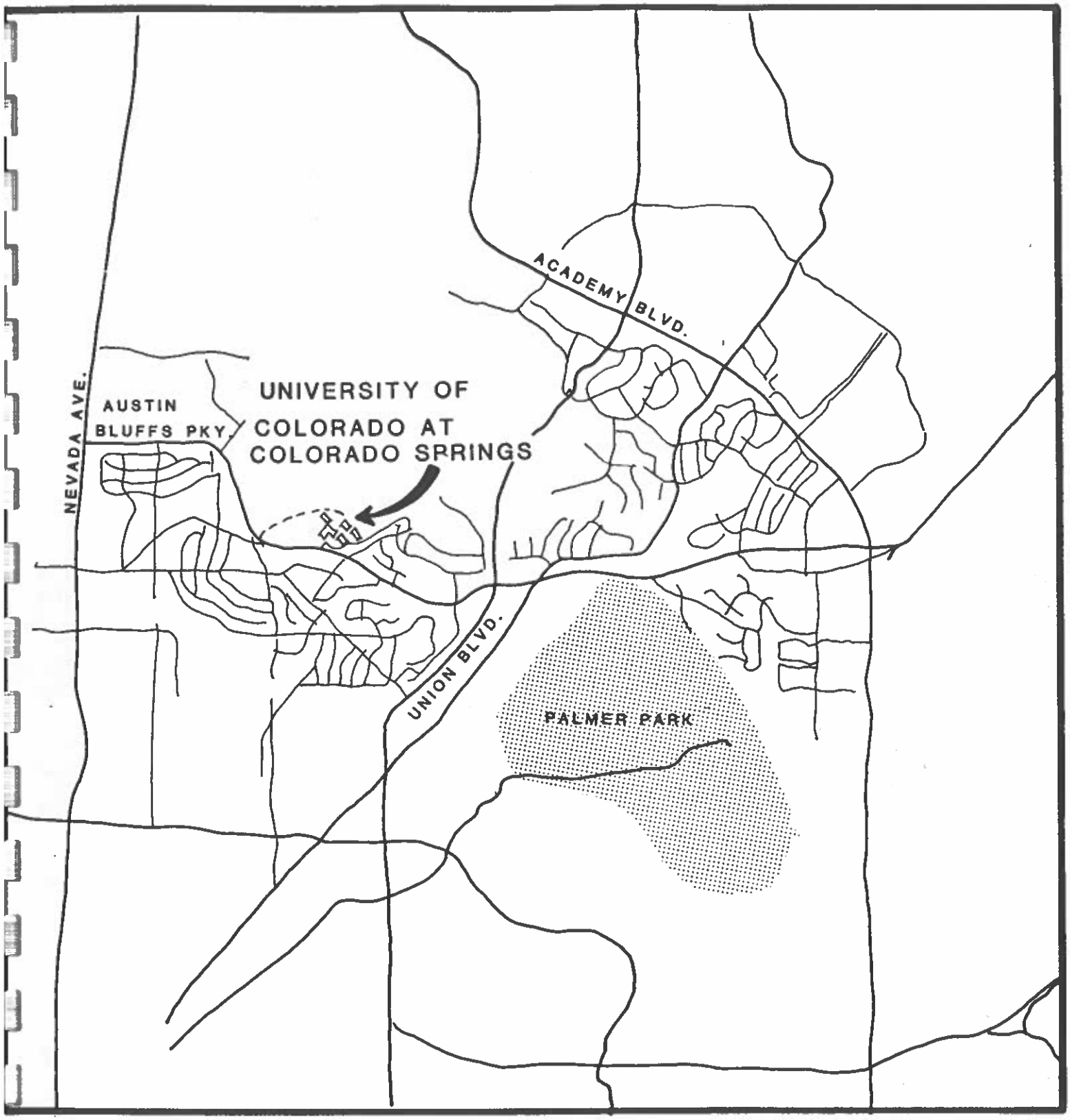
As in all traffic controls, we follow the approved standards and guidelines in the Manual on Uniform Traffic Control Devices.

Sincerely,

Ralph F. Wendland
Acting Assistant Traffic Engineer

RFW:fd

cc: Location file
Larry Lane



VICINITY MAP

U.C.C.S

North

SCALE: 1" = 1 MILE

Greiner Engineering Sciences, Inc.

5373 North Union Boulevard

A-22 Colorado Springs, Colorado

Fig. 1

SOIL TYPES

FIG. 2

- Runoff curve numbers for selected agricultural, suburban and urban land use. (Antecedent moisture condition II, and $I_a = 0.2S$.)

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
1/5 acre / 47	65	78	85	89
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

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

2. Good cover is protected from grazing and litter and brush cover soil.

Fig. 3

-- Determination of Runoff Depth in inches for selected CN's and rainfall amounts.

Curve[1] Number	(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:

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

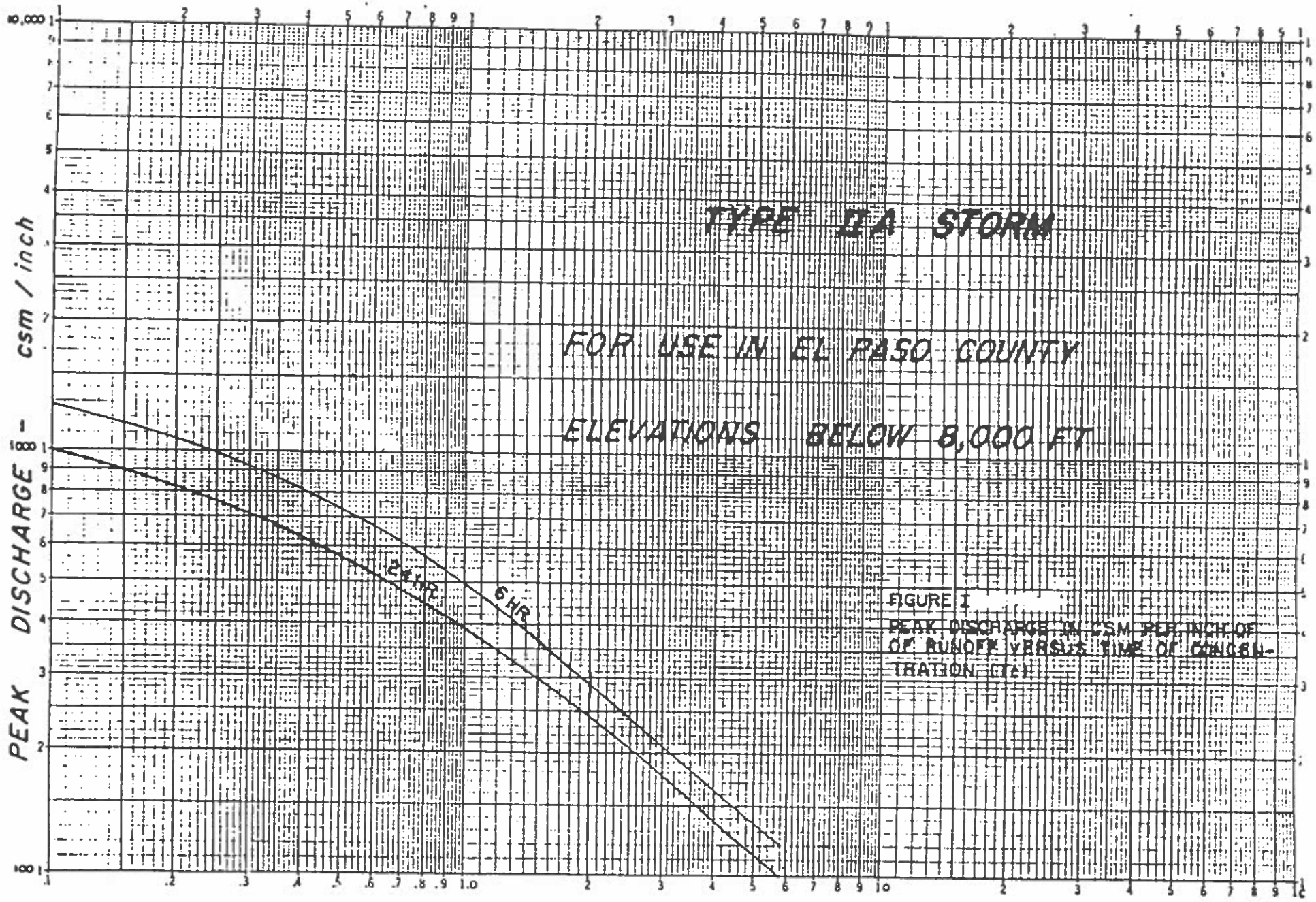
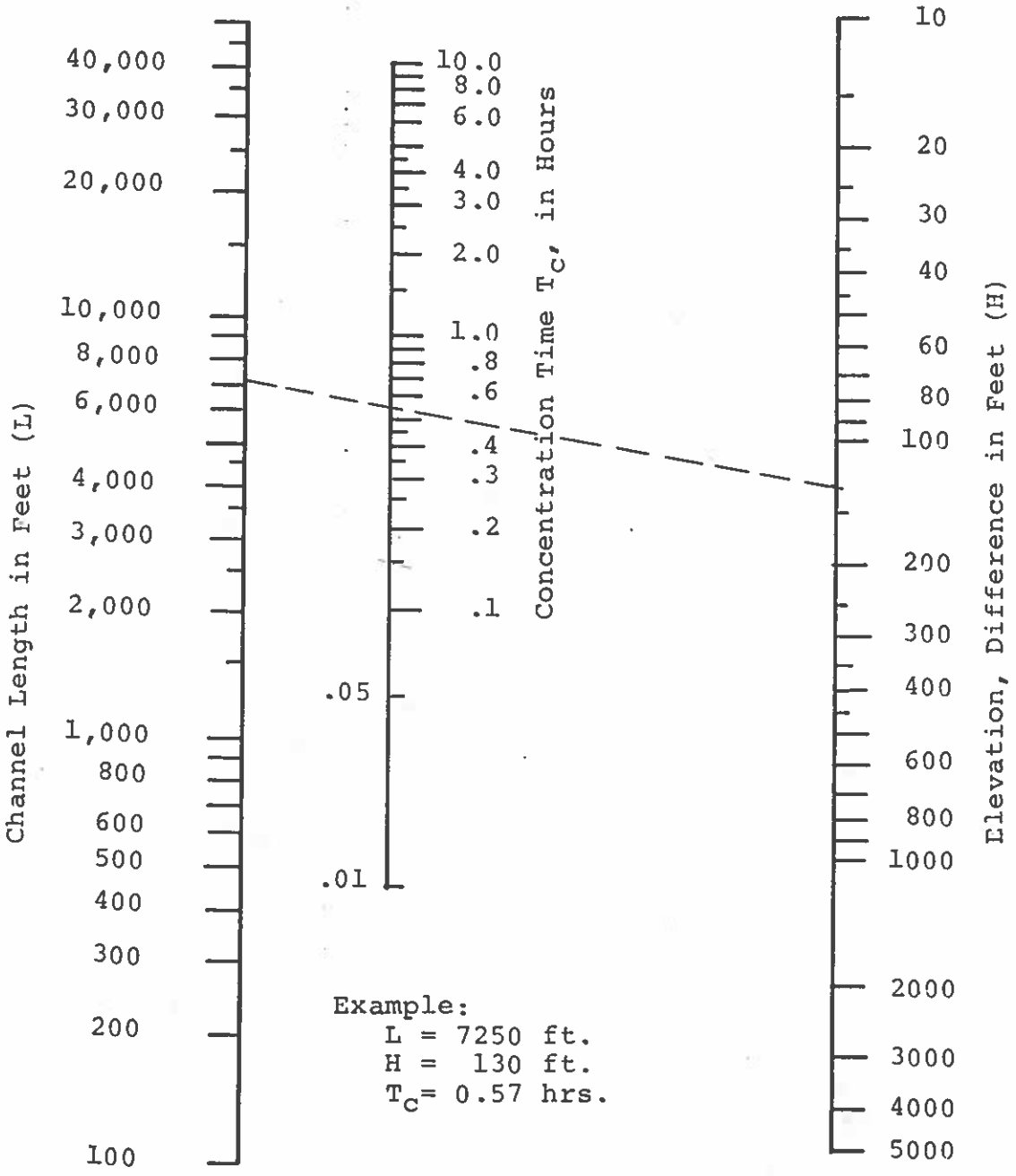


FIGURE I
PEAK DISCHARGE IN CSM PER INCH OF RUNOFF VERSUS TIME OF CONCENTRATION (TC)

FIGURE 5

$$T = \left(\frac{11.9\ L^3}{H}\right)\ .385$$

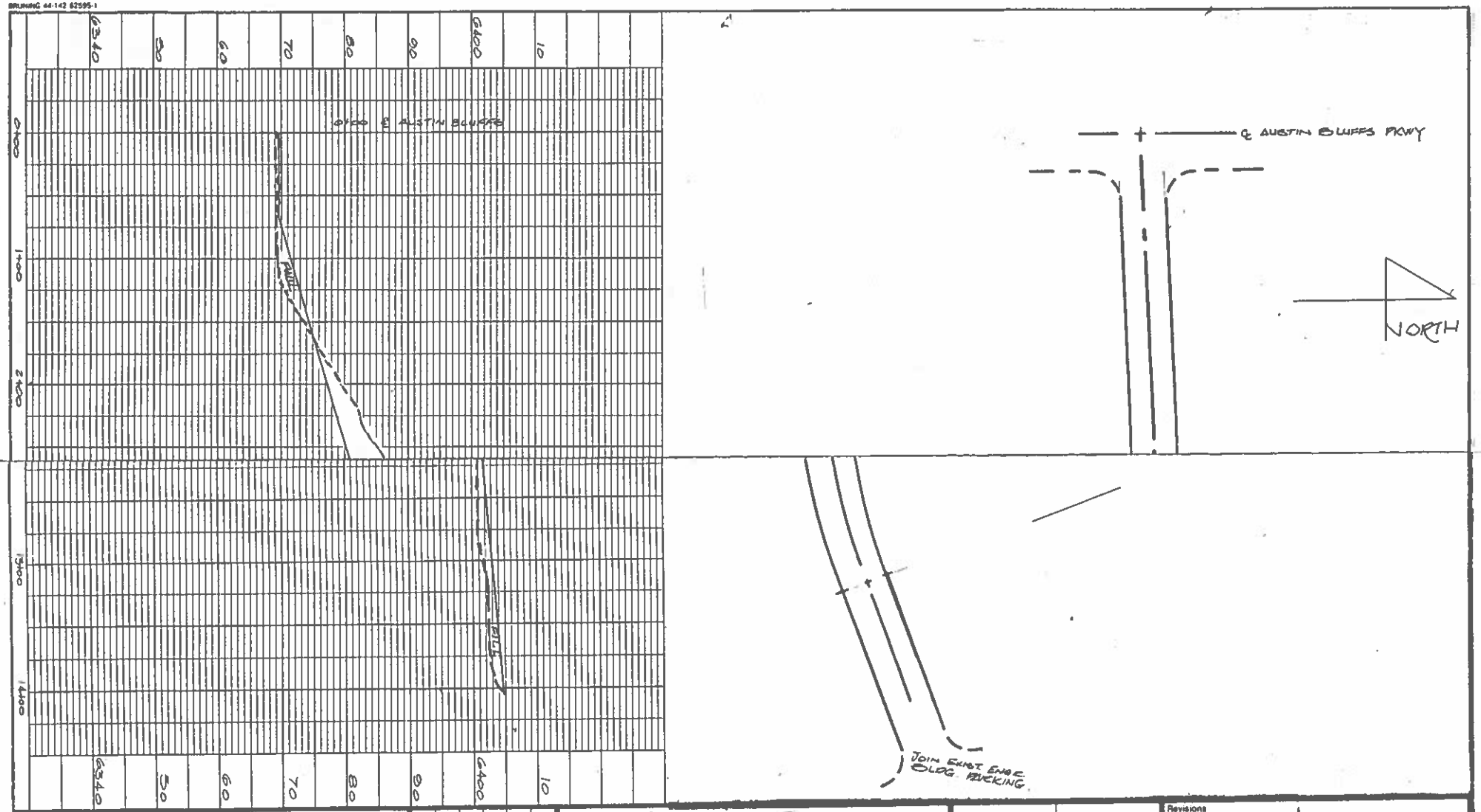
T = Tc in hours
L = Length of longest watercourse in miles
H = Elevation difference in feet



Estimating Tc from Lengths and Slopes of Natural Channels

Fig. 6

BRUNING 44-142 62595-1



Sheet 1 of 1	Job No. 51252201	Date MAR 85	UCCS 1 PROPOSED PLAN & PROFILE OF ACCESS ROAD FROM AUSTIN BLUFFS PKWY. TO ENGR. BLDG. PKNG. LOT	Scale HOR. 1"=50' VERT. 1"=10'	Check TEU	Drawn EDM	Design SKP	**Greiner Engineering** Greiner Engineering Sciences, Inc. Denver, Colorado Colorado Springs, Colorado Albuquerque, N.M. Kenmerer, Wyoming	Revisions 1

COMPUTATIONS

SUBDIVISION UNIVERSITY OF COLORADO
LOCATION COLORADO SPRINGS
JOB NO. 517 5201
DESIGN STORM 5 YR. RECURRENCE INTERVAL
MAJOR STORM 100 YR. (REVISED COMPS)
COMPUTATIONS BY MWC DATE 3/5/85
CHECKED BY T. SMART DATE 3/7/85

GREINER ENGINEERING
5455 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO 80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Q_p = (AQ)\, q$

Area Designation	A (Acres) (Mi^2)	CN	6 Hr	Q in.	AQ $mi.^2$-in.	ΣAQ $mi.^2$-in.	t_c hr.	q csm/in.	Q_p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in	Min. Slope %	Length ft.	VEL V fps	Δt (min)	
A	14.30	89	5YR	1.12	0.025		0.063	1250	31.3		66.0	42" CMP					INLET CONTROL 15" M. 42"
	0.0223		100YR	2.36					66.0						6.86		
B_1	7.06	89	5 YR	1.12	0.0124		0.040	1250	15.4		32.4	30" CMP					15" M 30"
	0.0110		100 YR	2.36					32.4						6.60		
B_2	4.76	89	5 YR	1.12	0.0084		0.035	1250	10.4								
	0.0075		100 YR	2.36					21.9								
B_3	14.88	89	5YR	1.12	0.0260		0.033	1250	32.6								DITCH FOR B_2 & B_3 n = 0.045 s = 0.015 B = 3' V = 4.53 D = 2.5 1 2
	0.0232		100 YR	2.36					68.7								
$B_2 + B_3$	19.66	89	5 YR	1.12		0.0344	0.035	1250	43.0		90.6	48" CMP					16" M 48
	0.0307		100 YR	2.36					90.6						7.21		
ΣB_n = B	40.45	89	5 YR	1.12		0.0708	0.070	1250	88.5								
	0.0632		100 YR	2.36					186.5								
C_1	8.44	92	5 YR	1.33	0.0175		0.037	1250	21.9		43.5	36" CMP					M 10 36
	0.0132		100 YR	2.64					43.5						6.15		
$\Sigma C_1 + C_2$ = C	14.38	91	5 YR	1.26		0.0284	0.040	1250	35.4								DITCH FOR D n = 0.045 s = 0.015 B = 2' V = 8.4 $\frac{1}{3}$ D = 1.4'
	0.0225		100 YR	2.54					71.4								
$D_1 + D_2$	16.75	89	5 YR	1.12		0.0293	0.050	1250	36.6		77.0	48" CMP					12" M 48"
	0.0262		100 YR	2.36					77.2						6.13		
ΣD_n = D	25.5	92	5 YR	1.33		0.0529	0.090	1250	66.2								
	0.0398		100 YR	2.64					131.4								

BDIVISION UNIVERSITY OF COLORADO
CATION COLORADO SPRINGS
NO. 517 5201
SIGN STORM 5 YR. RECURRENCE INTERVAL
JOR STORM 100 YR. (REVISED COMPS)
MPUTATIONS BY MWC DATE 3/7/85
ECKED BY T. Smart DATE 3/7/85

GREINER ENGINEERING
5455 N. UNION BOULEVARD
COLORADO SPRINGS, COLORADO
80918

RUNOFF COMPUTATIONS
(SCS METHOD)
$Qp = (AQ)\,q$

Area Designation	A (Acres) (Mi^2)	CN	6 Hr	Q in.	AQ $mi.^2$-in.	ΣAQ $mi.^2$-in.	t_c hr.	q csm / in.	Q p cfs	Street capacity cfs	Flow in Pipe cfs	Pipe Dia. in	Min. Slope %	Length ft.	VEL V fps	at (min)	
E_1	6.78	95	5 YR	1.58	0.0167		0.05	1250	20.9								
	0.0106		100 YR	2.94					38.9								
E_2	1.33	91	5 YR	1.26	0.0026		0.03	1250	3.3								
	0.0020		100 YR	2.54					6.6								INLET CONTROL
E_3	2.28	91	5 YR	1.26	0.0045		0.03	1250	5.6		11.3	21" CMP			4.70		12" MIN 21"
	0.0036		100 YR	2.54					11.3								
E_2, E_3 E_4	11.91	94	5 YR	1.49		0.0277	0.06	1250	34.6								
	0.0186		100 YR	2.84					66.1								
F	5.14	91	5 YR	1.26	0.0101		0.035	1250	12.7								
	0.0080		100 YR	2.54					25.6								
G	2.49	92	5 YR	1.33	0.0052		0.032	1250	6.5								
	0.0039		100 YR	2.64					12.9								
H	1.16	90	5 YR	1.18	0.0021		—	1250	2.8								
	0.0018		100 YR	2.45					5.8								

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☐ ALBUQUERQUE, NEW MEXICO
☐ KEMMERER, WYOMING

PROJECT UCCS
JOB NUMBER 51752-01 SHEET 1 OF 1
CALCULATED BY J. PETERS DATE 3/8/85
CHECKED BY _____ DATE _____

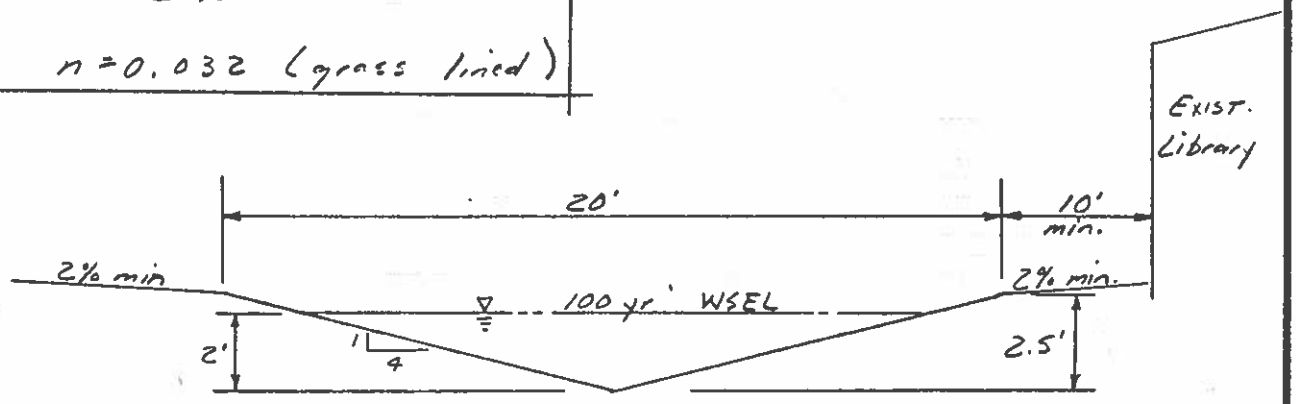
100 yr SWALE - WEST OF LIBRARY

Design Data:

Q = 100 cfs

S = 2 %

n = 0.032 (grass lined)



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

At d = 2.0'

$Q = \frac{1.486}{.032} (16.0)(.97)^{2/3}(.02)^{1/2}$

Q = 103 cfs

V = 6.4 cfs

At d = 2.5'

$Q = \frac{1.486}{.032} (25)(1.21)^{2/3}(.02)^{1/2}$

Q = 186.4 cfs

V = 7.5 fps

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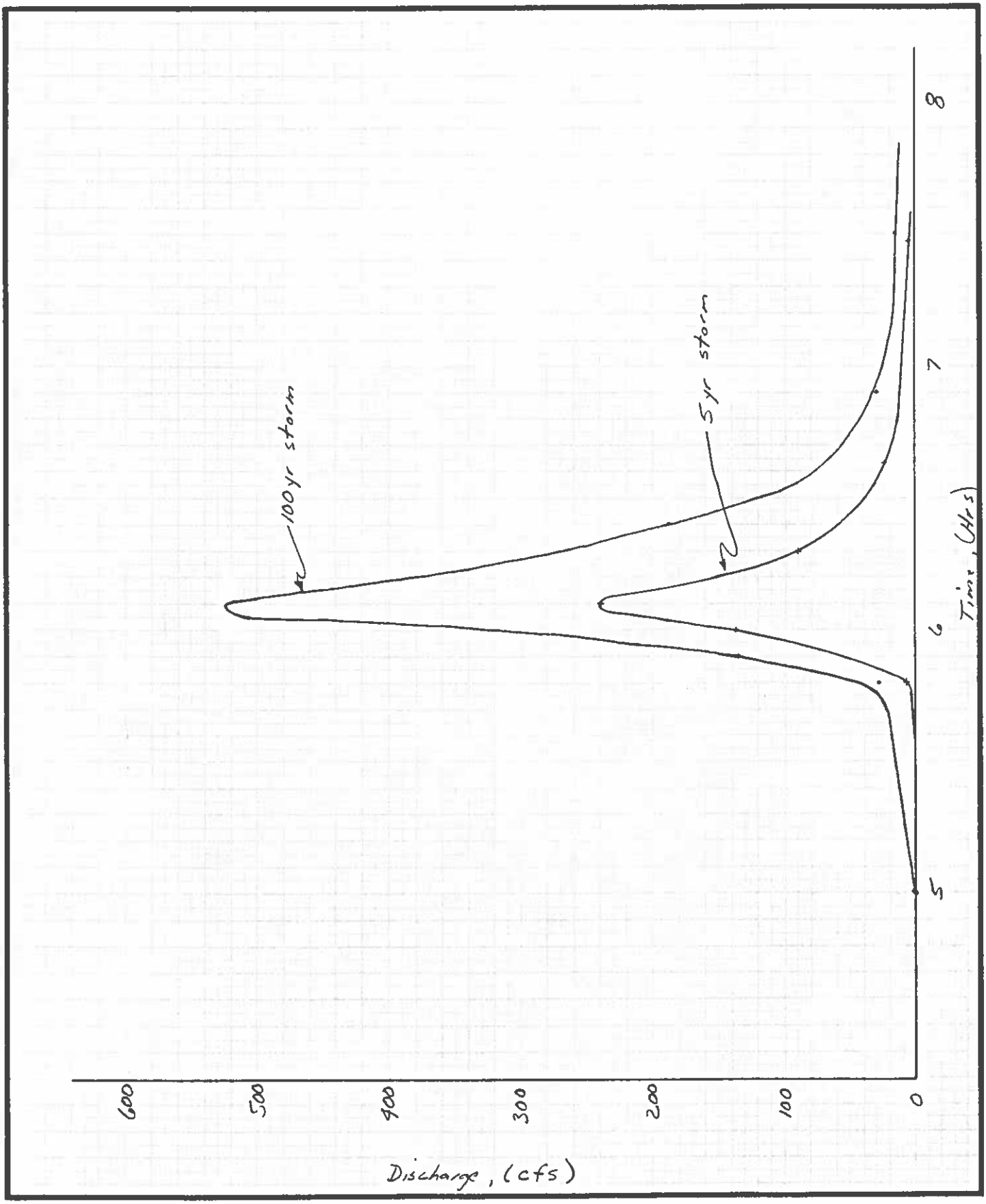
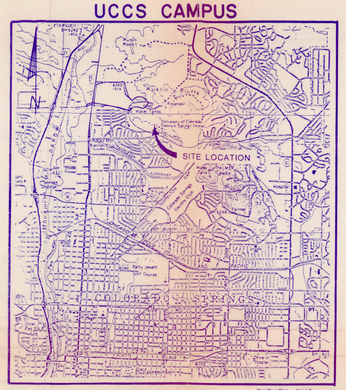
PROJECT UCCS
JOB NUMBER 5175201 SHEET 1 OF 1
CALCULATED BY J. Peters DATE 3-20-85
CHECKED BY _____ DATE _____



UCCS CAMPUS



VICINITY MAP
SCALE 1" = 2000'

PIKEVIEW QUAD
SECTIONS 28 & 29
TOWNSHIP 13 S.
RANGE 66 W.

LEGEND

- MAJOR BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- (B) MAJOR BASIN DESIGNATION
- (B-1 / 21.9) SUB-BASIN DESIGNATION, AREA IN ACRES
- (7.5 / 11.7) DESIGN STORM (5 yr) RUNOFF (c.f.s.) / MAJOR STORM (100 yr) RUNOFF (c.f.s.)
- (30") EXISTING STORM SEWER WITH INLET AND MANHOLE, PIPE CAPACITY - CFS
- FUTURE STORM SEWER WITH INLET AND MANHOLE
- PROPOSED STORM SEWER WITH INLET AND MANHOLE
- INDICATES DIRECTION OF FLOW

SCALE 1"=100'

SECTION 'A'
SCALE: 1"=20'

SECTION - B & B-1
N.T.S.

SECTION 'C'
CONCRETE TRICKLE CHANNEL

SLOTTED DRAIN DETAIL 1
N.T.S.

SECTION 'D'
N.T.S.

SECTION 'E'
N.T.S.

Greiner Engineering
Greiner Eng. Sciences, Inc.
Denver, Colorado Colorado Springs, Colorado
Albuquerque, N.M. Cheyenne, Wyoming

DESIGNED BY TS
DRAWN BY
CHECKED BY TEW
SCALE: AS SHOWN

UCCS
FIRE LANE STORM DRAINAGE IMPROVEMENTS PROJECT

RECOMMENDED DRAINAGE IMPROVEMENTS

DATE: MARCH 85
JOB NO. 5175201