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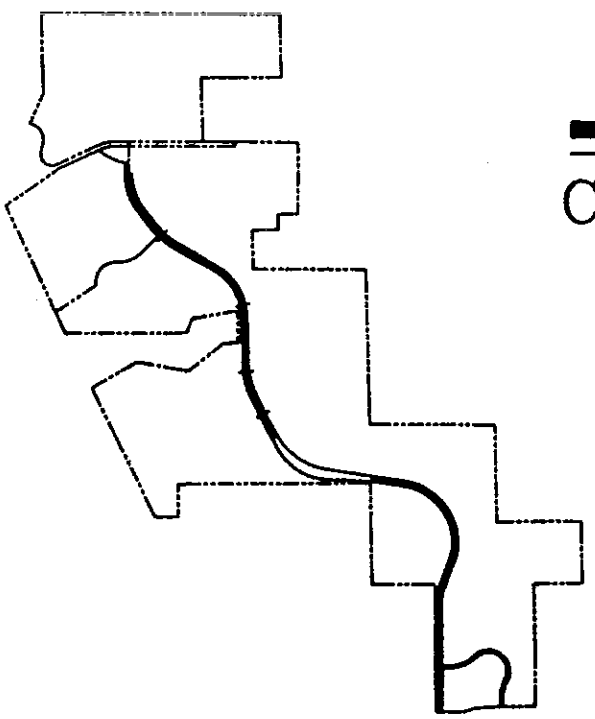
Northgate Master Development Drainage Plan
(Monument Branch & Middle Tributary Basins)



City of Colorado Springs

December, 1987

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN
(MONUMENT BRANCH AND MIDDLE TRIBUTARY BASINS)

DECEMBER 7, 1987

Revised: March 4, 1988
Revised: May 5, 1988
Revised: June 27, 1988

PREPARED BY: URS CONSULTANTS, INC.
5450 Tech Center Drive, Suite 327
Colorado Springs, Colorado 80919
(719) 590-7377

PREPARED FOR: THE OLIVE COMPANY
5450 Tech Center Drive, Suite 400
Colorado Springs, Colorado 80919
(719) 598-3000

URS Consultants Project No. 45206

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Bryan T. Law 3/3/88

Bryan T. Law, P.E.

Developer's Statement:

The Developer has read and will comply with all of the requirements specified in this drainage report and plan.

The Olive Company

BY: Kenneth J. Wall

TITLE: Development Manager

3/3/88
Date

City of Colorado Springs:

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.

City Engineer

11/1/88
Date

SUBJECT TO ANY ADDITIONAL REQUIREMENTS OF THE U.S. AIR FORCE ACADEMY, THE COLORADO DEPARTMENT OF HIGHWAYS, EL PASO COUNTY AND THE ARMY CORPS OF ENGINEERS

SUBJECT TO ALL FINAL DESIGN REQUIREMENTS

THE OLIVE COMPANY

October 26, 1988

Mr. Chris Smith, Subdivision Administrator
Public Works Department
City Engineering Division
City of Colorado Springs
P.O. Box 1575
Colorado Springs, CO 80901

RE: Landowner Notification for Detention Pond Construction on Existing or Future Development within the City of Colorado Springs Middle Tributary and Monument Branch Drainage Basins

Dear Chris:

Please find attached a copy of the executed letter setting forth our agreement regarding the above notification of property owners within **NORTHGATE.** I appreciate your efforts in this regard and feel that we have reached an equitable solution so that we may proceed ahead with orderly development of drainage facilities within our **NORTHGATE** development.

Please contact me (or Tom Berg) if you should have any questions or further comments regarding this item.

Sincerely,

THE OLIVE COMPANY

Kevin J. Walker
Development Manager

KJW/jb
Enclosure

cc: Tom Berg

5450 TECH CENTER DRIVE, SUITE 400, COLORADO SPRINGS, COLORADO 80919
COLORADO SPRINGS (719) 598-3000 FAX: (719) 528-8360 DENVER (303) 893-9555

CITY OF COLORADO SPRINGS
The "America the Beautiful" City
DEPARTMENT OF PUBLIC WORKS CITY ENGINEERING DIVISION (719) 578-6606
30 S. NEVADA SUITE 403 P.O. BOX 1575
COLORADO SPRINGS, COLORADO 80901

October 11, 1988

The Olive Company
3550 North Academy Blvd.
Colorado Springs, CO 80907
Attn: Kevin Walker

RE: Landowner notification for detention pond construction on existing or future development within the City of Colorado Springs Middle Tributary and Monument Branch drainage basins.

Dear Mr. Walker:

Per our previous discussions, it is the understanding of the City of Colorado Springs Engineering Division that at the Development Plan-Preliminary Plat Stage of the platting process for all proposed development which occurs within the boundaries of the Monument Branch and Middle Tributary drainage basins, that a preliminary drainage report will be prepared which definitively states the necessity for and construction of detention ponds as called for in the Monument Branch and Middle Tributary Master drainage basin studies. The preliminary drainage report for each parcel will state whether or not a pond is to be constructed on the property, or as an alternative, whether the property being platted must construct a pond upstream to insure that the over detention referred to in portions of the master drainage basin reports is accomplished. The preliminary drainage report will be submitted to the City Engineering Division concurrently with the plat submittals or developmental plan submittals to the City Planning department. Furthermore is this Divisions understanding that no parcels within Northgate are exempt from this requirement.

Prior to final plat approval of any parcel within the Northgate ownership, a final drainage report will be submitted to the City Engineering for review and approval. The final drainage report will indicate any detention ponds located on the property and define eastments required for those ponds. If ponds are constructed upstream of the property which is being platted the pond will be located accordingly and the appropriate easements will be granted prior to final plat approval of that subdivision.

If this letter correctly sets for our agreement, would you please sign the enclosed copy of this letter and return it to us while keeping a copy for your own files.

Sincerely,

Chris Smith
Subdivision Administrator

This letter correctly sets for the agreement we have reached between the City of Colorado Springs and the Northgate property owners.

Dated this day of 1988

Mr. Kevin Walker
Olive Company

CS/rm

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

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NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

I. PURPOSE AND SCOPE

The purpose of this Master Development Drainage Plan (MDDP) is to identify all major drainageways and facilities within the Northgate Master Plan. This plan includes the area lying north of the Black Squirrel Creek Drainage Basin and south of the Smith Creek Drainage Basin. This report is intended to show location and approximate sizes for major facilities. It also provides a guide to the drainage patterns for initial systems.

The Northgate development is located in the northern outskirts of the City of Colorado Springs and El Paso County. The development generally lies between Interstate 25 on the west, Northgate Road on the north and State Highway 83 on the east and south.

The Northgate development lies within four major drainage basins, Black Squirrel Creek, Middle Tributary, Monument Branch, and Smith Creek. Except for the Smith Creek Basin, all ofthe other basins have approved Drainage Basin Planning Studies. This report will exclude those areas within Black Squirrel Creek and Smith Creek Basins. Drainage reports have been approved and submitted for limited roadway construction in the Black Squirrel Creek Basin. A Master Development Drainage Plan will be submitted for the Black Squirrel Creek Basin at a later date. Smith Creek Basin is not considered since there is no Drainage Basin Planning Study. The majority of the basins are not currently developed.

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

This report evaluates the present conditions of the major channels along with providing recommendations for future fully developed conditions. The overall plan is considered to be the most compatible with projected land use and environmental concerns and conforms to the above mentioned Drainage Basin Planning Studies, as well as the City of Colorado Springs/El Paso County Drainage Criteria Manual (October, 1987).

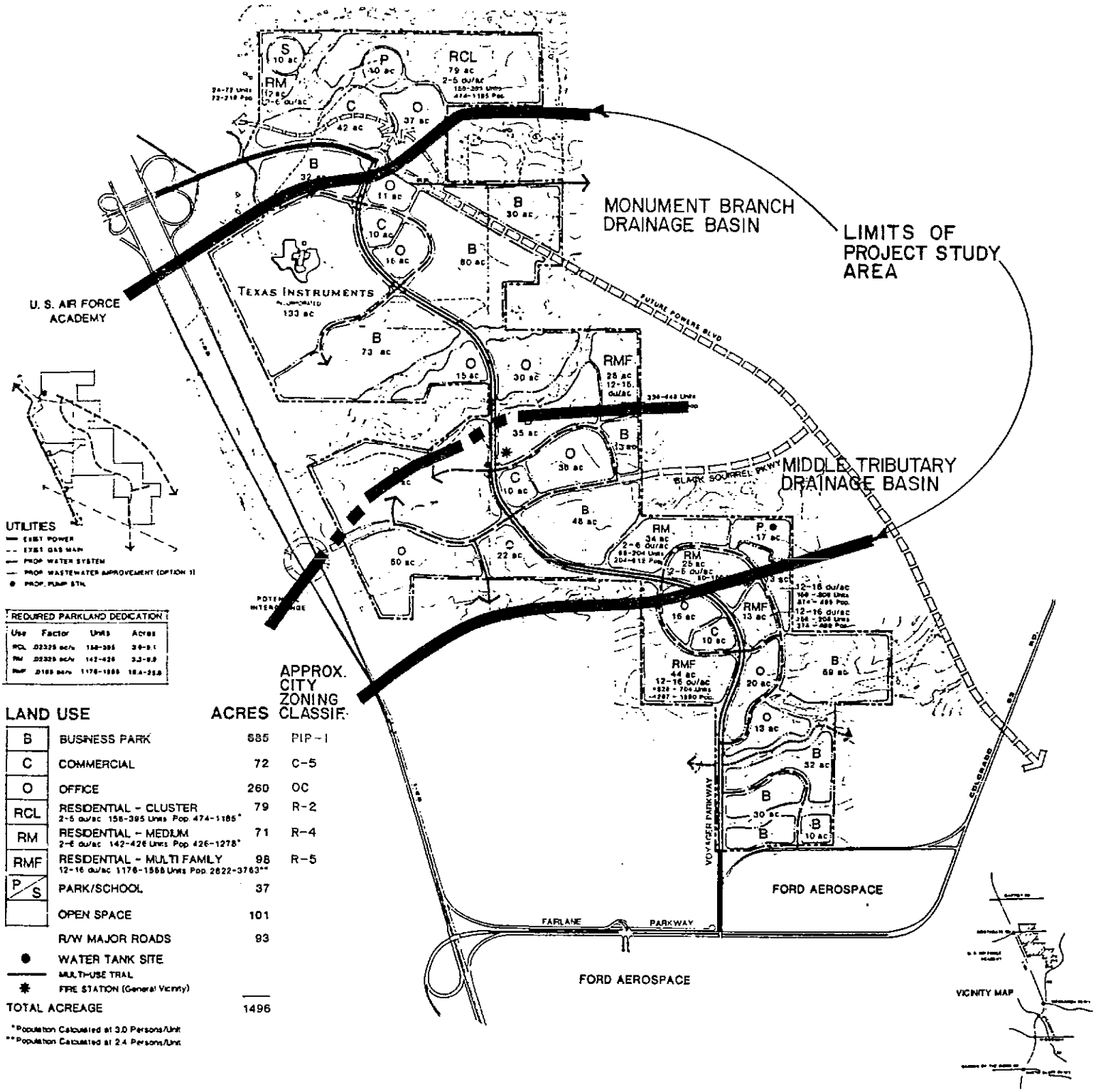
II. PROJECT AREA DESCRIPTION

The Project Study Area encompasses the entire Northgate Development except for those areas within Black Squirrel Creek Basin and Smith Creek Basin, as shown on Figure 4 (attached). The development generally slopes from east to west and outfalls onto the Air Force Academy property at Interstate 25. The development is located in Township 12 south, Range 66 west, Sections 6, 7, 8, 16, 17, and 18 of the 6th Principal Meridian.

The total development area considered consists of 958 acres and lies within the City of Colorado Springs, in the Middle Tributary (383 acres) and Monument Branch (575 acres) Drainage Basins. Major road locations planned within the basin were obtained from the approved Northgate Land Use Plan, Figure 1. Presently, only utility and access roads exist within the Project Study Area.

The area within the Northgate development was assumed to be developed per the mixed land use presented on the Northgate Land Use Plan.

LAND USE PLAN



REQUIRED PARKLAND DEDICATION

Use	Factor	Units	Acres
RCL	.02325 ac/u	158-395	3.6-9.1
RM	.02325 ac/u	142-426	3.3-9.9
RMF	.0169 ac/u	1176-1568	18.4-25.8

LAND USE		ACRES	APPROX. CITY ZONING CLASSIF.
B	BUSINESS PARK	585	PIP-1
C	COMMERCIAL	72	C-5
O	OFFICE	260	OC
RCL	RESIDENTIAL - CLUSTER 2-5 du/ac 158-395 Units Pop 474-1185*	79	R-2
RM	RESIDENTIAL - MEDIUM 2-6 du/ac 142-426 Units Pop 426-1278*	71	R-4
RMF	RESIDENTIAL - MULTI FAMILY 12-16 du/ac 1176-1568 Units Pop 2822-3763**	98	R-5
P/S	PARK/SCHOOL	37	
	OPEN SPACE	101	
	R/W MAJOR ROADS	93	
●	WATER TANK SITE		
———	MULTI-USE TRAIL		
✱	FIRE STATION (General Vicinity)		
TOTAL ACREAGE		1496	

*Population Calculated at 3.0 Persons/Unit
**Population Calculated at 2.4 Persons/Unit

NORTHGATE

THE OLIVE COMPANY

THE PLANNING CENTER

FIGURE 1

III. GEOLOGY AND SOILS

Soil and land use characteristics directly affect the relationship between rainfall and runoff within a basin. The U. S. Soil Conservation Service classifies soils into four hydrologic groups (A, B, C and D) according to a soil's runoff potential. Group A soils exhibit high infiltration rates when thoroughly wetted and are considered to have low runoff potential. Group B soils exhibit moderate infiltration rates when thoroughly wetted. Group C soils exhibit slow infiltration rates when thoroughly wetted. Group D soils exhibit very slow infiltration rates when thoroughly wetted and are considered to have high runoff potential.

Soil types within the Northgate Development are listed in Table 1 and delineated in Figures 2 and 3. Approximately 95 percent of the Development consists of hydrologic soil group B soils with the remaining five percent split between groups C and D.

The soil types within the Development also influence the potential site locations for reservoirs. All of the soils within the Development are well drained. In addition, soils types 67, 68, 69, 92 and 93 have potential problems with low strength and many require importation of suitable fill material and/or excavation below the natural ground surface. All of the soils are expected to have moderate potential for frost action.

In addition, a preliminary geological and geotechnical investigation was performed by Geotechnical Consultants, Inc. Their study is included in Appendix B for reference. The recommendations made in the geotechnical report were adhered to in the design recommendations included in this Master Development Drainage Plan.

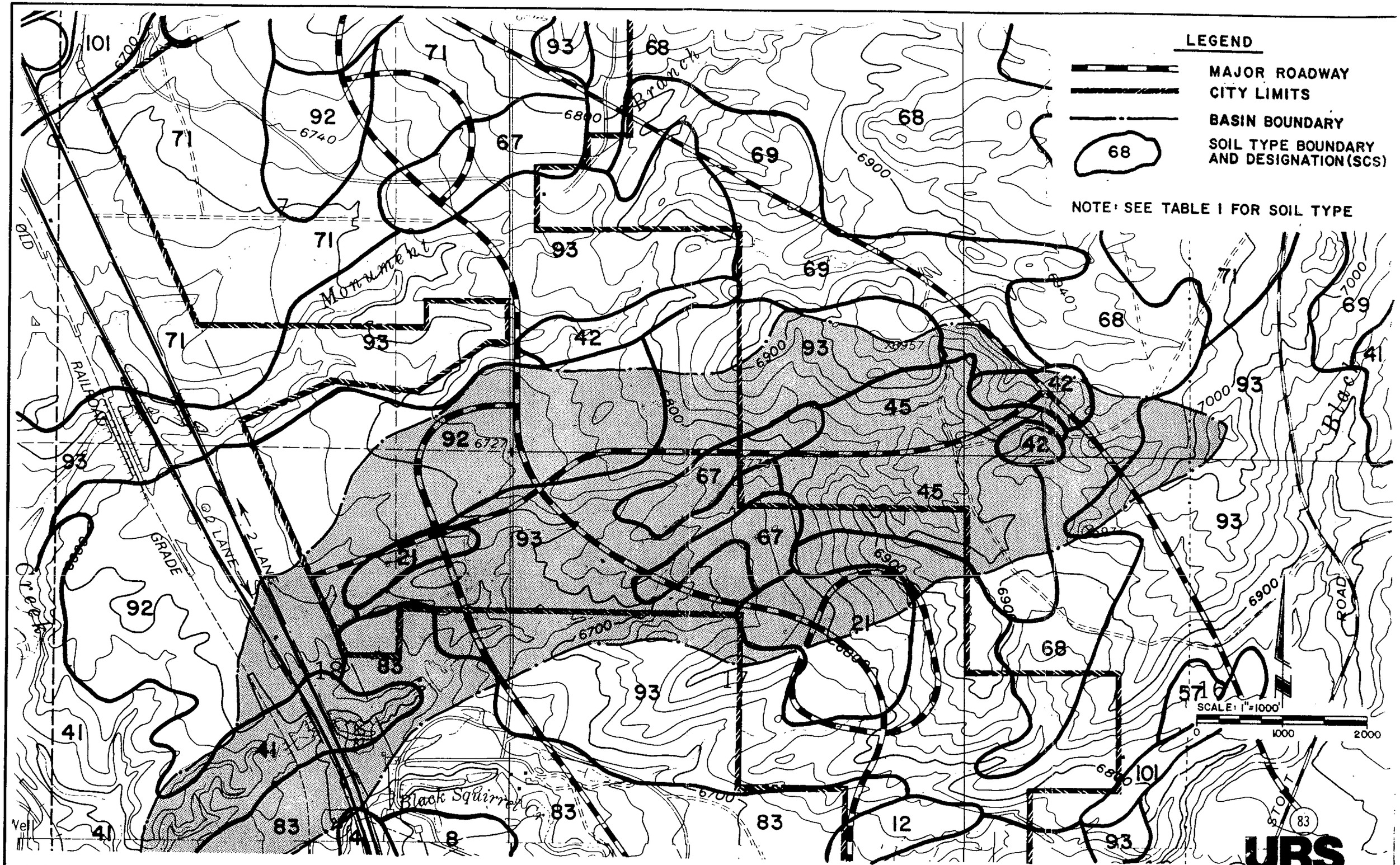
TABLE 1

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

SOIL TYPES

SOIL I.D. NUMBER	SOIL NAME	HYDROLOGICAL SOIL GROUP	EROSION POTENTIAL
21	CRUCKTON SANDY LOAM	B	MODERATE
42	KETTLE ROCK OUTCROP	D	SLIGHT-HIGH
45	KUTCH CLAY LOAM	C	MODERATE
67	PEYTON SANDY LOAM	B	MODERATE
68	PEYTON PRING COMPLEX	B	MODERATE
69	PEYTON PRING COMPLEX	B	MODERATE
71	PRING COARSE SANDY LOAM	B	MODERATE-HIGH
83	STAPLETON SANDY LOAM	B	MODERATE
92	TOMAH-CROWFOOT LOAMYSAND	B	SLIGHT-MODERATE
93	TOMAH-CROWFOOT LOAMYSAND	B	MODERATE

SOURCE: SOIL SURVEY OF EL PASO COUNTY AREA COLORADO
U.S. SOIL CONSERVATION SERVICE
JUNE 1981



NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN
MIDDLE TRIBUTARY DRAINAGE BASIN

SCS SOILS TYPES

FIGURE 2

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LEGEND

MAJOR ROADWAY

CITY LIMITS

BASIN BOUNDARY

68 SOIL TYPE BOUNDARY AND DESIGNATION (SCS)

NOTE: SEE TABLE I FOR SOIL TYPE

MONUMENT BRANCH DRAINAGE BASIN

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN SCS SOILS TYPES

SCALE 1"=1000

0 1000 2000

FIGURE 3

URS CONSULTANTS

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IV. EXISTING DRAINAGE FACILITIES

Existing major drainage facilities and historic flows are shown on Figure 4 (attached). Currently, major drainage facilities downstream of the Development are constructed at the following locations:

1) Two horseshoe-shaped culverts at old railroad grade (AT&SF) -not shown on Figure 4.
2) One 12' X 12' double concrete box culvert at southbound I-25.
3) One 10' X 10' double concrete box culvert, one 6' X 7' single concrete box culvert, and one 48" reinforced concrete pipe, all at northbound I-25.
4) One 12' X 8' single concrete box culvert and one 48" corrugated metal pipe crossing both lanes of I-25.

The above mentioned structures are all of adequate size to pass the historic flows, except for the single concrete box culvert at northbound I-25. It is inadequately sized to convey the 100-year storm flows. To accommodate this excess runoff, a diversion has been proposed to carry the flows to the double concrete box culvert, which can convey the peak flows. This diversion will be discussed in Section VI.

In addition, there is one small "stockpond" type reservoir on the Monument Branch channel. The Colorado State Engineer's Office has this "stockpond" on file. It is referred to as the Allison Reservoir (#805), located in the SE 1/4 of Section 7, Township 12 South, Range 66 West, of the 6th Principal Meridian.

This stockpond is located near design point 14 in Figure 4. Field reconnaissance of the "stockpond" reservoir found that there was no embankment protection or emergency spillway. The "stockpond" reservoir will have to be removed or evaluated and upgraded for use as a detention facility by the developer of the surrounding land as part of this Master Development Plan. The adequacy of the "stockpond" will be evaluated in the final drainage report. For the purpose of this report, all "stockponds" were neglected. However, future site specific studies must incorporate the applicable city, county, state and federal regulations into their design considerations.

The remainder of the existing drainage facilities in the study area consist solely of small culverts beneath roads. All of the channels within the development are natural with no improvements.

Historic conditions for the Northgate Development were taken as present (1987) conditions. Figure 4 (attached) delineates the historic drainage basins. The Federal Emergency Management Agency (FEMA) has not delineated any 100-year floodplain through the Development. Tables 3 and 5 show flows locally and regionally for historic conditions. It should be noted that the hydrology does not take into account any "stockponds".

The following discusses design points and reaches along the major channel(s) for current conditions. All flow data is from the associated Master Basin Drainage Studies. Refer to the design points and reaches of Figure 4. Cross sections were obtained through field reconnaissance and USGS Quadrangle Maps.

Soils information was obtained from the Soil Survey of El Paso County, Colorado. The historic 100-year 24-hour storm flows are discussed since they are larger than the historic 100-year 2-hour storm.

Design point 10 is located at the U.S.A.F.A. Boundary. The 100-year 24-hour flow is 129 cfs and the 10-year 24-hour flow is 28 cfs. All downstream facilities are adequate to pass the historic 100-year flow.

Reach 4, located between design points 9 and 10, is a shallow, broad channel with a partially vegetated sandy bottom. The predominant soil type in this area is Tomah-Crowfoot loamy sand, which has a slight to moderate hazard of erosion. Some erosion may occur along the channel bottom for the more frequent storm events. Larger, less frequent storm events will have less of an effect due to the flat, vegetated side slopes.

Design point 9 is located at the future Black Squirrel Parkway crossing. The 100-year 24-hour flow is 68 cfs and the 10-year 24-hour flow is 37 cfs.

Reaches 2 and 3 are shallow, undefined to slightly defined channels. The reaches are primarily vegetated with native grasses and shrubs. The predominant soil type for these reaches is a Tomah-Crowfoot loamy sand which has a moderate hazard of erosion. Little to no erosion is expected along these reaches for the major and minor historic storms.

Design point 8 is located at the Northgate/County Boundary. The 100-year 24-hour storm is 202 cfs and the 10-year 24-hour storm is 41 cfs. All downstream facilities are adequate to pass the 100-year flow.

Design point 7 is located at the proposed Voyager Parkway crossing. The 100-year 24-hour flow is 161 cfs and the 10-year 24-hour flow is 40 cfs.

Design point 5 is located at the proposed Black Squirrel Parkway crossing. The 100-year flow is 55 cfs and the rational 10-year flow is 30 cfs.

Design point 3 is located at the Northgate/County Boundary. The 100-year 24-hour storm is 546 cfs and the 10-year 24-hour storm is 177 cfs. All downstream facilities are adequate to pass the 100-year flow.

Design point 2 is located at the proposed Voyager Parkway crossing. The 100-year 24-hour flow is 546 cfs and the 10-year 24-hour flow is 177 cfs.

Reach 1 is a shallow, narrow channel with a bare sandy bottom and moderately vegetated banks. The predominant soil type for this reach is a combination of Peyton sandy loam and Tomah-Crowfoot loamy sand, each possessing a moderate hazard of erosion. Little to no erosion is expected along this reach for the major and minor historic storms.

Design point 22 is located at the U.S.A.F.A. boundary. The 100-year 24-hour peak flow is 730 cfs and the 10-year 24-hour peak flow is 261 cfs. The CBC

immediately downstream is inadequate to pass the 100-year storm. Provisions to divert the excess flow are discussed later in this report.

Reach 12 is a shallow slightly defined channel. The reach is primarily vegetated with native grasses. The predominant soil type for this reach is a Pring coarse sandy loam which has a moderate erosion potential. Very little erosion is expected to occur along this reach during the major and minor historic storms.

Design point 19 (hist.) is located at the proposed Voyager Parkway crossing at the upper end of Reach 11. A diversion from design point 19 (hist.) to design point 19 (dev.) is proposed and is discussed further in Section VI. The 100-year 24-hour and 10-year 24-hour peak flows at this point are 378 cfs and 141 cfs respectively. Upstream of Design point 19 (hist.) is a slightly defined channel vegetated with native grasses as in Reach 11.

Design point 12 is located at the proposed Voyager Parkway crossing. Currently, there are no facilities at this point. The 100-year 24-hour flow is 797 cfs and the 10-year 24-hour storm is 254 cfs at this design point.

Design point 11 is located at the Northgate/County boundary. The 100-year 24-hour peak flow is 755 cfs and the 10-year 24-hour peak flow is 252 cfs.

Reach 5 is a long, meandering channel with a wide, shallow cross section at its lower end, transitioning to a deep, narrow channel at its upper end. The

channel bottom is generally bare and sandy with some natural grasses and shrubs along its sides. The predominant soil in the lower end is Tomah-Crowfoot loamy sand, while the soil in the upper end is a Peyton-Pring complex which has a moderate to high erosion potential. Erosion and side sloughing is expected to occur in the upper end of Reach 5.

Design point 20 is located at the Northgate/County boundary. The peak flow here is 1460 cfs for the 100-year 24-hour storm and 470 cfs for the 10-year 24-hour storm.

Reach 11 is characterized by steep, deep banks and some rock outcrops. The channel bottom is generally wide and sandy with shrubs along the banks. The predominant soil type in Reach 11 is Tomah-Crowfoot loamy sand. Some erosion is expected in the channel bottom during low flows and some bank erosion during the higher flows.

Design point 14 is located at the proposed Voyager Parkway crossing. There are no facilities currently at this point. The peak flow here is 1448 cfs for the 100-year 24-hour storm and 469 cfs for the 10-year 24-hour storm. Just upstream of Design point 14 is the Allison Reservoir. The detention capability of this "stockpond" was not considered in the hydrologic analysis of this basin. This reservoir should be removed or evaluated and upgraded for use as a detention facility.

Reach 6 is similar to Reach 5 in the fact that it is wide and shallow at its lower end while its upper end has steep sides. Again, the soils in the lower end are Tomah-Crowfoot loamy sands and the soils in the upper end are a Peyton-Pring complex. Erosion and side sloughing is expected in the upper end of this reach. The vegetation consists of natural grasses and shrubs in the channel.

Design point 13 is located at the Northgate/County boundary. The peak flow is 1448 cfs for the 100-year 24-hour storm and 469 cfs for the 10-year 24-hour storm.

Energy dissipation structures shall be required at all outfall points from the Northgate site to reduce scouring velocities to acceptable levels at the U. S. Air Force Academy and El Paso County boundaries.

A summary of the peak flows at each design point are found in Table 5.

V. HYDROLOGY

Determining runoff needs to consider the affects of many different variables. In the absence of a reliable historic record of rainfall, runoff, and other pertinent variables, it is usually necessary to use a synthetic unit hydrograph method to determine the runoff that will occur for a given rainfall event. The SCS method of determining peak flood flows and hydrographs was used to estimate direct runoff for basins in excess of 100 acres. For an explanation of the procedures used, see the "SCS National Engineering Handbook, Section 4". Due to the number of computations necessary to determine the hydrographs and hydrologic routing of the given storm events, the calculations for the main channel were performed with the aid of the TR-20 computer program. Copies of the input and output files for the TR-20 computer runs are included in the techical addenda to the Monument Branch and Middle Tributary Drainage Basin Planning Studies.

For this study the City of Colorado Springs/El Paso County Drainage Criteria Manual was used. For the major facilities (basins greater than 130 acres), the design peak flow shall be the greater of the peak flows determined for the 100 year 24 hour storm and the 100 year 2 hour storm. In all cases the 24 hour event produced greater peak flows as determined in the corresponding Drainage Basin Planning Studies.

Design of minor facilities (basins less than 130 acres) shall be for the 10 year storm in both El Paso County and the City of Colorado Springs. Flows for subbasins shall be calculated using the Rational Method. Minor facilities less

than 130 acres shall be designed and planned to integrate with the major drainage system to provide overflow capability for major storms. The intent of 100 year overflow provisions are to safely and economically direct 100 year flow from points of concentration and to not impact buildings or structures. The onsite drainage basin boundaries were determined from the topography flown by Analytical Surveys, Inc. The subbasin boundaries and design points determined for fully developed conditions are shown on Figure 4 (attached).

The hydrologic soil groups were then determined for each subbasin. For historic (present) conditions, a weighted curve number was determined for each subbasin based on soil types, type of cover, and taking into account presently platted areas. For future developed conditions, a weighted curve number was determined based on soil types, type of cover, and taking into account projected development.

As the calculations proceed downstream, the hydrograph was routed through each subsequent reach and combined with local inflow to produce a composite hydrograph at each design point. Hydrologic channel routing was performed by inputting flow vs. area vs. elevation for a representative cross section for each reach. The TR-20 computer program uses the Modified Att-Kin routing method for each reach based on the cross section entered. For detention ponds, the hydrologic reservoir routing was performed by inputting outflow vs. storage vs. elevations, for an assumed reservoir and outlet size. These variables were modified by trial and error until the desired volume of the reservoir and peak outflow were obtained. Peak flows for historic and developed conditions were

taken from their respective Drainage Basin Planning studies and summarized in Table 5 and in Table 6 for the detention ponds.

The rainfall depths of 3.0 and 4.6 inches were obtained form isopluvials for the project area for the 10 year 24 hour and 100 year 24 hour storm events, respectively. Table 2 shows the dimensionless precipitation distribution for the SCS Type 11A storm. The rainfall depths of 2.0 and 3.0 inches were obtained from the "Areawide Urban Runoff Control Manual" for the 10 year 2 hour and 100 year 2 hour storm events, respectively. Intensity curves for the Rational Method were obtained from the City/County drainage criteria manuals.

TABLE 2

NORTHGATE DEVELOPMENT
RAINFALL DISTRIBUTION
SCS TYPE IIA STORM

24-Hour Storm		2-Hour Storm	
Time (hrs)	Distribution	Time (min)	Distribution
0.00	0.000	0	0.000
2.00	0.010	5	0.009
4.00	0.030	10	0.035
4.50	0.050	15	0.074
5.00	0.060	20	0.144
5.50	0.100	25	0.265
6.00	0.700	30	0.481
6.50	0.750	35	0.602
7.00	0.780	40	0.671
8.00	0.820	45	0.725
9.00	0.840	50	0.768
9.50	0.850	55	0.803
10.00	0.860	60	0.837
10.50	0.865	65	0.872
11.00	0.870	70	0.889
11.50	0.885	75	0.907
11.75	0.888	80	0.917
12.00	0.890	85	0.927
12.50	0.900	90	0.938
13.00	0.905	95	0.948
13.50	0.910	100	0.958
14.00	0.915	105	0.969
16.00	0.940	110	0.979
20.00	0.980	115	0.990
24.00	1.000	120	1.000

VI. PLAN RECOMMENDATIONS

The overall recommendation of this Master Development Drainage Plan is the use of subregional detention facilities in conjunction with partially lined major drainage channels. The plan should be used as a layout for future drainage facilities and take a natural regime approach to drainage. Channels should be designed to be stable under design flow conditions and still retain as many natural features as possible. Major facilities as outlined in the Monument Branch and Middle Tributary Drainage Basin Planning Studies shall be publically owned and maintained. Initial systems, ultimately, shall be publically owned and maintained if they are located in an adequate drainage easement or road right-of-way. Elements of the recommended drainage planning study are shown on Figure 4 (attached) and described in this section. This plan incorporates the City of Colorado Springs / El Paso County Drainage Criteria Manual.

Two design assumptions are incorporated into this report, 1) subregional off and on stream detention facilities are strategically placed within the study area for the purpose of reducing subregional developed runoff, and 2) partially lined channels incorporating drop structures and trickle channels are provided for the purpose of stabilizing and maintaining the natural character of the channel. The design of the channels shall be based on maximum allowable velocities, determined by soil characteristics.

The use of detention for this Development is required due to the location of the U. S. Air Force Academy and Interstate 25 downstream of the Development.

Detention facilities are required to maintain storm runoff at or below historic levels at the Air Force Academy boundary and so that the capacities of existing Colorado Department of Highways structures at Interstate 25 are not exceeded. Subregional detention facilities are located as shown on Figure 4 (attached). The facilities should be designed to detain the difference between the historic and developed peak flows for both the 10 year and the 100 year storm events. The bottom of the emergency spillway in all cases, was assumed to be less than 10 feet high, therefore, foregoing State Engineers jurisdiction. Inflow and outflow hydrographs for detention ponds are shown in the Technical Addendums associated with their respective Drainage Basin Planning Studies. A summary of the peak flows for historic and developed conditions are shown on Tables 3, 4, and 5.

MAJOR CHANNEL FACILITIES

Reaches 1, 5, 6 and 11 are proposed to be partially lined channels. Their bottom widths are estimated to range in size from 25 feet to 50 feet and to have depths ranging from 3.5 feet to 4.5 feet. Partially lined channel sections are required where shown on Figure 4. Furthermore, drop structures and trickle channels are proposed in order to stabilize the channel. Developed velocities in the partially lined channels shall comply with the recommendations of the Drainage Criteria Manual. As an alternative for using trickle channels, as proposed in the Basin Studies, the major channels and drop structures shall be sized to maintain flows below erosive velocities. Many alternatives exist for drop structures and their selection will depend on site specific, jurisdictional and economic factors.

Shown on figure 4, but not limited to, are reaches requiring an overflow capability for major storms. The purpose of these facilities is to provide additional capacity to safely manage major storm runoff from points where major storm runoff has been concentrated such as at arterial road crossings. These facilities will generally be streets, parking lots and graded landscaping. Future drainage reports shall require overflow provisions incorporated into the planning and design of all initial drainage systems in order to route the major storm safely and economically. These facilities are not to be reimbursable since they are a part of the initial system. See Figure 8 for possible representations.

All channels are to be designed and constructed according to the City/County Criteria Manual and are eligible for reimbursement if they are delineated in their respective basin plans. Other possible requirements may be imposed by the Corps of Engineers through their 404 permit process. Additional costs associated with this process have not been included in the basin fee and therefore are not reimbursable.

Channels should be designed by using normal depth and backwater calculations where appropriate. Box culverts should be designed with an appropriate depth ratio for subcritical channels, with appropriate reservoir routing techniques for detention ponds, or with appropriate transitions for supercritical channels.

A diversion of the runoff upstream of Design Point 19 (hist.) is proposed because the existing Colorado Department of Highways box culvert at Interstate 25 downstream of Design Point 22 is inadequately sized to pass the 100 year storm. This runoff is routed to Design Point 19 (hist.) via street and pipeflow from basins V & W to a detention facility. From here the flow is discharged under Voyager Parkway through a 48" RCP to a partially lined channel (Reach 9) and finally discharging into Reach 11, design point 19 (dev.). Once in Reach 11, this runoff will be conveyed from offsite at Design Point 20 to a box culvert under northbound I-25. This additional flow will pass adequately and from here will join the flows from Design Points 22 and 23 and return to its historic patterns.

A second diversion is proposed at Design Point 23. This will divert the flows from subbasin X through Reach 13 and into the detention pond at Design Point 22. The discharge released from the detention pond at Design Point 22 will be conveyed to an existing box culvert at I-25. This culvert is adequate to pass this released flow.

Flow enters the Development at design points 1, 11, 13, 15 and 18. Design points 15 and 18 are proposed 42" and 36" cross culverts located under existing Northgate Road. Design points 1, 11, and 13 designate entry points to the development along the major channels. Design point 16, located at proposed Powers Boulevard, is a 5' X 4' CBC. Facilities at design points 2, 7, 12 and 19 (hist.) are respectively a 8' X 8' CBC, a 60" RCP, a 10' X 8' CBC and a 48" RCP. These points are located at the proposed Voyager Parkway crossings.

Design points 5 and 9, located at the proposed Black Squirrel Parkway, are a 54" RCP and a 5' X 5' CBC, respectively. Flow then leaves the development at design points 3, 8, 10, 12, 20, 21, and 22. Under ultimate conditions, flows at design points 3, 8, 12 and 20 are conveyed to the County at historic levels. When routed to the Air Force Academy property, it is required by the U. S. Air Force Academy and CDOH that these flows shall not exceed historic levels. However, precautions must be taken to reduce downstream degredation by implementing dissipation structures. Dissipation structures, if temporary, are not considered public facilities and therefore will not be reimbursable. Flows at design points 10, 21, 22 and 23 are conveyed to the Air Force Academy property at or below historic levels. Facilities are not proposed through the Air Force Academy. Thus, dissipation structures at these points are required and are reimbursable under the appropriate basin fee.

Reaches between this site and the Air Force Academy are proposed to be partially lined channels, as shown in their associated Basin Plans. The necessary easements for these facilities will be similar to those just upstream. Actual facility and easement size shall be determined at the preliminary and final drainage report level.

DETENTION FACILITIES

Within the development are ten proposed detention facilities. Four of these facilities are recommended to be onstream and are located at design points 7, 8, 10 and 22. The remaining detention facilities are proposed to be offstream and are located at design points 2, 4,6, 17, 19 (hist.), and 21. Outside of

the development are four onstream detention facilities located at design points 1, 11, 15 and 24. These facilities over detain for some onsite areas and, therefore, are included in this report and are required construction for buildout of this site. The proposed drainage areas tributary to each pond are shown in Figures 9 through 24. Some ponds are required to over detain, and these areas are shown as well. It is intended that all these facilities be constructed as proposed in the Middle Tributary and Monument Branch Drainage Basin Planning Studies to maintain historic flow conditions downstream with the build-out of the Northgate Development. The one exception is the diversion (Reach 9) and the detention facility located at design point 19 (hist.) (formerly at design point 14) which has been relocated from the Basin Plan concept due to topographical and road constraints.

It shall be the responsibility of the developers that plat and develop land tributary (including over detained areas) to the proposed detention facility(s) to either have the permanent detention facility(s) affecting his site constructed or to construct temporary onsite detention facilities to maintain onsite developed flows to historic levels. The permanent facility must have the ultimate outlet works constructed initially. However, the volume can be increased as development occurs until ultimate conditions are met. The temporary facility, however, will be maintained and operated privately and is not reimburseable. Once the permanent detention facility(s) is constructed, within the tributary area, the temporary facility(s) must become non-operational so that the basin drainage system may operate as intended by the Drainage Basin Planning Study. These issues shall be addressed in the

preliminary and final drainage reports for each developed site.

During the Voyager Parkway construction it is proposed that temporary detention facilities shall be designed, constructed and implemented to detain developed runoff from only the newly constructed Parkway. The ponds shall be temporarily sized in order to detain just the developed road runoff, although the outlet works, spillway and embankment shall be designed for the permanent, fully developed conditions. The ponds shall be privately owned and maintained until they are upgraded for ultimate conditions. It is anticipated that some of these ponds will be permanently sized once the land around them is developed, and would then become publically owned and maintained. This will be discussed in more detail in the upcoming drainage report for Voyager Parkway.

SUMMARY

Tables 6 and 7 include a brief description of proposed improvements for each channel reach and detention pond. Figures 5 thru 8 represent conceptual details for typical drop structures, dam sections, and channels. Figure 4 states the approximate right-of-way requirements for major facilities. All drainage improvements in the City that are in a public right-of-way shall be maintained by the City.

The Olive Company, per their annexation agreement, must maintain all public drainage facilities prior to August 13, 1990. After that date, the City of Colorado Springs shall be responsible for maintaining all public drainage facilities once the two year warranty period is up.

TABLE 3

NORTHGATE DEVELOPMENT
HISTORIC SUB-BASIN HYDROLOGY

SUB-BASINS	DRAINAGE AREA (AC)	TIME OF CONC. (MIN)	10-YEAR STORM C	10-YEAR STORM INTENSITY i (in/hr)	10-YEAR STORM FLOW Q (cfs)	100-YEAR STORM C	100-YEAR STORM INTENSITY i (in/hr)	100-YEAR STORM FLOW Q (cfs)
A	13	14	0.32	4.0	17	0.40	6.0	31
B	82	16	0.28	3.8	87	0.34	5.7	159
C	16	8	0.28	5.0	22	0.34	7.5	41
D	19	6	0.28	5.6	30	0.34	8.4	54
E	11	5	0.28	6.0	18	0.34	9.0	34
F	28	9	0.28	4.8	38	0.34	5.5	52
G	22	9	0.28	4.8	30	0.34	7.2	54
H	38	7	0.28	5.2	55	0.34	8.0	103
I	45	13	0.28	4.1	52	0.34	6.3	96
J	35	10	0.28	4.7	46	0.34	7.0	83
K	37	18	0.28	3.6	37	0.34	5.4	68
L	27	8	0.28	5.0	38	0.34	7.5	69
M	10	9	0.28	4.8	13	0.34	7.2	24
N	77	17	0.28	3.7	80	0.34	5.6	147
O	16	10	0.28	4.7	21	0.34	7.0	38
P	38	18	0.28	3.6	38	0.34	5.4	70
Q	38	22	0.28	3.2	34	0.34	4.8	62
R	12	5	0.28	6.0	20	0.34	9.0	37
S	16	7	0.28	5.2	23	0.34	8.0	44
T	30	11	0.28	4.4	37	0.34	6.8	69
U	3	5	0.28	6.0	5	0.34	9.0	9
V	81	13	0.28	4.1	93	0.34	6.3	174
W	31	8	0.28	5.0	43	0.34	7.5	79
X	44	13	0.28	4.1	51	0.34	6.3	94
Y1	98	14	0.28	4.0	110	0.28	6.0	165
Y2	64	14	0.28	4.0	72	0.28	6.0	108
Z	27	14	0.28	4.0	30	0.34	6.0	55

NOTE: Hydrologic calculations are based on the Rational Method

TABLE 4

NORTHGATE DEVELOPMENT
DEVELOPED SUB-BASIN HYDROLOGY

SUB-BASINS	DRAINAGE AREA (AC)	TIME OF CONC. (MIN)	10-YEAR STORM C	10-YEAR STORM INTENSITY i (in/hr)	10-YEAR STORM FLOW Q (cfs)	100-YEAR STORM C	100-YEAR STORM INTENSITY i (in/hr)	100-YEAR STORM FLOW Q (cfs)
A	13	7	0.32	5.2	22	0.40	8.0	42
B	82	7	0.52	5.2	222	0.64	8.0	420
C	16	5	0.52	6.0	50	0.64	9.0	92
D	19	5	0.52	6.0	59	0.64	9.0	109
E	11	5	0.52	6.0	34	0.64	9.0	63
F	28	5	0.52	6.0	87	0.64	5.5	99
G	22	5	0.52	6.0	69	0.64	9.0	127
H	38	5	0.52	6.0	119	0.64	9.0	219
I	45	9	0.52	4.8	112	0.64	7.2	207
J	35	5	0.52	6.0	109	0.64	9.0	202
K	37	6	0.52	5.6	108	0.64	8.4	199
L	27	5	0.52	6.0	84	0.64	9.0	156
M	10	6	0.52	5.6	29	0.64	8.4	54
N	77	12	0.50	4.2	162	0.63	6.5	315
O	16	7	0.56	5.2	47	0.64	8.0	82
P	38	12	0.50	4.2	80	0.69	6.5	170
Q	38	12	0.60	4.2	96	0.63	6.5	156
R	12	5	0.72	6.0	52	0.80	9.0	86
S	16	5	0.72	6.0	69	0.89	9.0	128
T	30	9	0.72	4.8	104	0.89	7.2	192
U	3	5	0.72	6.0	13	0.89	9.0	24
V	81	5	0.72	6.0	350	0.89	9.0	649
W	31	5	0.72	6.0	134	0.89	9.0	248
X	44	5	0.72	6.0	190	0.89	9.0	352
Y1	98	6	0.72	5.6	395	0.89	8.4	733
Y2	64	6	0.72	5.6	258	0.89	8.4	478
Z	27	9	0.72	4.8	93	0.89	7.2	173

NOTE: 1.) Hydrologic calculations are based on the Rational Method
2.) All flows are undetained.

TABLE 5

NORTHGATE DEVELOPMENT
DESIGN PEAK FLOWS FOR
PRESENT AND RECOMMENDED CONDITIONS
24-HOUR STORM

	PRESENT CONDITIONS		RECOMMENDED CONDITIONS	
DESIGN POINT	10-YR (cfs)	100-YR (cfs)	10-YR (cfs)	100-YR (cfs)
1	142	441	142	445
2	177	546	177	560
3	177	546	177	560
4	9	39	9	27
5	30	55	56	104+
6	12	45	12	35
7	40	161	40	161
8	41	202	41	223
9	37+	68+	108+	199+
10	28	129	28	123
11	252	755	252	757
12	254	797	265	777
13	469	1448	469	1312
14	469	1448	469	1312
15	43	106	43	86
16	58	143	85	152
17	32	58	32	80
18	33	85	33	80
19	141	378	141	152
20	470	1454	470	1454
21	45	116	45	94
22	261	730	261	384
23	42	115	80	267++
24	453	1391	453	1290

\+ Calculated by the Rational Method, all others based on SCS/TR20.

++ Flows in excess of 80 cfs are diverted to detention facility at DP22.

Note: 1) Present conditions include routed flows without existing "stockponds" or proposed detention facilities. Present conditions are assumed to represent historic conditions.

2) Recommended conditions include routed flows through proposed detention facilities.

3) For calculation of peak flows refer to Monument Branch and Middle Tributary Drainage Basin Studies.

TABLE 6

NORTHGATE DEVELOPMENT
SUMMARY OF PROPOSED
DETENTION FACILITIES
(PUBLICALLY OWNED AND MAINTAINED)

D.P.	LOCATION	TYPE	PEAK INFLOW (cfs)	PEAK OUTFLOW (cfs)	PEAK HISTORIC (cfs)	SURFACE AREA (ac)	VOLUME (ac-ft)	ONSITE TRIBUTARY AREA (subbasins)	CORRESPOND. FIGURE APPENDIX A
1	CITY/COUNTY BNDRY.	ONSTREAM	1045	441	441	3.7	22.4	A	16
2	VOYAGER PKWY.	OFFSTREAM	359	162	162	1.3	6.0	B	9
4	BSC PKWY.	OFFSTREAM	107	27	39	0.9	2.3	G	11
6	VOYAGER PKWY.	OFFSTREAM	139	35	45	1.0	3.0	F	10
7	VOYAGER PKWY.	ONSTREAM	278	98	98	1.2	5.7	E,H	12
8	CITY/COUNTY BNDRY.	ONSTREAM	376	202	202	1.4	6.3	I	13
10	USAFA BNDRY.	ONSTREAM	461	123	129	2.2	10.3	J-M	14
11	CITY/COUNTY BNDRY.	ONSTREAM	1384	755	755	4.6	30.4	OFFSITE	23,24
15	CITY/COUNTY BNDRY.	OFFSTREAM	163	86	106	0.6	2.0	R	21
17	VOYAGER PKWY.	OFFSTREAM	167	80	85	1.1	3.9	W	20
19	VOYAGER PKWY.	OFFSTREAM	817	152	378	5.8	29.2	V,T	19
21	USAFA BNDRY.	OFFSTREAM	220	94	116	1.4	5.0	Q	18
22	USAFA BNDRY.	ONSTREAM	1046	384	730	5.3	29.9	Y1,Y2,X	22
24	POWERS BLVD.	ONSTREAM	2008	1290	1391	6.0	39.9	O,P,S,U+OFFSITE	17

NOTE: DATA FROM MIDDLE TRIBUTARY AND MONUMENT BRANCH
DRAINAGE BASIN PLANNING STUDIES

REFER TO FIGURE 4 FOR DESIGN POINTS

BASINS C,D,N AND Z ULTIMATELY ARE PROPOSED
TO BE HELD TO HISTORIC LEVELS DUE TO DELAYED
PEAK. TEMPORARY DETENTION IS REQUIRED UNTIL
FULL DEVELOPMENT. SEE FIGURES 15 AND 23, APPENDIX A.

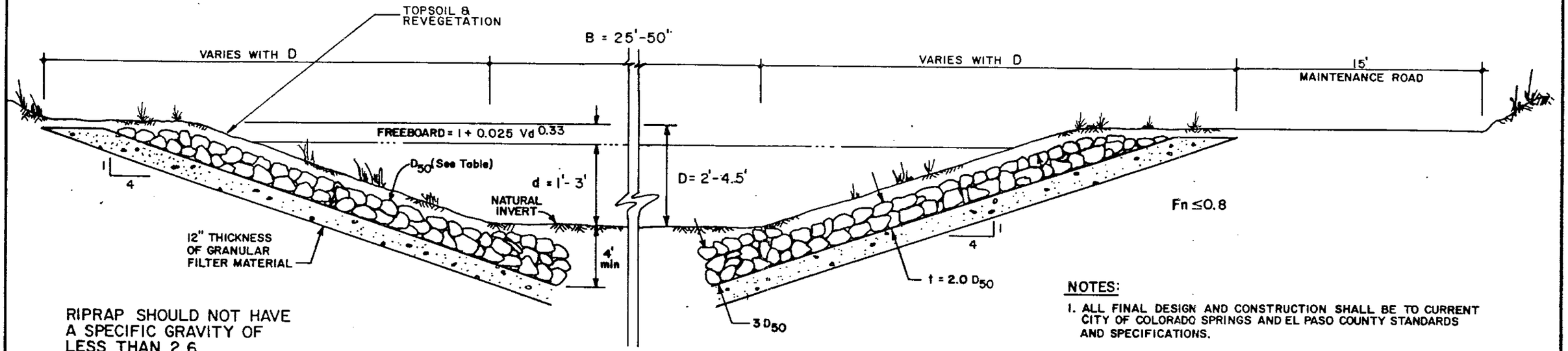
TABLE 7

NORTHGATE DEVELOPMENT
PROPOSED PUBLIC DRAINAGE FACILITIES

DESIGN POINT	REACH	FACILITY	DESIGN FLOW (cfs)	
1	-	DETENTION FACILITY (OFFSITE)	441	(out)
-	1	25' X 4' X 1400' PLC, 8 DROPS	445	
2	-	DETENTION FACILITY	162	(out)
		8' X 8' X 160' CBC	560	
3	-	BOUNDARY	560	
4	-	DETENTION FACILITY	27	(out)
5	-	54" X 160' RCP	104	*
6	-	DETENTION FACILITY	35	(out)
-	2	100 YEAR OVERFLOW PROVISION	323	*
7	-	DETENTION FACILITY	98	(out)
		60" X 160' RCP	161	
-	3	100 YEAR OVERFLOW PROVISION	376	
8	-	DETENTION FACILITY	202	(out)
9	-	5' X 5' X 160' CBC	199	*
-	4	100 YR OVERFLOW PROVISION	461	
10	-	DETENTION FACILITY	123	(out)
11	-	BOUNDARY/DET. FAC. (OFFSITE)	755	(out)
-	5	40' X 4' X 3500' PLC, 10 DROPS	777	
12	-	10' X 8' X 160' CBC	777	
13	-	BOUNDARY	1312	
-	6	40' X 4.5' X 1200' PLC, 2 DROPS	1312	
14	-	12' X 10' X 240' CBC	1312	
15		BOUNDARY/DET. FAC. (OFFSITE)	86	(out)
		42" X 120' RCP	86	
-	7	100 YEAR OVERFLOW PROVISION	152	
16	-	5' X 4' X 240' CBC	152	
-	8	100 YEAR OVERFLOW PROVISION	152	
17	-	DETENTION FACILITY	80	(out)
		48" X 120' RCP	80	
-	9	8' X 3.0' X 800' PLC, 5 DROPS	152	
18	-	36" X 130' RCP	63	*
-	10	100 YEAR OVERFLOW PROVISION	63	
19	-	DETENTION FACILITY	152	(out)
		48" X 240' RCP	152	(out)
-	11	50' X 4.5' X 2800' PLC, 7 DROPS	1454	
20	-	BOUNDARY	1454	
21	-	DETENTION FACILITY/BOUNDARY	94	(out)
22	-	DETENTION FACILITY/BOUNDARY	384	(out)
23	-	DIVERSION STRUCTURE (PASS)	80	
		DIVERSION STRUCTURE (DIVERT)	187	
-	12	100 YEAR OVERFLOW PROVISION	376	
-	13	5' X 4.5' X 1750' PLC, 0 DROPS	187	
24	-	DETENTION FACILITY (OFFSITE)	1290	(out)
		11' X 10' X 280' CBC	1391	

* Calculated by the Rational Method.

NOTE:1) All flows from Middle Tributary and Monument Branch Drainage Basin Planning Studies.
2) All construction subject to final design requirements.



RIPRAP SHOULD NOT HAVE A SPECIFIC GRAVITY OF LESS THAN 2.6

TYPICAL PARTIALLY LINED RIPRAP CHANNEL SECTION

nts

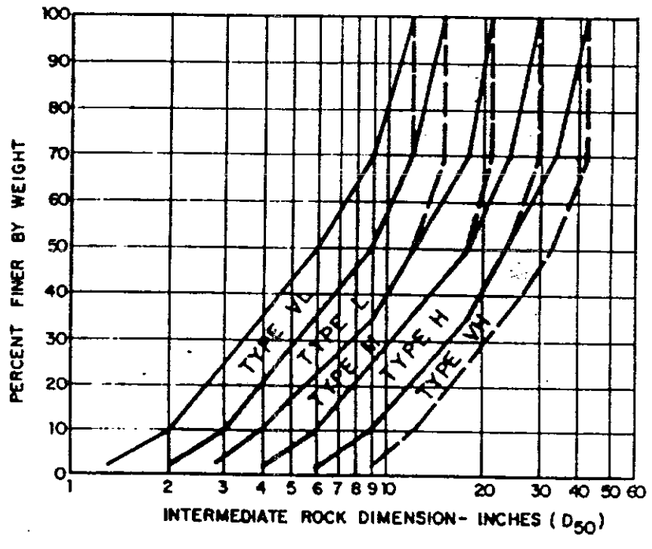
RIPRAP REQUIREMENTS FOR CHANNEL LININGS **

$VS^{0.17}/(S_s-1)^{0.66}$ * (feet per second)	Rock Type ***
1.4 to 3.2	VL
3.3 to 3.9	L
4.0 to 4.5	M
4.6 to 5.5	H
5.6 to 6.4	VH

* Use S_s = 2.5 unless the source of rock and its densities are known at the time of design.

** Table valid only for Froude number of 0.8 or less and side slopes no steeper than 2h:1v.

*** Type VL and L riprap shall be buried after placement to reduce vandalism.



GRADATION OF ORDINARY RIPRAP

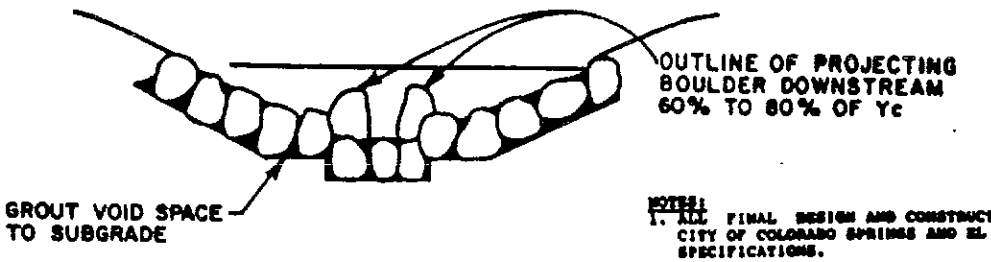
NOTES:

1. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS AND EL PASO COUNTY STANDARDS AND SPECIFICATIONS.
2. FINAL CHANNEL SIZING, TRANSITIONS, SUPERELEVATIONS & EASEMENTS ARE SUBJECT TO DETAILED DRAINAGE REPORTS OF THE SUBJECT AREA.
3. THIS DETAIL WAS USED FOR COST ESTIMATING PURPOSES FOR THIS MASTER PLAN ONLY.
4. TOPSOIL AND REVEGETATION ABOVE RIP-RAP ASSUMED TO BE NON-REIMBURSABLE.
5. MINIMUM EASEMENT REQUIREMENTS FOR EACH CHANNEL ARE SHOWN IN FIGURE 4.

SOURCE: URBAN DRAINAGE & FLOOD CONTROL DISTRICT, DRAINAGE CRITERIA MANUAL

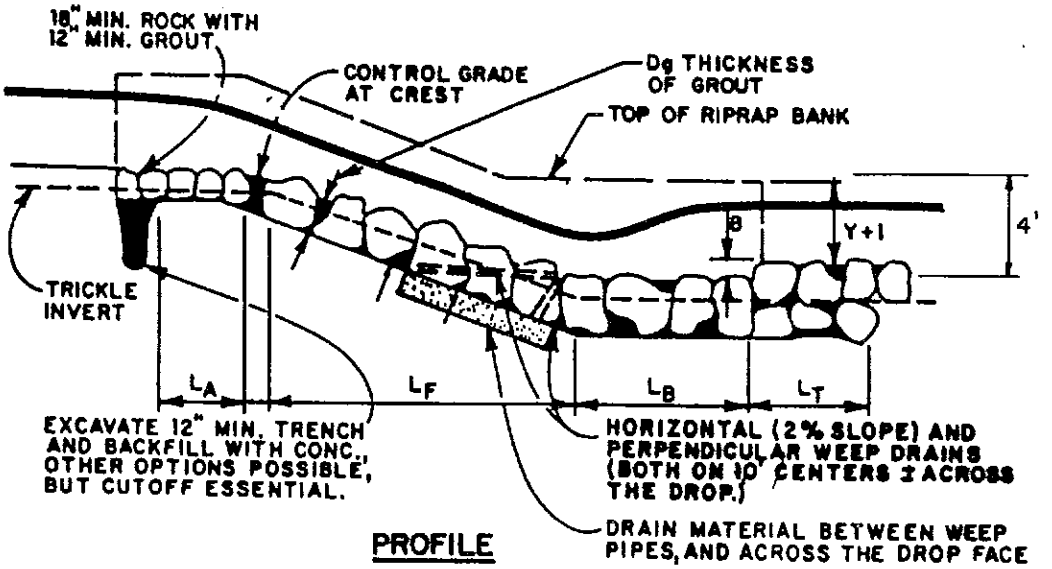
PARTIALLY LINED CHANNEL DETAIL
FIGURE 5

URS CONSULTANTS
MAKING TECHNOLOGY WORK

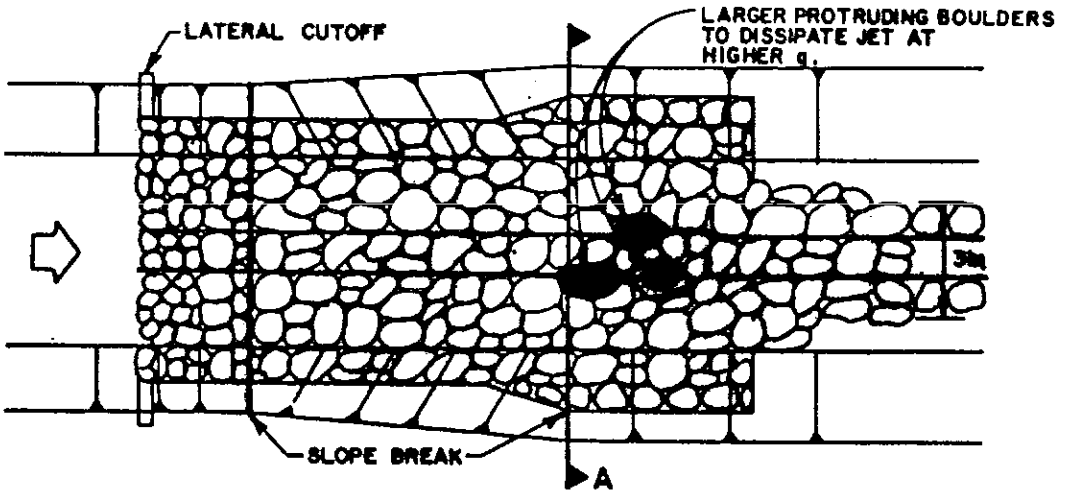


SECTION-A

NOTES:
1. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS AND EL PASO COUNTY STANDARDS AND SPECIFICATIONS.
2. FINAL DROP SIZING AND CONFIGURATION IS SUBJECT TO DETAILED DRAINAGE REPORTS OF THE SUBJECT AREA.
3. THIS DETAIL WAS USED FOR COST ESTIMATING PURPOSES FOR THIS MASTER PLAN ONLY.



PROFILE



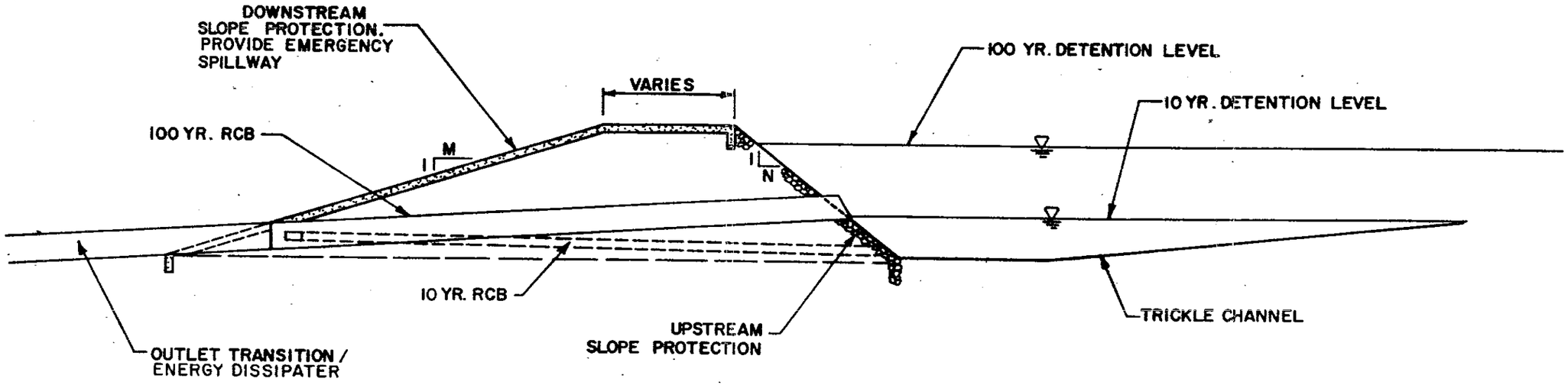
PLAN

FIGURE 6

GSB—GROUTED SLOPING BOULDER DROP

URS CONSULTANTS
MAKING TECHNOLOGY WORK

Reference: Urban Drainage & Flood Control District, Drop Structures in the Denver Metropolitan Area, Dec. 1986



CONCEPTUAL DAM SECTION

NOT TO SCALE

NOTES:

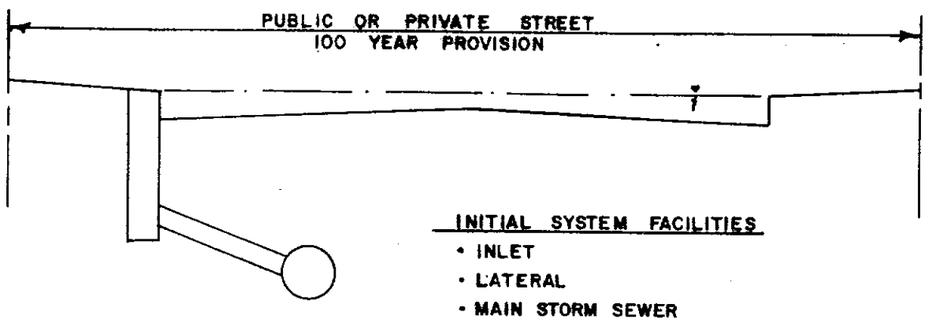
1. THIS SECTION WAS USED FOR COST ESTIMATING PURPOSES (THIS STUDY ONLY).
2. M & N SUBJECT TO GEOTECHNICAL DESIGN.
3. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS, EL PASO COUNTY, AND STATE OF COLORADO SPECIFICATIONS WHERE APPLICABLE.
4. WHERE ROAD EMBANKMENT IS USED FOR DETENTION POND EMBANKMENT THE TOP OF THE ROAD CANNOT BE USED AS AN EMERGENCY SPILLWAY. A SEPERATE OUTLET FACILITY MUST BE CONSTRUCTED
5. DETENTION FACILITIES UPSTREAM OF EXISTING CULVERTS SHALL HAVE OUTLET FACILITIES SIZED IN ORDER TO MAINTAIN CULVERT DESIGN FLOW. THIS MAY OR MAY NOT CAUSE THE DETENTION POND TO INCREASE IN VOLUME.

FIGURE 7

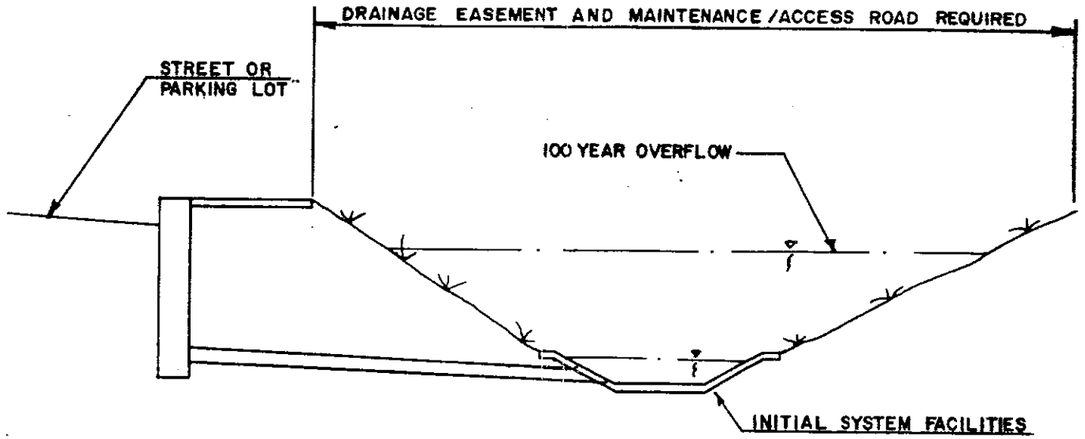
URS CONSULTANTS
MAKING TECHNOLOGY WORK

CONCEPTUAL
INITIAL SYSTEM DETAILS

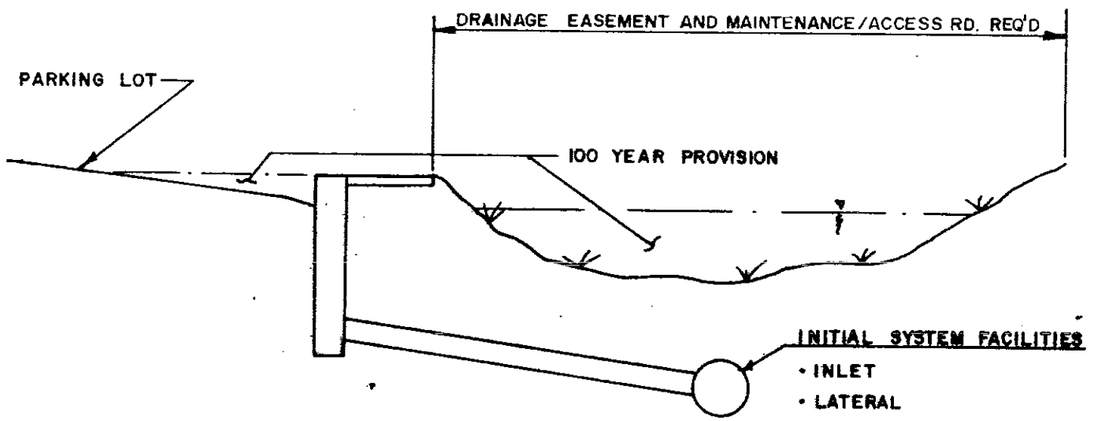
NTS



INITIAL SYSTEM FACILITIES
- INLET
- LATERAL
- MAIN STORM SEWER
- STREET & C&G



INITIAL SYSTEM FACILITIES
- IMPROVED CHANNEL
- INLET & LATERAL
- STREETS
- PARKING LOTS



INITIAL SYSTEM FACILITIES
- INLET
- LATERAL
- MAIN STORM SEWER
- PARKING LOTS
- BERMED OR EXCAVATED CHANNELS

NOTES:

1. ALL FINAL DESIGN AND CONSTRUCTION SHALL BE TO CURRENT CITY OF COLORADO SPRINGS AND EL PASO COUNTY STANDARDS AND SPECIFICATIONS.
2. ALL IMPROVEMENTS ON BASINS GREATER THAN 130 ACRES SHALL BE DESIGNED FOR THE 100-YR., 24-HR. STORM.
3. SUBJECT TO FINAL DESIGN & EASEMENT REQUIREMENTS.

FIGURE 8

URS CONSULTANTS MAKING TECHNOLOGY WORK

VII. FINANCIAL SECTION

Shown in Tables 8 and 9 are estimated construction and land costs for all proposed major drainage improvements (public) affecting the Northgate Development, as reflected in the associated Basin Plans. The facilities are broken out between the Middle Tributary and Monument Branch Basins for onsite and offsite. The estimated total cost for onsite facilities, including detention land costs, within the Middle Tributary Basin is $758,196, and for Monument Branch Basin is $2,513,722. The estimated total costs for offsite facilities, including detention land costs, within Middle Tributary Basin is $271,398, and for Monument Branch Basin is $1,224,596.

These costs only reflect buildout within the Northgate Development. Other cost considerations would be upstream of Northgate, such as detention and major channel facilities if required, as per discussion in Section VI. Downstream facilities may not be required by this development if developed flows are either detained (or overdetained) to maintain historic flows at the west boundary or if onsite temporary detention is used. Where historic rates are exceeded downstream, public drainage easements will also be required.

Initial facilities are required per the City/County Drainage Criteria Manual, but are not reimbursable in these basins, and are not sized or shown in this report.

TABLE 8

NORTHGATE - MIDDLE TRIBUTARY DRAINAGE BASIN
ESTIMATED CONCEPTUAL DESIGN IMPROVEMENT COSTS

DESIGN POINT	REACH	DESIGN FLOW (cfs)	LENGTH (ft)	COMMENTS	PROPOSED IMPROVEMENT	UNIT COST ($)	UNIT	ESTIMATED 1988 CONSTRUCTION COSTS: DRAINAGE CONSTRUCTION COST($)	ESTIMATED 1988 CONSTRUCTION COSTS: DRAINAGE LAND COST($) *
ONSITE									
-	1	445	1400	PART. LINED CHAN.	25'x 4.0'x 1400' PLC	80.00	LF	$112,000	
2	-	560	200	VOYAGER PKWY	8'x 8'x 200' CBC	334.00	LF	66,800	
2	-	-	-	DETENTION FACILITY	6.0 AC-FT STORAGE	-	-	54,000	$18,252
4	-	-	-	DETENTION FACILITY	2.3 AC-FT STORAGE	-	-	25,000	12,636
5	-	104	160	B.S. PKWY	54" dia x 160' RCP	148.00	LF**	23,680	
6	-	-	-	DETENTION FACILITY	3.0 AC-FT STORAGE	-	-	29,000	14,040
7	-	161	160	VOYAGER PKWY.	60" dia x 160' RCP	157.00	LF**	25,120	
7	-	-	-	DETENTION FACILITY	5.7 AC-FT STORAGE	-	-	50,000	16,848
8	-	-	-	DETENTION FACILITY	6.3 AC-FT STORAGE	-	-	58,000	19,656
9	-	199	160	B.S. PKWY.	5'x 5'x 160' CBC	160.00	LF	25,600	
10	-	-	-	DETENTION FACILITY	10.3 AC-FT STORAGE	-	-	90,000	30,888
					SUBTOTAL (ONSITE)			$559,200	$112,320
					CONSTRUCTION COST			$559,200	
					CONSTRUCTION CONTINGENCY	@ 5%		27,960	
					ENGINEERING FEES	@ 10%		58,716	
					LAND COSTS			-	112,320
					TOTAL (ONSITE)			$645,876	$112,320
OFFSITE									
1				DETENTION FACILITY	22.4 AC-FT STORAGE			$190,000	$51,948
					SUBTOTAL (OFFSITE)			$190,000	$51,948
					CONSTRUCTION COST			$190,000	
					CONSTRUCTION CONTINGENCY	@ 5%		9,500	
					ENGINEERING FEES	@ 10%		19,950	
					LAND COSTS			-	51,948
					TOTAL (OFFSITE)			$219,450	$51,948
					GRAND TOTAL (ONSITE + OFFSITE)			$865,326	$164,268

TOTAL ACREAGE WITHIN NORTHGATE 383

DETENTION LAND AREA COST/ACRE:
WITHIN CITY $15,600
WITHIN COUNTY $15,600

* LAND AREAS USED ARE ESTIMATES AND ARE SUBJECT TO CHANGE AT TIME OF FINAL DESIGN. LAND AREAS ARE REIMBURSABLE ONLY OUTSIDE OF HISTORIC CHANNEL.
** UNIT COSTS INCREASED 20% FOR INLET AND OUTLET TRANSITIONS.

TABLE 9

NORTHGATE - MONUMENT BRANCH DRAINAGE BASIN
ESTIMATED CONCEPTUAL DESIGN IMPROVEMENT COSTS

DESIGN POINT	REACH	DESIGN FLOW (cfs)	LENGTH (ft)	COMMENTS	PROPOSED IMPROVEMENT	UNIT COST ($)	UNIT	ESTIMATED 1988 CONSTRUCTION COSTS: DRAINAGE CONSTRUCTION COST($)	ESTIMATED 1988 CONSTRUCTION COSTS: DRAINAGE LAND COST($) *
ONSITE									
-	5	777	3500	PART. LINED CHAN.	40'x 3.5'x 3500' PLC	70.41	LF	$246,435	
				DROP STRUCTURES	10 DROPS	14,000	EA	140,000	
-	6	1312	1200	PART. LINED CHAN.	40'x 4.5'x 1200' PLC	80.48	LF	96,576	
-	9	152	800	PART. LINED CHAN.	8'x 3.0'x 800' PLC	100.00	LF	80,000	
				DROP STRUCTURES	5 DROPS	12,500	EA	62,500	
-	11	1460	2800	PART. LINED CHAN.	50'x 4.5'x 2800 PLC	81.36	LF	227,818	
				DROP STRUCTURES	6 DROPS	22,200	EA	133,200	
12	-	777	160	VOYAGER PKWY.	10'x 8'x 160' CBC	372.77	LF	59,643	
-	13	187	1750	PART. LINED CHAN.	5'x 4.5'x 1750' PLC	94.51	LF	165,393	
				DROP STRUCTURES	0 DROPS	0	EA	0	
14	-	1312	240	VOYAGER PKWY.	12'x 10'x 240' CBC	484.54	LF	116,289	
15	-	86	130	REPL. EX. CULVERT @ NORTHGATE RD.	42" dia x 130' RCP	124.90	LF	16,237	
16	-	152	240	POWERS BLVD.	5'x 4'x 240' CBC	143.70	LF	34,488	
17	-	-	-	DETENTION FACILITY	3.9 AC-FT STORAGE	-	-	36,090	$15,444
17	-	-	120	LOOP ROAD	48" dia x 120' RCP	139.20	LF	16,704	
18	-	63	130	REPL. EX. CULVERT @ NORTHGATE RD.	36" dia x 130' RCP	104.40	LF	13,572	
19 (HIST)	-	152	240	VOYAGER PKWY.	48" dia x 240' RCP	139.20	LF	33,408	
19 (HIST)	-	-	-	DETENTION FACILITY	29.2 AC-FT STORAGE	-	-	241,020	81,432
21	-	-	-	DETENTION FACILITY	5.0 AC-FT STORAGE	-	-	45,000	19,656
22	-	-	-	DETENTION FACILITY	29.9 AC-FT STORAGE	-	-	246,690	74,412
					SUBTOTAL (ONSITE)			$2,011,063	$190,944
					CONSTRUCTION COSTS			$2,011,063	
					CONSTRUCTION CONTINGENCY @ 5%			100,553	
					ENGINEERING FEES @ 10%			211,162	
					LAND COSTS			-	$190,944
					TOTAL (ONSITE)			$2,322,778	$190,944
OFFSITE									
11	-	-	-	DETENTION FACILITY	30.4 AC-FT STORAGE	-	-	$251,000	$64,584
-	5	777	500	PART. LINED CHAN	40'x 3.5'x 500' PLC	70.41	LF	35,205	
				DROP STRUCTURES	2 DROPS	14,000	EA	28,000	
15	-	-	-	DETENTION FACILITY	2.0 AC-FT STORAGE	-	-	20,700	8,424
24	-	-	-	DETENTION FACILITY	39.9 AC-FT STORAGE	-	-	327,690	84,240
24	-	1290	280	POWERS BLVD.	11'x 10'x 280' CBC	445.28	LF	124,700	
-	6	1312	1700	PART. LINED CHAN.	40'X 4.5'X 1700' PLC	80.48	LF	136,816	
					SUBTOTAL (OFFSITE)			$924,111	$157,248
TOTAL ACREAGE WITHIN NORTHGATE		575			CONSTRUCTION COSTS			$924,111	
					CONSTRUCTION CONTINGENCY @ 5%			46,206	
DETENTION LAND AREA COST/ACRE:					ENGINEERING FEES @ 10%			97,032	
WITHIN CITY	$15,600				LAND COSTS			-	$157,248
WITHIN COUNTY	$15,600				TOTAL (OFFSITE)			$1,067,348	$157,248
					GRAND TOTAL (ONSITE + OFFSITE)			$3,390,126	$348,192

* LAND AREAS USED ARE ESTIMATES AND ARE SUBJECT TO CHANGE AT TIME OF FINAL DESIGN. LAND AREAS ARE REIMBURSABLE ONLY OUTSIDE OF HISTORIC CHANNEL.

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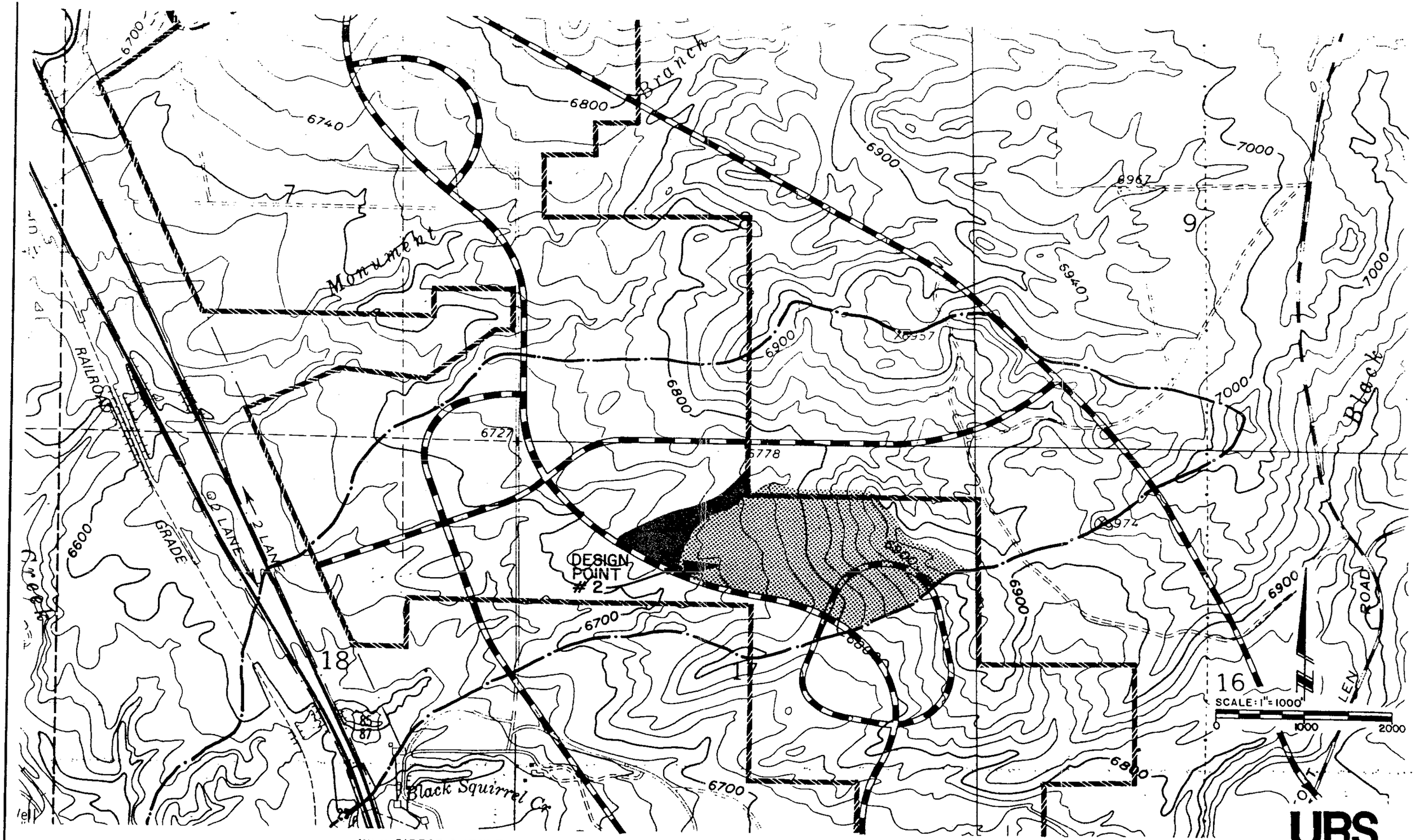
URS Consultants, Inc.
April, 1987

Monument Branch Drainage Basin Planning Study
URS Consultants, Inc.
April, 1987

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

APPENDIX A: CONCEPTUAL DETENTION POND TRIBUTARY AREAS



DESIGN POINT 2 (MDDP)
DESIGN POINT 5 (DBPS)

DIRECT DETENTION SUB-BASIN E

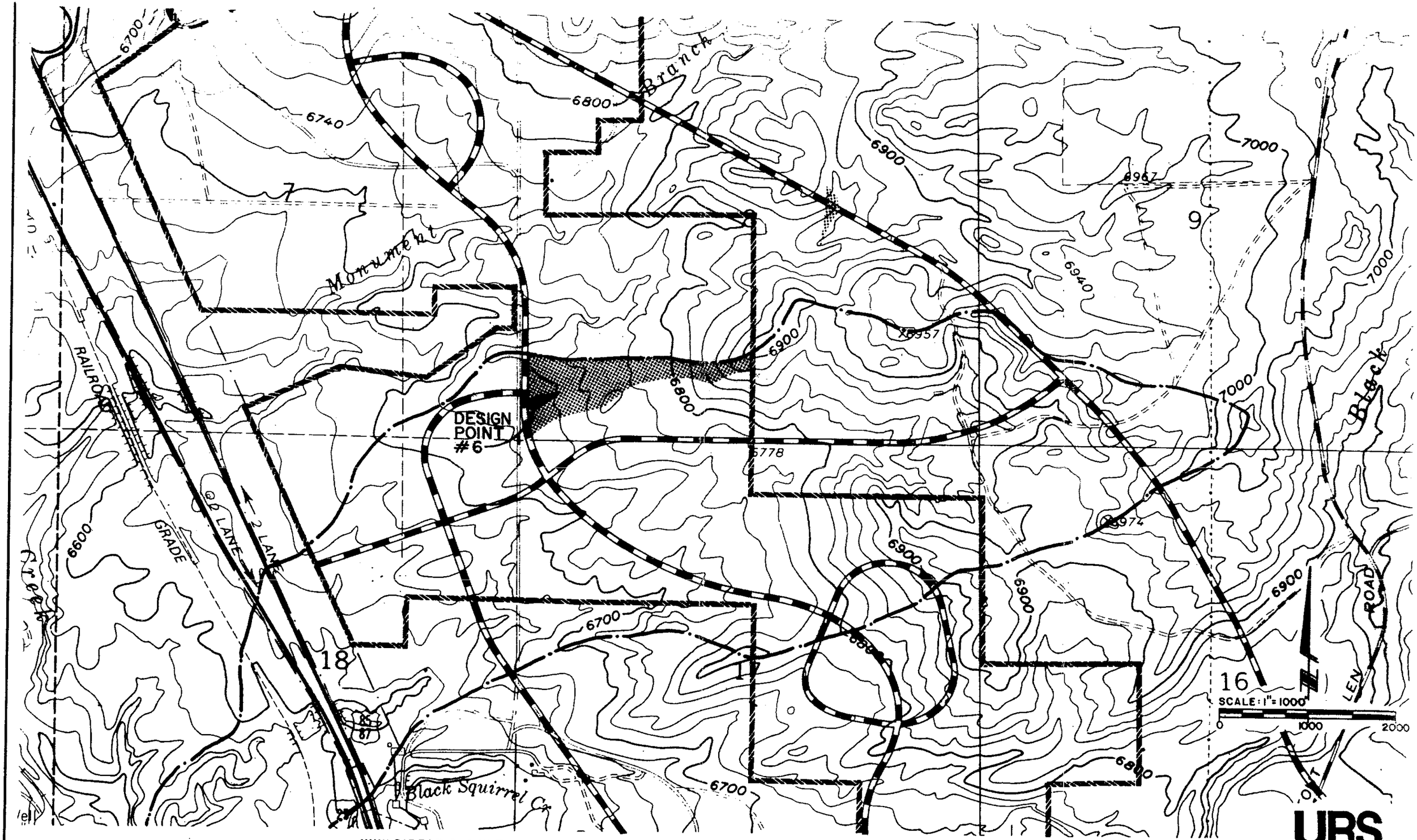
AREA OVER-DETAINED PORTION OF SUB-BASIN E

See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

CONCEPTUAL DETENTION POND TRIBUTARY AREA

URS CONSULTANTS
MAKING TECHNOLOGY WORK

FIGURE 9



DESIGN POINT 6 (MDDP)
DESIGN POINT 7 (DBPS)

DIRECT DETENTION
SUB-BASIN G1

See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

CONCEPTUAL DETENTION POND TRIBUTARY AREA

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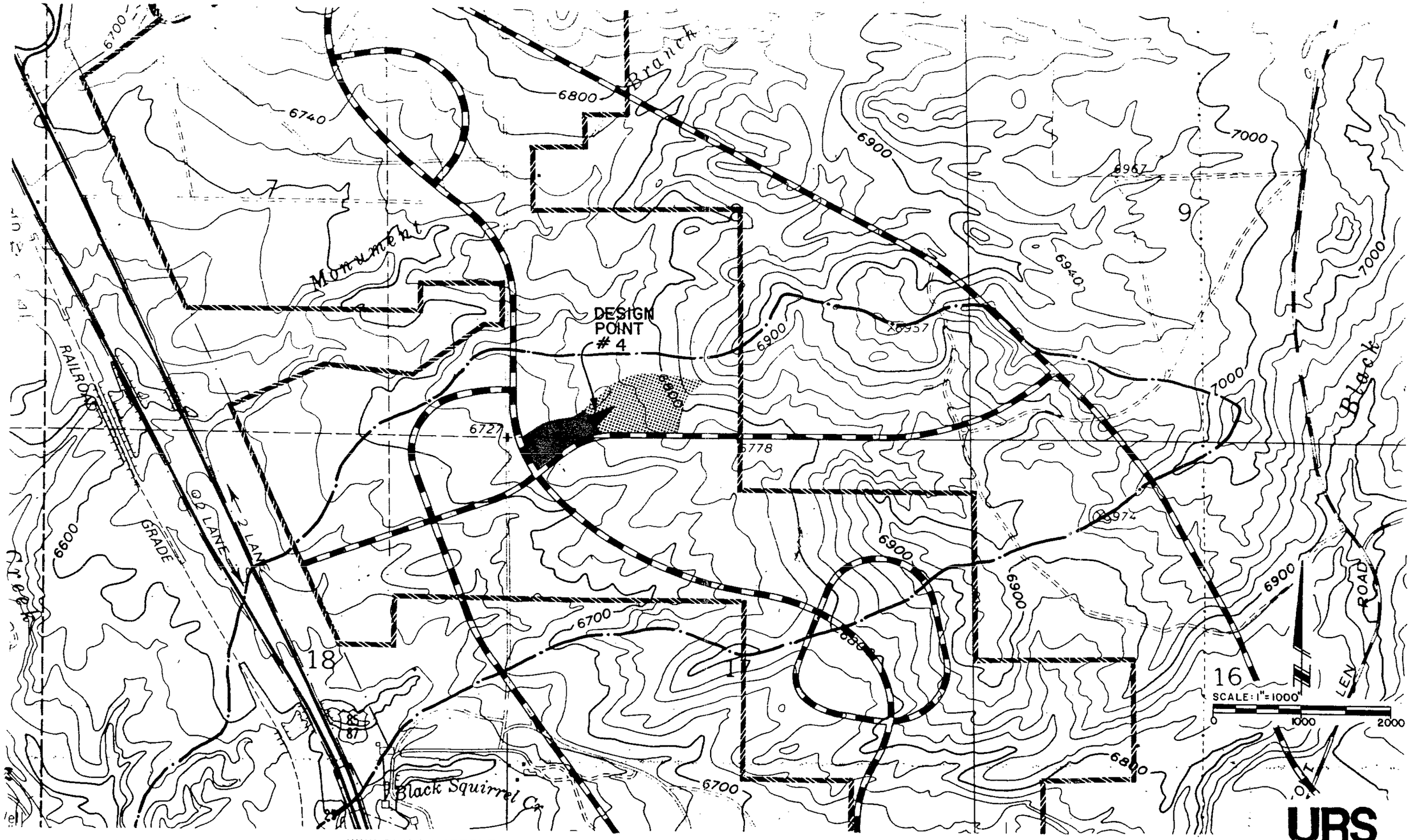
FIGURE 10



DESIGN POINT 4 (MDDP)
DESIGN POINT 8 (DBPS)

DIRECT DETENTION SUB-BASIN G2

AREA OVER-DETAINED PORTION OF SUB-BASIN G2

See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

CONCEPTUAL DETENTION POND TRIBUTARY AREA

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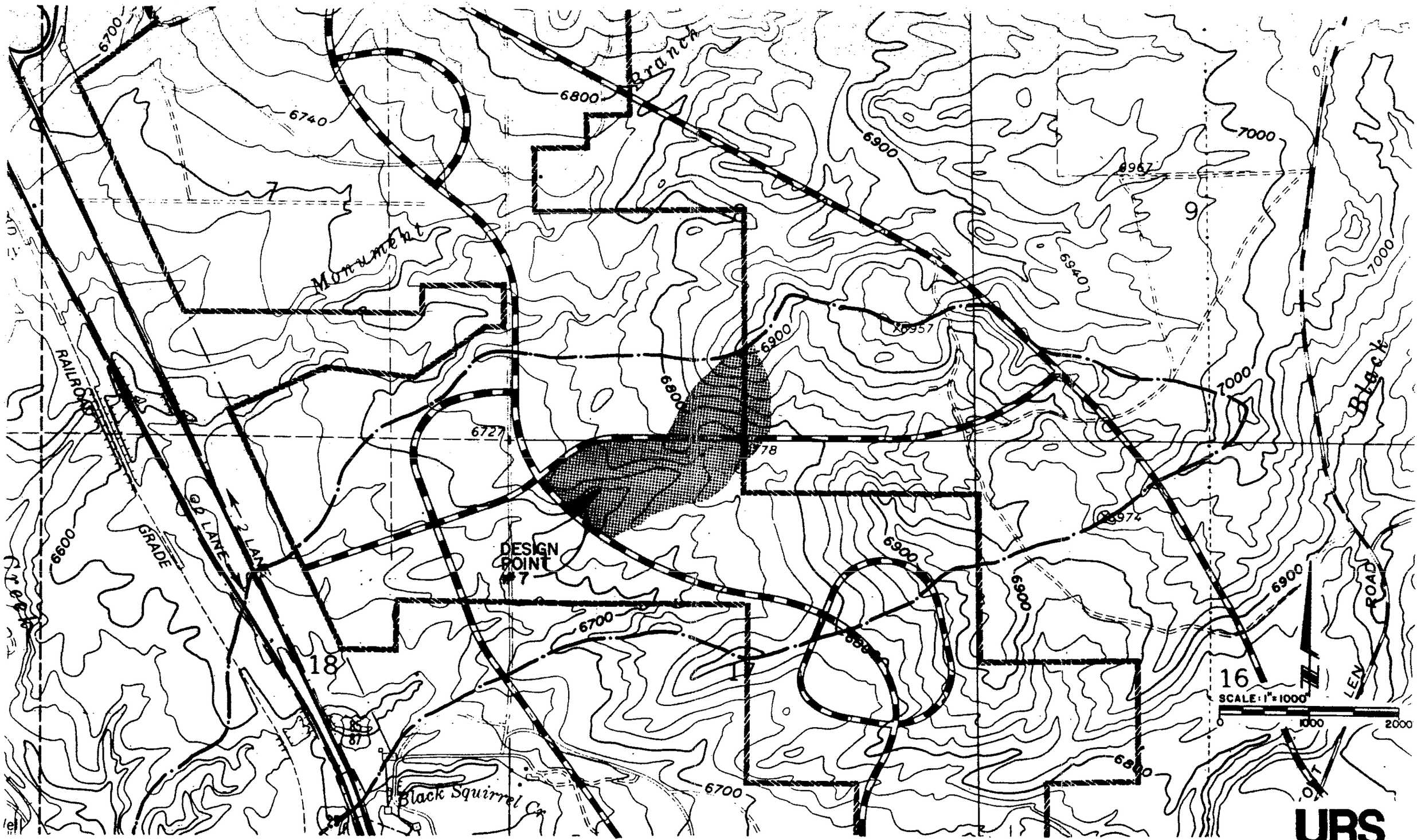
FIGURE 11



DESIGN POINT 7 (MDDP)
DESIGN POINT 9 (DBPS)

DIRECT DETENTION SUB-BASIN H,I

See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

CONCEPTUAL DETENTION POND TRIBUTARY AREA

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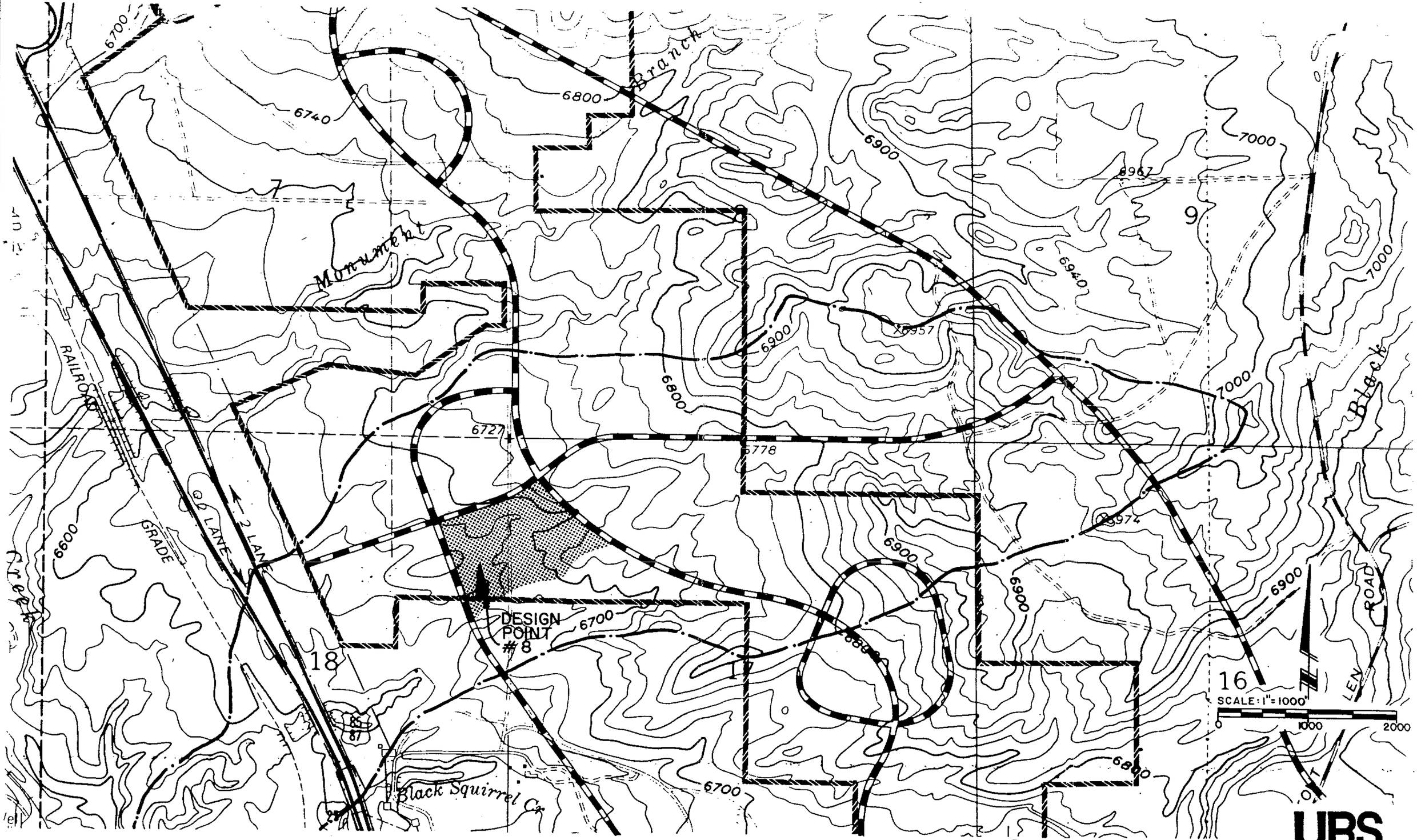
MAKING TECHNOLOGY WORK

FIGURE 12



DESIGN POINT 8 (MDDP)
DESIGN POINT 10 (DBPS)

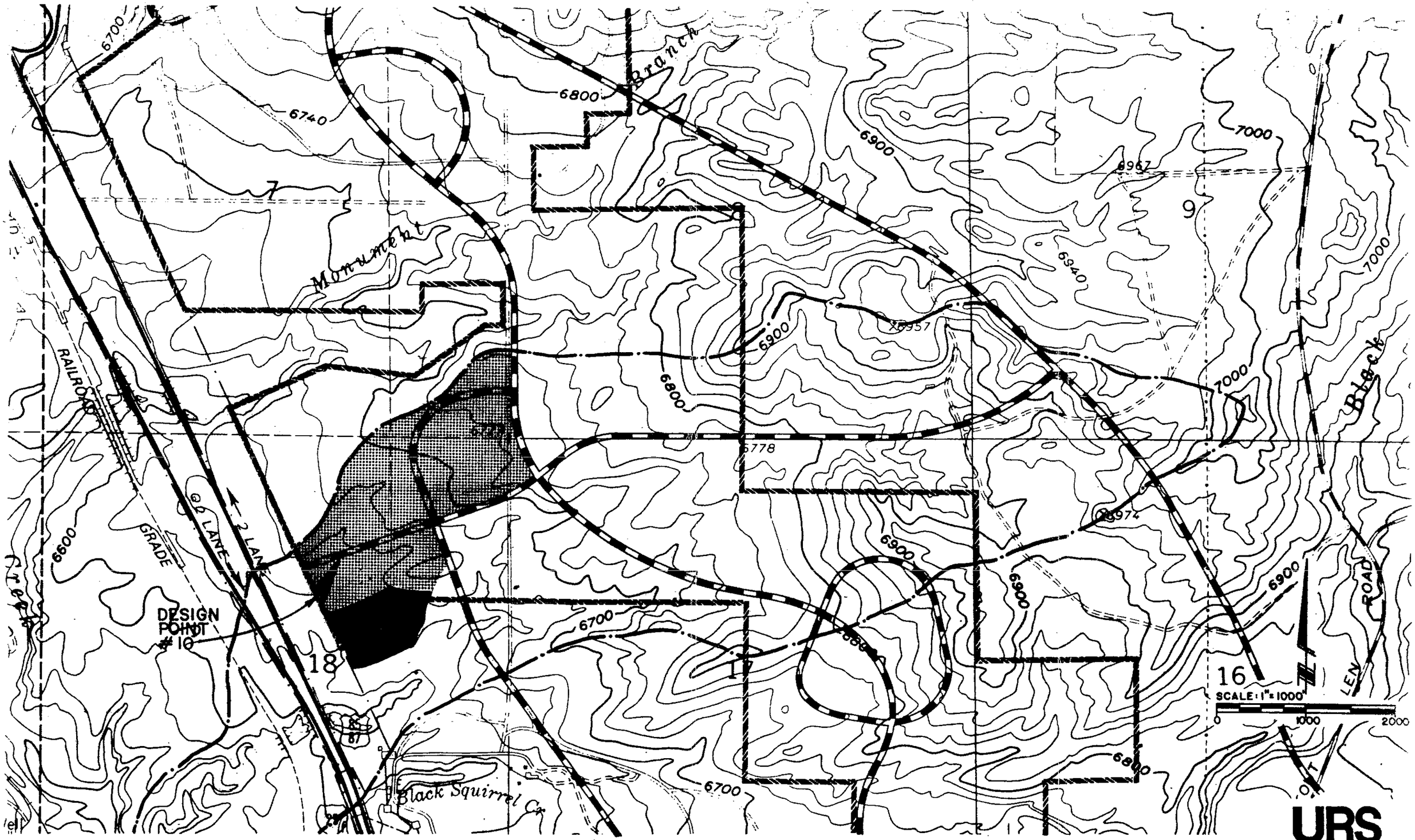
DIRECT DETENTION SUB-BASIN K

See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

CONCEPTUAL DETENTION POND TRIBUTARY AREA

URS CONSULTANTS
MAKING TECHNOLOGY WORK

FIGURE 13



DESIGN POINT 10 (MDDP)
DESIGN POINT 14 (DBPS)

DIRECT DETENTION SUB-BASIN J,M,N

AREA OVER-DETAINED PORTION OF SUB-BASIN N-2

CONCEPTUAL DETENTION POND TRIBUTARY AREA
See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

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MAKING TECHNOLOGY WORK

FIGURE 14

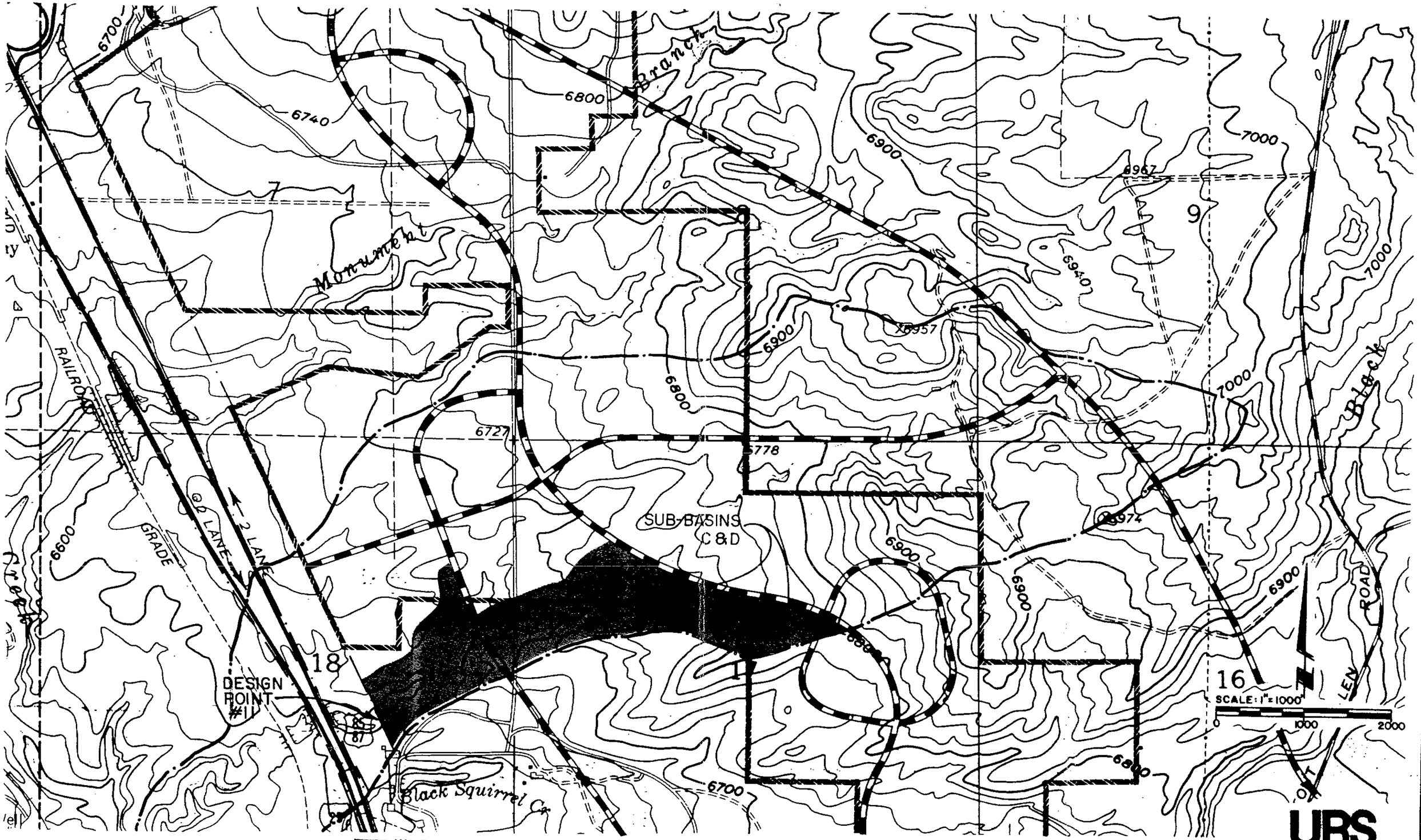
6700
6740
6800
Branch
6900
7000
6967
9
Monument
6940
6957
6900
7000
6800
6727
6778
7000
Black
RAILROAD
6974
SUB-BASINS
C&D
6600
GRADE
2 LANE
2 LANE
6900
6900
6900
18
DESIGN
POINT
#11
16
SCALE: 1"=1000'
0
1000
2000
LEN
ROAD
6700
Black Squirrel Cr.
6800
MAINTAINED TO HISTORIC DUE TO DELAYED PEAK FROM UPSTREAM PONDS UNDER FULLY DEVELOPED CONDITIONS. TEMPORARY DETENTION REQUIRED UNTIL FULL DEVELOPMENT.
SUBBASINS C & D (MDDP)
DESIGN POINT 6,11 (DBPS)
CONCEPTUAL TEMPORARY DETENTION POND TRIBUTARY AREA
See Middle Tributary Drainage Basin Planning Study
for design point and sub-basin designations.
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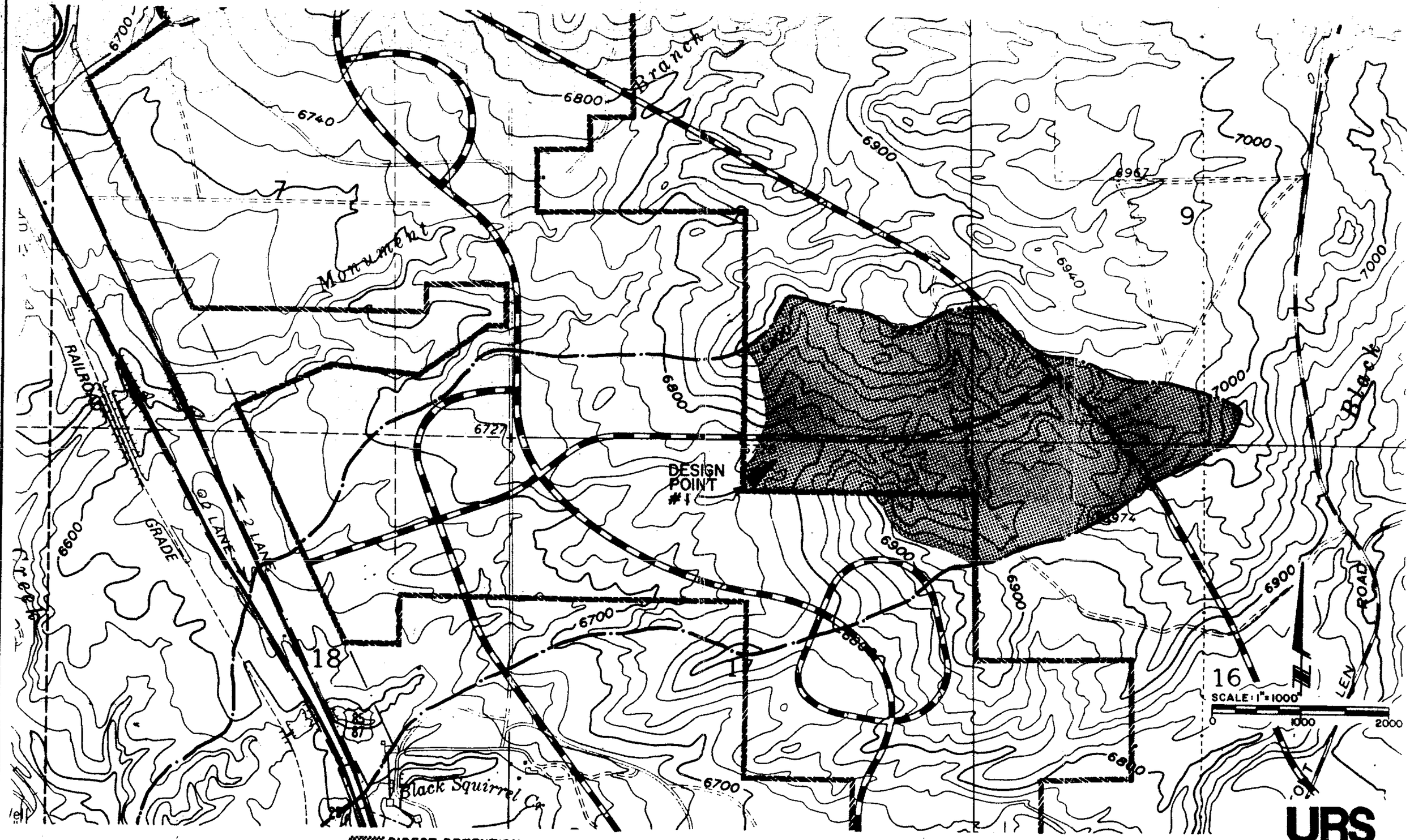
FIGURE 15



CONCEPTUAL DETENTION POND TRIBUTARY AREA

See Middle Tributary Drainage Basin Planning Study for design point and sub-basin designations.

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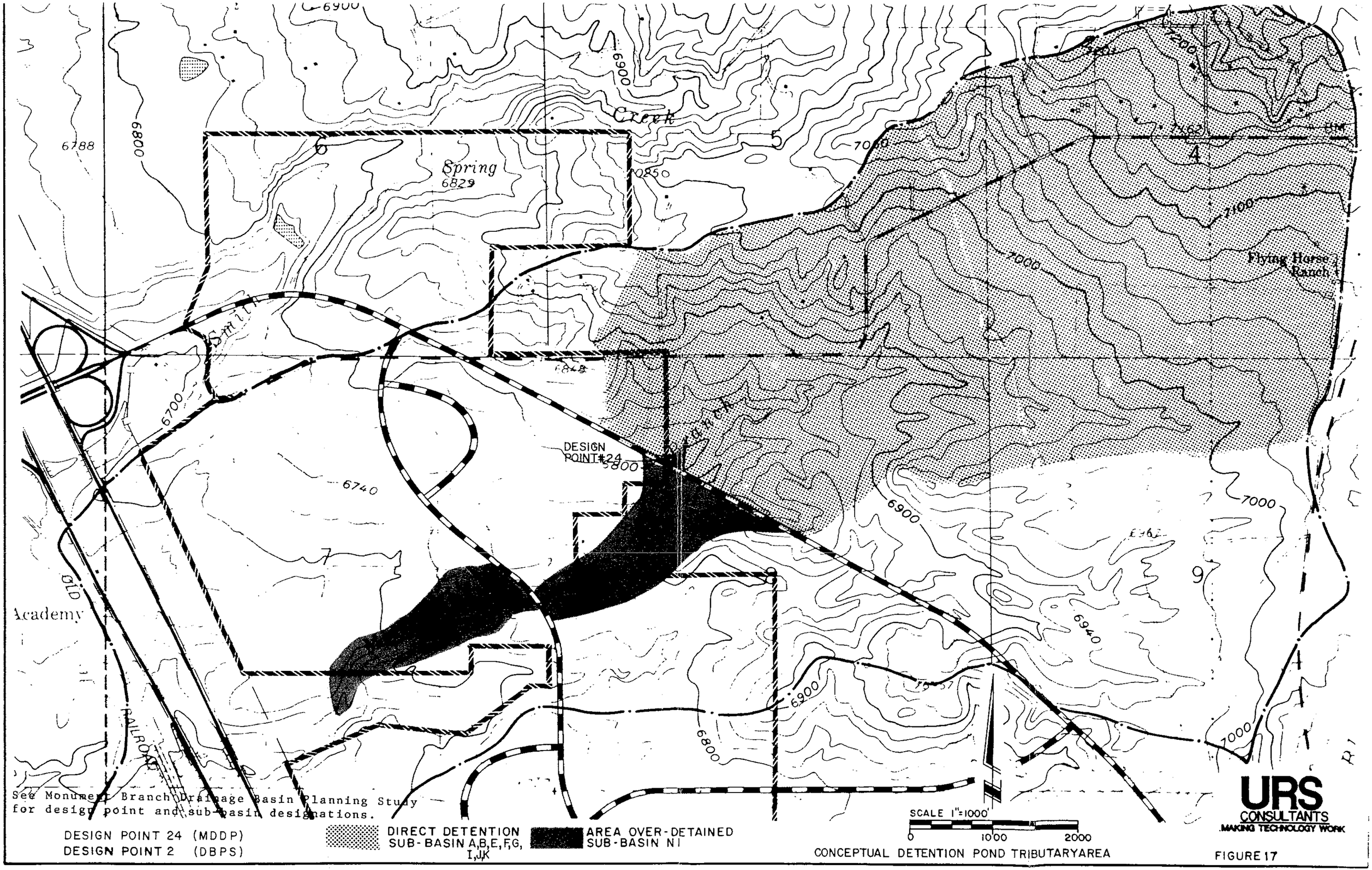
FIGURE 16



See Monument Branch Drainage Basin Planning Study for design point and sub-basin designations.

DESIGN POINT 24 (MDDP)
DESIGN POINT 2 (DBPS)

DIRECT DETENTION SUB-BASIN A,B,E,F,G, I,J,K

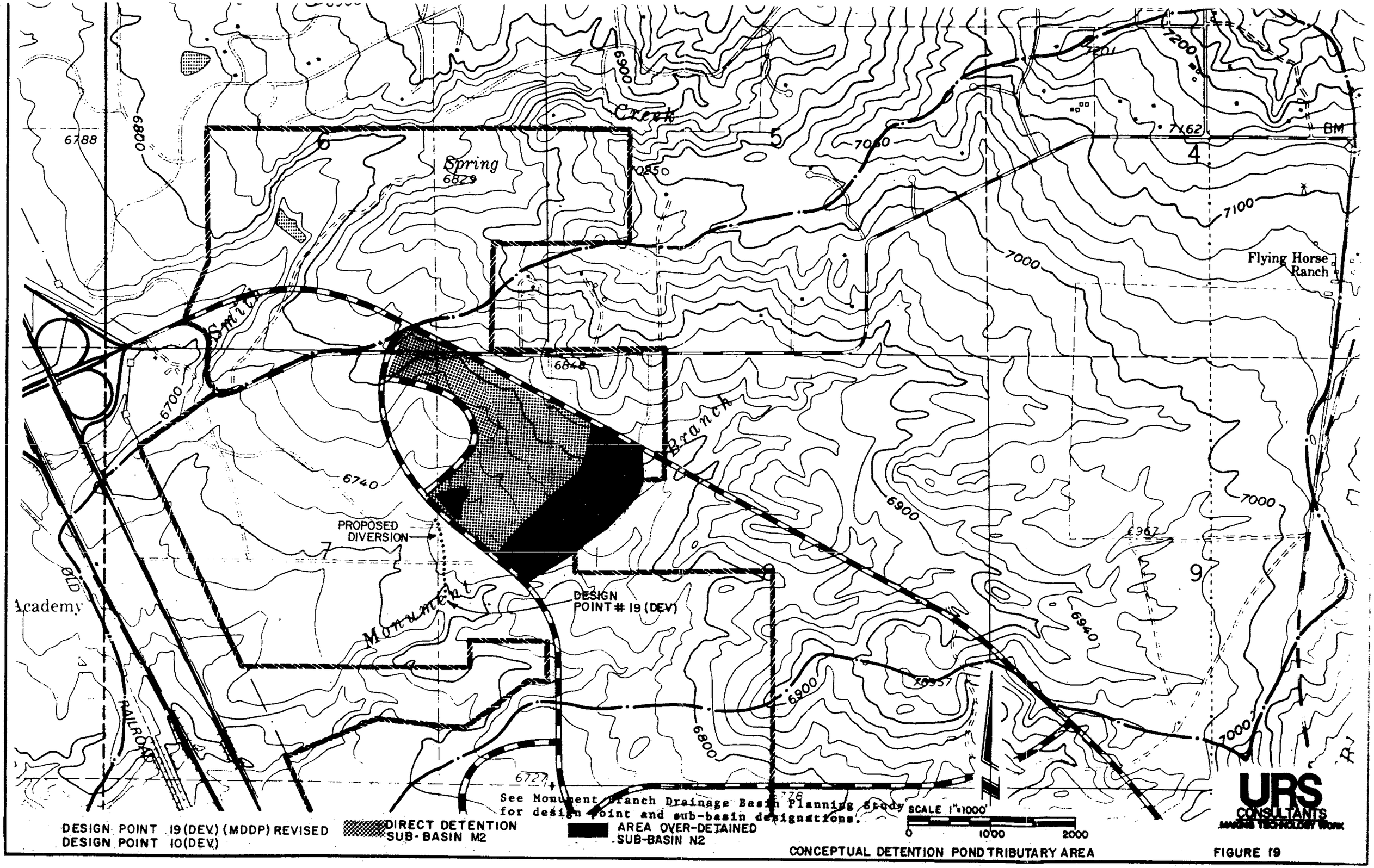
AREA OVER-DETAINED SUB-BASIN N1

SCALE 1"=1000'
0 1000 2000

CONCEPTUAL DETENTION POND TRIBUTARYAREA

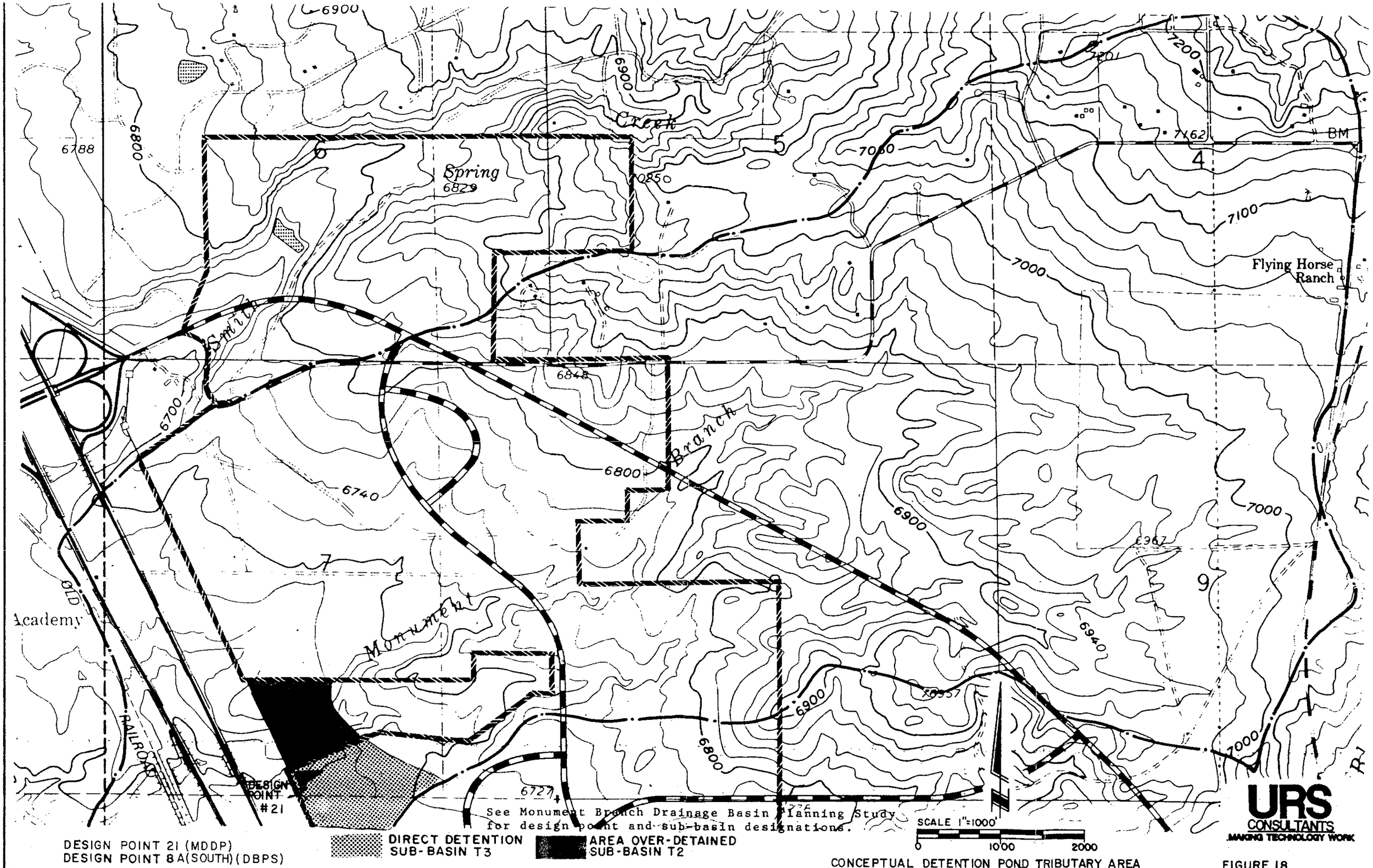
URS CONSULTANTS
MAKING TECHNOLOGY WORK

FIGURE 17



CONCEPTUAL DETENTION POND TRIBUTARY AREA

FIGURE 19



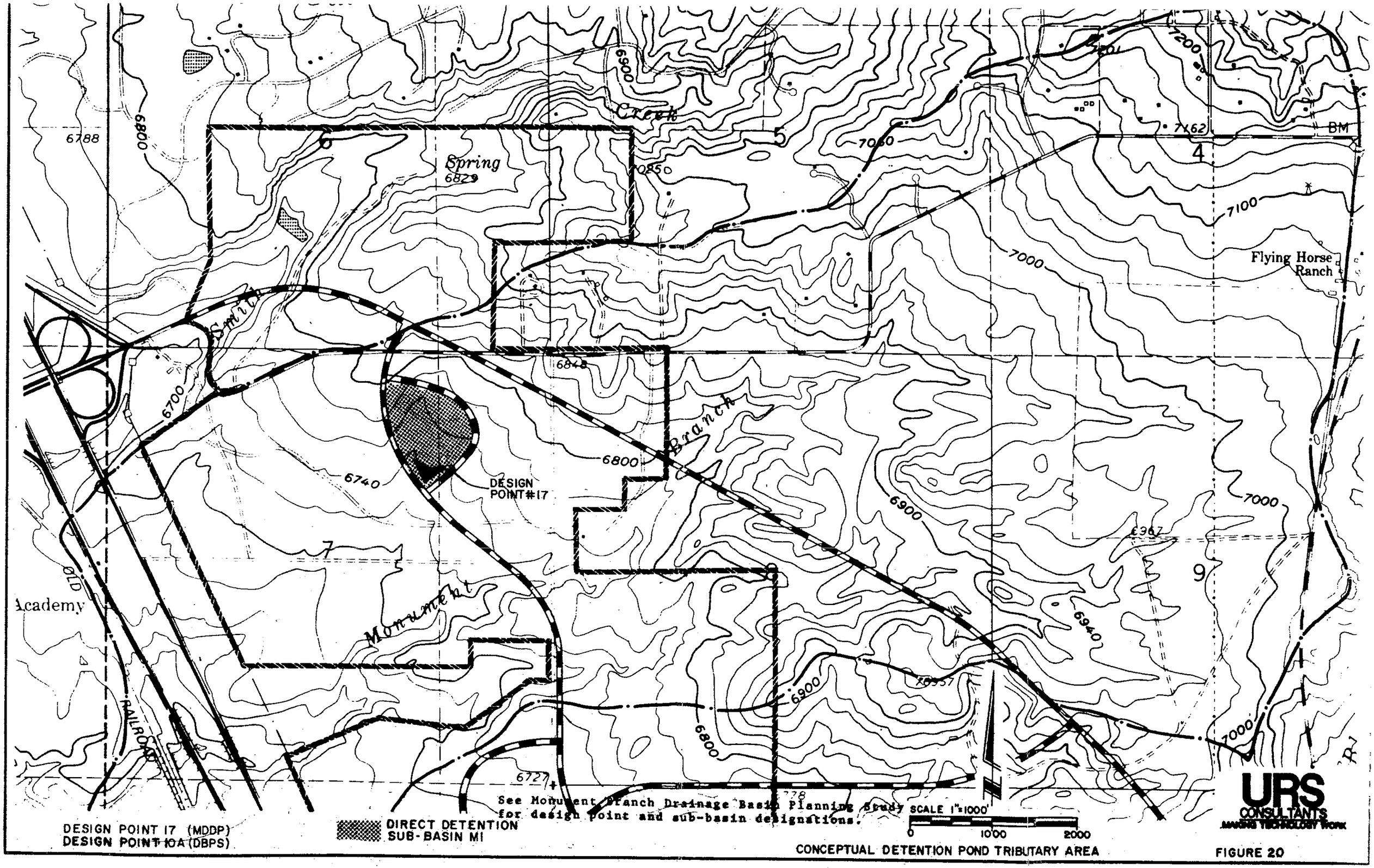
DESIGN POINT 21 (MDDP)
DESIGN POINT 8A(SOUTH)(DBPS)

DIRECT DETENTION
SUB-BASIN T3

AREA OVER-DETAINED
SUB-BASIN T2

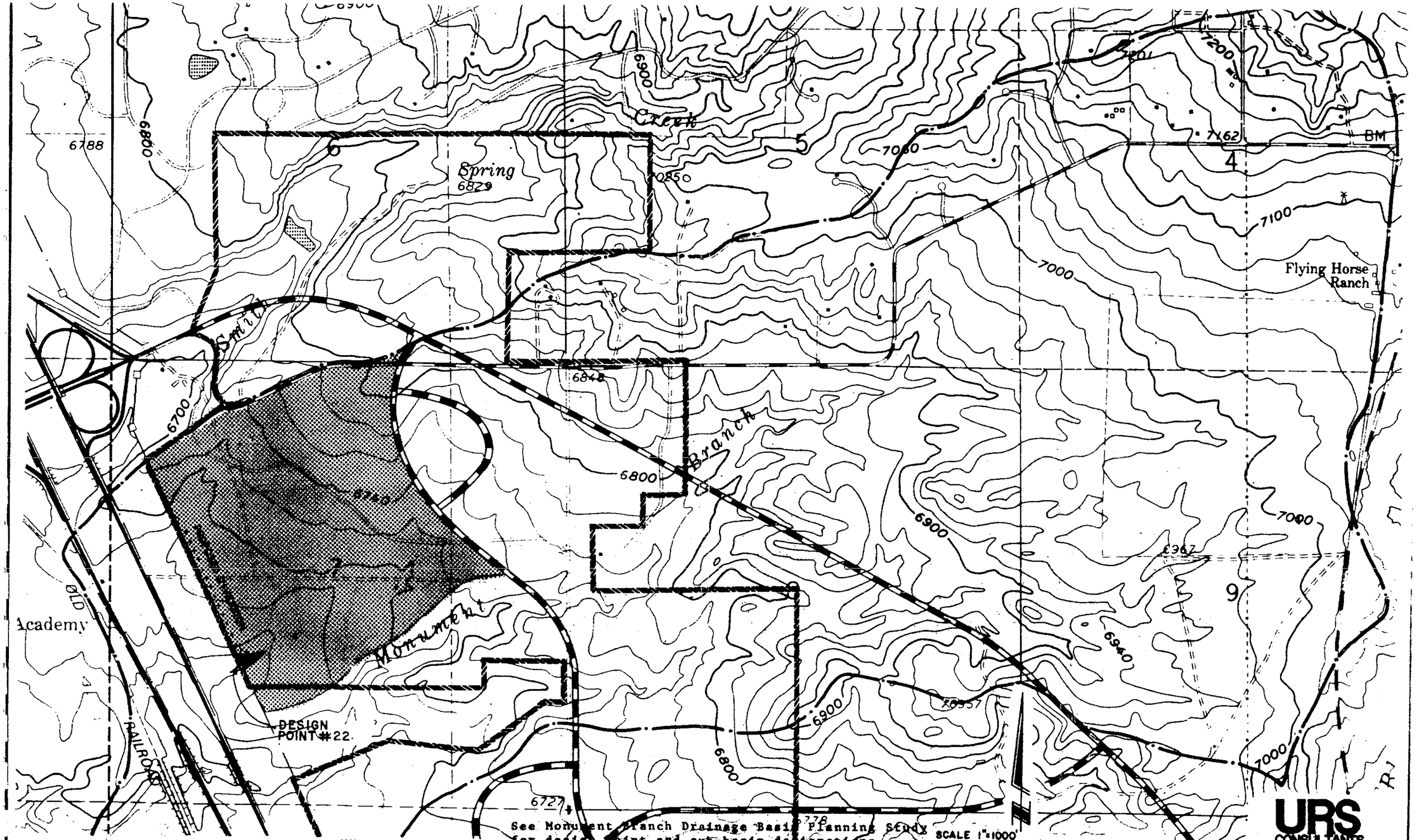
CONCEPTUAL DETENTION POND TRIBUTARY AREA

FIGURE 18



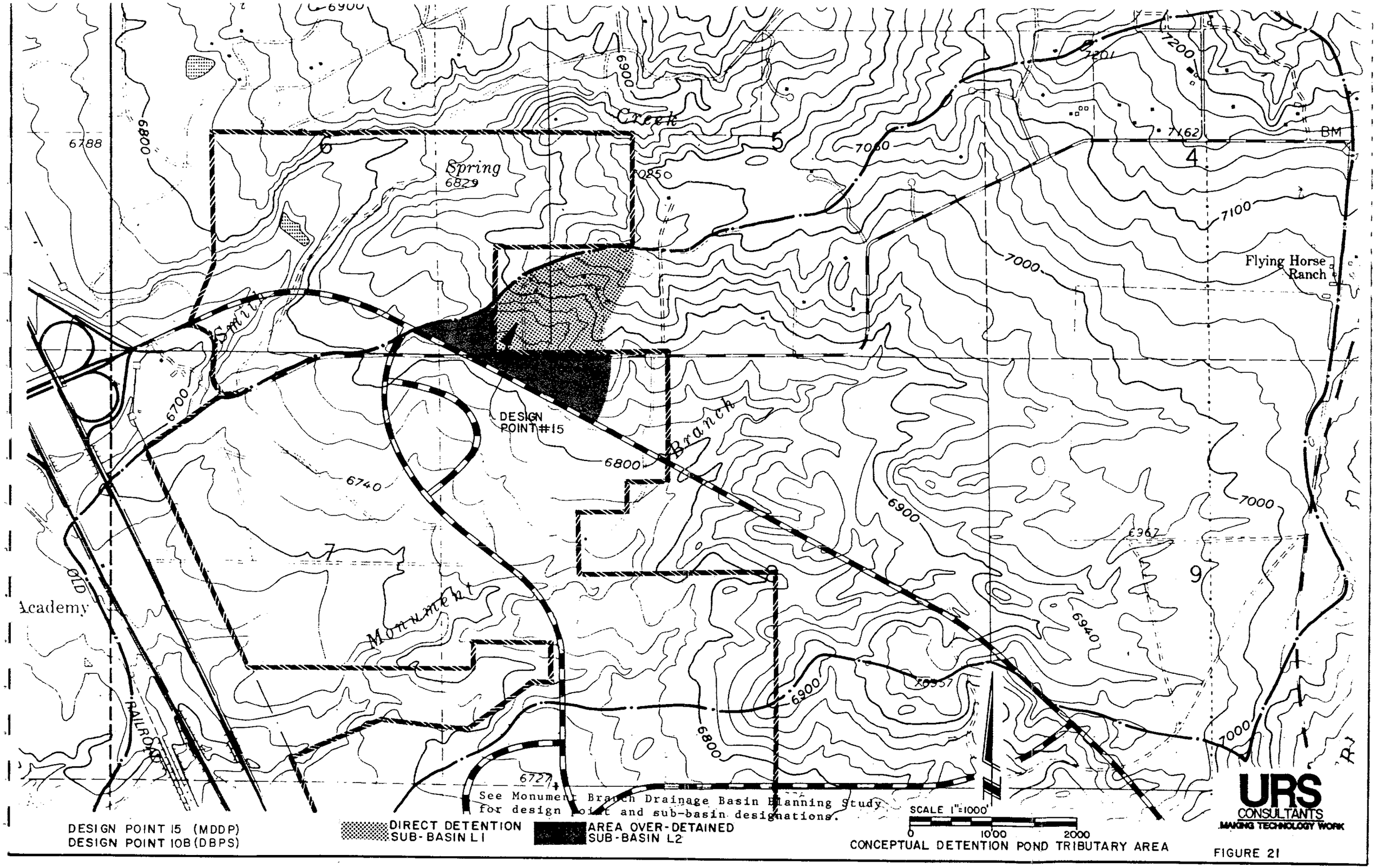
CONCEPTUAL DETENTION POND TRIBUTARY AREA

FIGURE 20



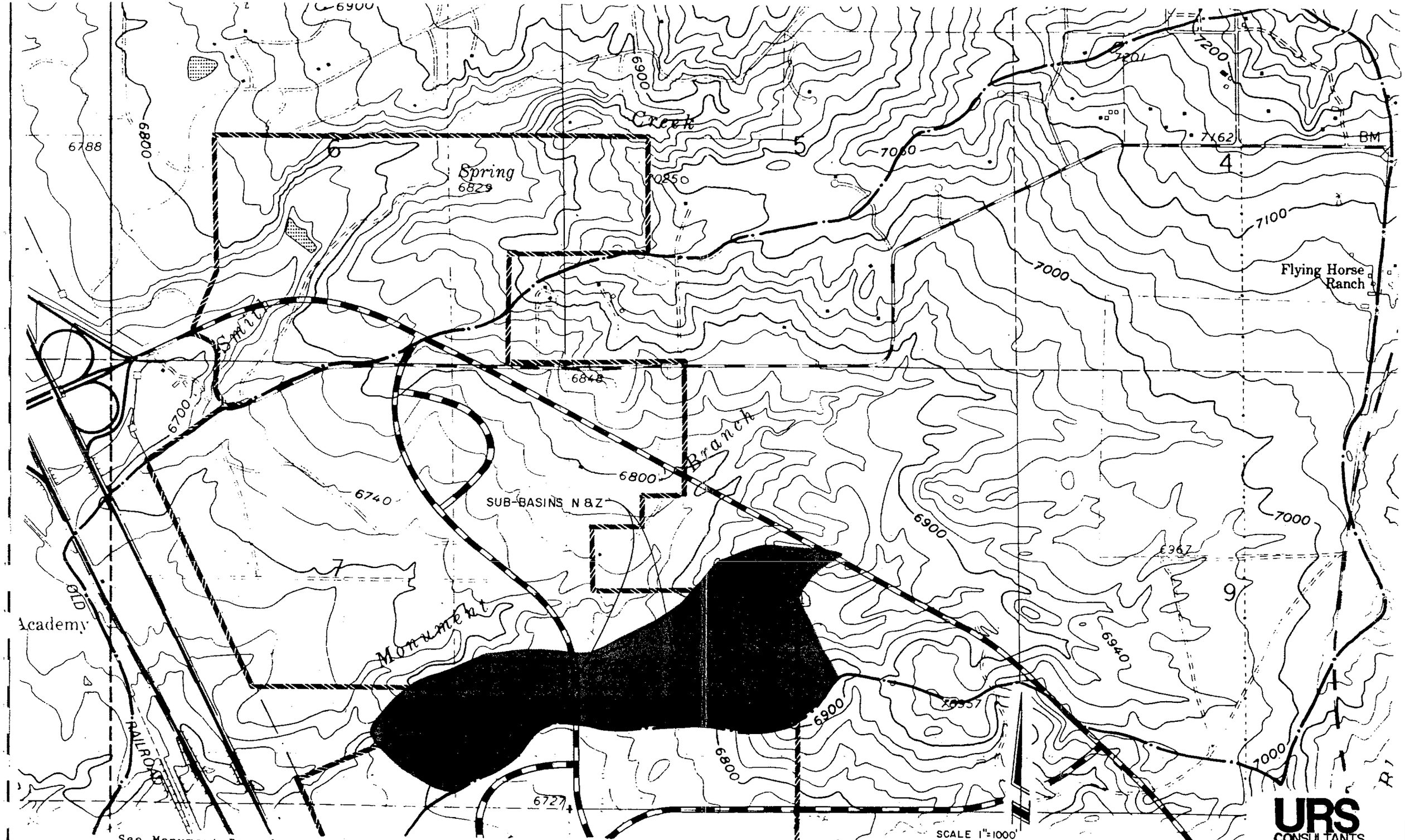
CONCEPTUAL DETENTION POND TRIBUTARY AREA

FIGURE 22



CONCEPTUAL DETENTION POND TRIBUTARY AREA

FIGURE 21



See Monument Branch Drainage Basin Planning Study for design point and sub-basin designations.
DESIGN POINT 6,7(DBPS); SUB-BASINS N &Z (MDDP)

MAINTAINED TO HISTORIC DUE TO DELAYED PEAK FROM UPSTREAM PONDS UNDER FULLY DEVELOPED CONDITIONS. TEMPORARY DETENTION REQUIRED UNTIL FULL DEVELOPMENT.

CONCEPTUAL TEMPORARY DETENTION POND TRIBUTARY AREA

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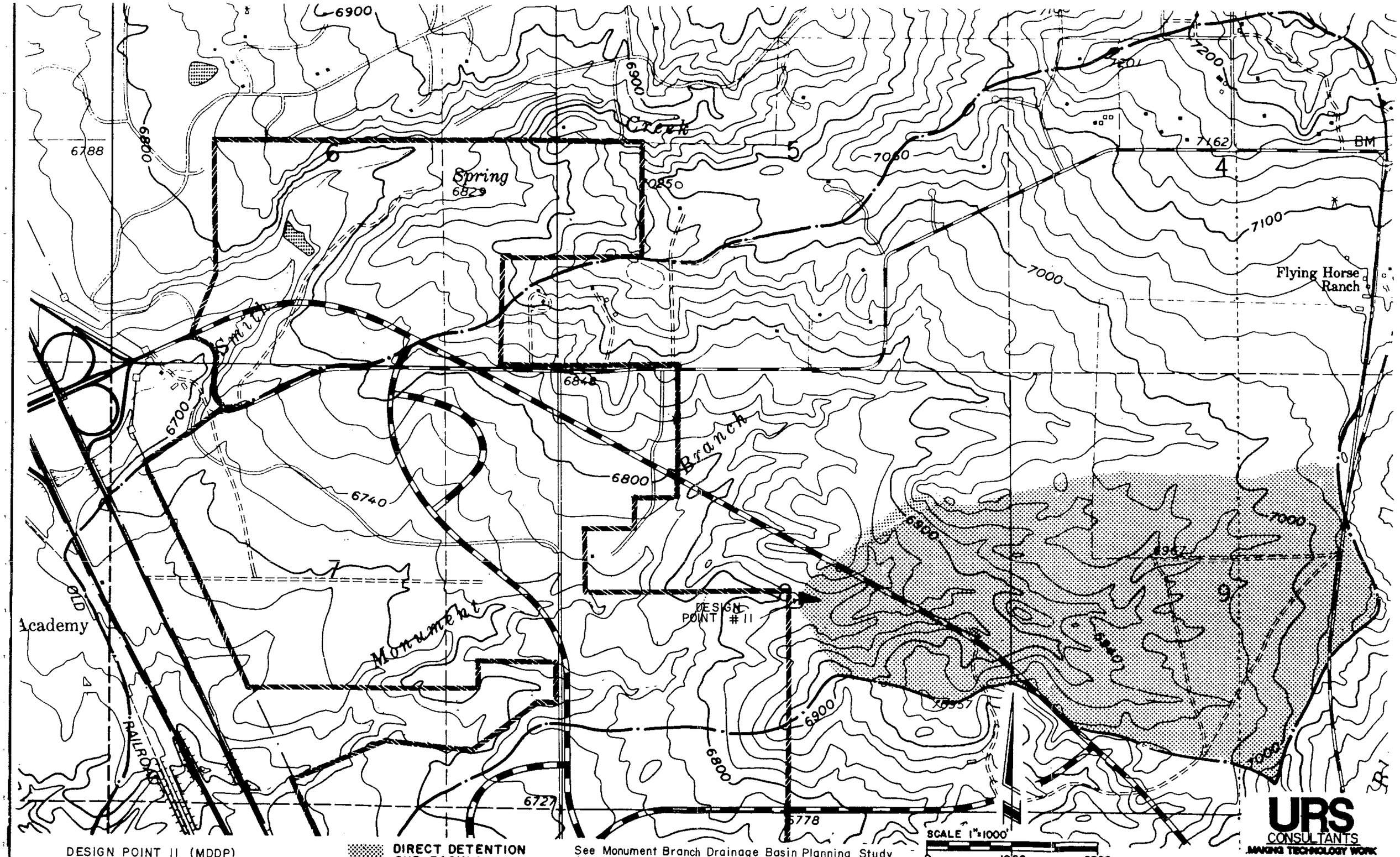
MAKING TECHNOLOGY WORK

FIGURE 23



CONCEPTUAL DENTENTION POND TRIBUTARY AREA

FIGURE 24

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

APPENDIX B: NORTHGATE GEOTECHNICAL REPORT

Geotechnical Consultants, Inc.

December 2, 1987

URS Corporation
5450 Tech Center Drive, #327
Colorado Springs, CO 80919

Re: Geologic Study and Preliminary
Geotechnical Recommendations
Middle Tributary Channel
Northgate Development

Gentlemen:

In accordance with your request, personnel of GCI have performed a preliminary geological and geotechnical study for the Middle Tributary Channel within the Northgate Development. This letter is intended to serve as our preliminary report and contains our preliminary recommendations for development of this channel.

The Middle Tributary Channel consists of a Main Stem which flows through the property, with a substantially smaller northern branch which flows through the property and joins the Main Stem down stream of the property. Several smaller drainages feed the Middle Tributary, and these have not been studied.

The Main Stem crosses the central portion of the Northgate Development near the point of narrowest width. The length of the streambed on the property is approximately 2,000 feet. Below the property, the distance from the property line to Interstate 25 along the channel is approximately 4,000 feet. Based upon the drainage report by URS (April 1987) the maximum 100-year, 24-hour discharge for the Middle Tributary is approximately 1,000 cfs with the peak 100-year, 24-hour discharge on the property itself being approximately 600 cfs. The morphology of the Main Stem is somewhat variable, being relatively steep, narrow and incised in the upper reaches, and being broad and flat through the middle reaches. The channel once again becomes steep and incised in the lower reaches well below the Northgate property as it descends to Monument Creek.

The North Stem of the Middle Tributary is approximately 4,000 feet in length through the property itself, and joins the Main Stem approximately 1,000 feet below the Northgate boundary. The peak 100-year, 24-hour discharge under developed conditions is shown in the drainage report to be approximately 200 cfs at the point where the channel leaves the property. The North Stem generally forms a broad U-shaped valley with a moderate streambed slope. However, at places along the stream, the flows have incised into the streambed a limited extent.

Our geologic research consisted of a review of aerial photography to provide an indication of local geologic units based upon land forms observed on the stereo photographs. The channel was then observed on foot, and the materials identified during this field reconnaissance were compared to the units derived from the aerial photography research. Test borings previously drilled in the vicinity of the channel by GCI were reviewed to determine the type of soil and bedrock encountered at the test boring location.

GEOLOGIC SETTING

Bedrock underlying the Middle Tributary drainage basin consists of the Dawson Arkose formation of Tertiary age. Overlying the bedrock are various surficial deposits which have been placed in more recent geologic times. The mapped and interpreted geologic units are shown on the enclosed Figure I.

The Dawson Arkose is the upper and youngest formation in the Dawson Group. The Dawson Group formations were deposited in ancient times in the Denver Structural Basin, during the uplifting and mountain building along the Front Range. The Dawson Arkose is exposed in several areas along the channels. These exposures indicate that the Dawson Arkose consists of a variable sequence of sandstones, siltstones and claystones. The layers within the formation are typically lensatic and exhibit a high degree of variability, both horizontally and vertically. This is a consequence of the fact that the Dawson formations were laid down by rivers and streams and in small bodies of standing water.

The materials exposed in the Middle Tributary channel indicate that most of the rock is slightly cemented, and of moderate to high density. Desiccation and ravelling of the exposed siltstone and claystone beds indicate that they contain a minor to moderate amount of expansive clay minerals.

Surficial Deposits: The bedrock in the Middle Tributary basin is overlain by alluvial deposits of various ages on different terrace levels. The recent alluvium in the present channel bottom and flood plain is the youngest of these terrace deposits. Generally speaking, the terraces which are topographically higher are the oldest. The alluvial terraces have been deposited by the actions of the Middle Tributary when it flowed at higher levels, and possibly by the actions of Monument Creek, especially in the lower reaches of the basin. The present topography is the result of various episodes of stream cutting and deposition of sediments. During these episodes of erosion and deposition, the stream also cut benches within the flood plain of the stream at that time. More recent episodes of stream action (which have also been generally smaller with the passage of time) have served to modify the older terraces. That is, the older, higher Middle

terraces are partially or wholly disected by younger stream action. The alluvial terrace deposits are composed of a stratified sequence of sands, silts and silty clays.

Along significant portions of the stream channel, the stream banks and slopes are underlain by deposits of colluvium. Colluvium (slope wash) is uncolsolidated surficial deposits which have been placed as a result of wind, surficial sheet flows and gravity. This colluvium overlies the bedrock materials and possibly some older alluvial terrace deposits as well.

Alluvial fan deposits are located adjacent to the stream channel in many areas. These fan deposits generally are the result of debris flow or mudflow from small drainages which discharge into the main channel. In some instances, the alluvial fan has redirected the channel location by "pushing" the flowline of the stream to the side of the valley opposite of the origination of the fan. Typically, fan deposits consist of a jumbled sequence of silty sands and silty clays with scattered rock fragments.

Some eolian or wind deposited sands are indicated within the Middle Tributary basin on the enclosed geologic map. Generally, these sands are located on hilltops and ridgetops rather than being within the channel bed.

Some areas of recent manmade fill were noted to exist within the channel and its floodplain. These fills primarily represent roadway embankments and embankments for small stock ponds. They presumably have been constructed using locally available materials. In most cases, these fills will be removed as a consequence of channel development. Their erosive potential would be expected to be equal to or somewhat greater than that of the alluvial and colluvial native deposits.

EROSION CHARACTERISTICS OF SOIL MATERIALS

The majority of the surficial materials in the channel banks and bed of the Middle Tributary are unconsolidated deposits such as alluvial or colluvial soils. These materials will tend to erode rather rapidly. These deposits will contain a significant quantity of silt and fine sand which are particularly susceptible to erosion. In most cases these unconsolidated surficial deposits will not contain an appreciable percentage of coarse gravel and cobbles which would improve the resistance to erosion and do not contain appreciable cementation or high plasticity binder which might also tend to reduce erosion. Generally speaking, we expect these materials to erode at velocities of between two and three feet per second.

In a somewhat more limited percentage of the streambed, the materials were noted to consist of weathered bedrock. These bedrock materials will be somewhat more resistant to erosion than the unconsolidated surficial deposits. Of the materials within the Dawson Arkose formation, the siltstones will be most erosive. cemented sandstones will be least erosive, and the claystone materials will be somewhere in between. Differentiation of the bedrock units is difficult at the scale and scope of this report, and much of the materials observed were combined rock types, such as clayey siltstone for example. Therefore, we will make no differentiation between the weathered bedrock types in terms of permissive flow velocities. Generally speaking, the weathered bedrock materials should be capable of withstanding flow velocities of between four and five feet per second.

Areas where bedrock materials were exposed in the stream channel are indicated on Figure I. In all other areas, the channel bed and bank materials can be assumed to be unconsolidated surficial deposits.

Observation of the stream on foot will reveal that in many areas in which the bedrock materials are exposed, active erosion is occurring. Conversely, in many areas where the unconsolidated surficial deposits are exposed, the soils are not eroding. This would lead the casual observer to conclude that the bedrock materials are more erosive than the surficial sands. However, we would point out that most areas of bedrock exposure are places where flow velocities are higher, such as in steep channel reaches where headward erosion is occurring, or on the outsides of channel bends. In these areas, the less erosive surficial deposits have been scoured off of the bedrock materials, resulting in bedrock exposure. When the flow velocities have exceeded the permissible velocities of the bedrock materials, erosion has continued within the exposed bedrock.

CHANNEL IMPROVEMENTS

We do not know the specific type of development proposed adjacent to the channel at all reaches, nor do we know the specific visual effect desired from the development. However, in keeping with our understanding of the development goals for Northgate as a whole, we assume that a "planned park" appearance with dressed slopes of variable gradient and grasses and vegetation which will be periodically mowed or otherwise maintained, will probably be used. In conjunction with this, it is possible that public or private trails and recreational use areas may be constructed, possibly with the placement of trees or other vegetation. We assume that a rigid "industrial" type of channel lining, such as concrete or grouted riprap is not desirable aesthetically for this development. We also assume that a "wild" appearance for

the streambed is not aesthetically desirable, either.

In order to maintain the more natural "soft channel" appearance for the development, it will be necessary to selectively reduce the velocities to levels which are acceptable for channel bed and bank materials. The most straightforward method for reducing velocities is by use of grade control structures, or "drops". Good locations for drops are places where headward erosion is presently occurring. We have indicated several significant "headcuts" on the geologic map (Figure I). Drops also will be appropriate in other places where it is desirable to reduce the stream gradient, such as in long, narrow reaches. Grade control structures are probably not necessary in flatter, wider channel reaches where deposition is presently occurring.

Where developed velocities for 100-year peak flow conditions will be less than two to three feet per second, or where velocities are reduced to this magnitude by construction of grade control structures, no erosion protection is necessary. In these areas we recommend seeding and mulching of disturbed or bare slopes to provide revegetation and protection against rain drop or rill erosion. In areas where shallow bedrock materials are exposed, the permissible velocity for unlined channels will be on the order of four feet per second for fully developed, 100-year peak flow conditions.

Where velocities are expected to be higher than the values specified in the preceeding paragraph, some form of channel protection will be required. Flow velocities can probably be reduced to the point where the establishment of grasses will provide suitable erosion protection. We suggest that this be accomplished in conjunction with a suitable erosion control fabric or mat to retain the soil until the grass root system can be established, and to interlock with the root system to provide additional strength and erosion resistance. Two types of erosion control mat are Enkamat and Miramat. Based upon manuracturer's literature, these materials, when used in conjunction with grass revegetation, are capable of withstanding velocities on the order of ten feet per second or greater. However, we feel that an average velocity on the order of six feet per second or less is probably more realistic for most applications.

Perhaps the most significant consideration in achieving satisfactory performance from erosion control products is the treatment of edges and joints of the material, and proper anchorage of the material to the slope. Boundaries and transitions appear to be the weak link in any type of channel protection. The manufacturer will have details illustrating their recommended procedures for installation of their product. The actual construction should meet or exceed the requirements on these details.

At the outside of bends in the stream, the flow velocity will be higher than the average stream velocity, and scour or accelerated erosion is a potential problem. The manufacturer's literature for the Enkamkat and Miramat products would seem to indicate that these products can withstand the higher velocity. However, extreme caution is required to obtain an acceptable toe depth for bank lining, and proper joints and transitions within the slope protection are necessary to prevent the channel lining from being "outflanked" by the flows. A more substantial lining, such as buried riprap could be used in these locations, but again the critical factor will be the depth of the lining at the toe. As an alternative to channel lining for bank protection at the outsides of bends, a series of small groins could be placed against the bank to deflect water away from the bank, and thereby protect against erosion on the outside of bends.

While the use of grade control structures, the proper establishment of vegetation, and the possible use of erosion control netting can serve to reduce or eliminate erosion resulting from flows within the stream channel, there is also a potential for concentrated flows entering the channel at various points and causing localized erosion. This can be seen to be the case presently, as numerous small gullies and rills exist in the channel banks. This will become even more of a concern as the site is developed and concentrated discharges from drainage improvements are introduced into the channel. For these reasons, we recommend that drainage from the area adjacent to the channel be controlled in ditches or swales such that it does not enter the channel except at specific, planned locations. At these locations the flow should be discharged into the channel such that erosion does not occur. If stone or gabion drop structures are used, concentrated flows can probably be discharged onto these structures, and thereby dissipate energy. Alternatively, some sort of riprap bed or energy dissipating basin could be used for discharge of concentrated flows.

In addition to the concerns previously described for erosional stability, it will be necessary to develop the channel banks in such a manner that the gross stability against slope failure is acceptable. For these low banks, which typically are less than ten feet in height, a slope of three horizontal to one vertical should be acceptably stable for surficial deposits. The weathered bedrock materials can probably stand at steeper slopes, with face slope angles of 1.5 horizontal to 1 vertical probably being acceptable for the claystone and siltstone materials. It may be possible to leave some weathered bedrock outcrops at steeper angles, providing any trails, drainage swales or other improvements are set back to a location well behind the 1.5 to 1 slope plane.

A few areas of active seepage were identified during our field reconnaissance. These seeps will probably not exert hydrostatic pressure against the channel lining, due to the open, permeable nature of the linings which will probably be used. However, the seeps are of concern from a slope stability standpoint. If an area of active seepage becomes blocked during construction activities, the buildup of hydrostatic pressures behind the blockage will reduce the stability of the slope. Small drains of crushed rock or synthetic drainage products may be necessary where fill is placed over the seep areas.

It is believed that this report covers the erosion and stability characteristics of this channel in brief, as well as stating our interpretation of existing soil and geological conditions. While the discussion of the characteristics of various materials is somewhat general, application of our recommendations to the actual design of the channel should not be difficult. We request the opportunity to review and comment on the ultimate design, as well as the opportunity to inspect during construction to more accurately determine the extent of various soil and rock materials as grading is being performed.

Should you have any questions, or should additional discussion be required on any of the points covered in this report, please feel free to contact GCI at your convenience.

Respectfully submitted,

GEOTECHNICAL CONSULTANTS, INC.

By: John W. Himmelreich, Jr.
Professional Geologist

By: Robert L. Bass, P. E.

COLORADO REGISTERED
ROBERT L. BASS
18669
PROFESSIONAL ENGINEER

JWH/RLB/kk
GCI Job No. 2845

Geotechnical Consultants, Inc.

December 2, 1987

URS Corporation
5450 Tech Center Drive, #327
Colorado Springs, CO 80919

Re: Geologic Study and Preliminary Geotechnical Recommendations
Monument Branch Channel

Gentlemen:

As requested, personnel of GCI have performed a preliminary geological and geotechnical study for the Monument Branch Channel within the Northgate property. This letter is intended to serve as our preliminary report and contains our preliminary recommendations.

The Monument Branch Channel consists of a north and south tributary. The north tributary consists of an incised, flat and sandy bottomed stream channel. Parts of the channel bottom are heavily vegetated with willows and grasses while other reaches are sparsely vegetated. The width of this channel above the confluence ranges from about 15 feet in the extreme northern portion of the channel to as much as about 100 feet at a few locations. The gradient of this north tributary ranges from about 1-1/2% to 4%, but typically is in the range of 2-3%. The normal base flow in this stream is very slight and consists of a small trickle. In some areas of the stream, where the bottom is very sandy, this free water disappears underground and then resurfaces at some points in the stream. This disappearance of the free water and resurfacing occurs at a few locations along the reach observed. Since this tributary is incised into the soils and rock deposits, the height of the stream banks and steepness vary widely. Above the banks the native ground surface consists of gently to moderately sloping, rolling terrain, which is moderately to heavily vegetated with scrub oak, grass areas and pines. The total fall of the channel through the reach observed is on the order of 170 feet.

The southern tributary of the Monument Branch Channel varies from an incised, flat and sandy bottomed stream channel to a broad, grassy swale. The width of the incised portion of the channel varies from about 10 feet to almost 100 feet. The broad swale is approximately 200 feet wide in places. Below the confluence of the two channels, the stream bottom and physiographic flood plain is almost 200 feet wide at its widest point. This south tributary has similar gradients to the north tributary, ranging from about 1-1/2 to 4%. Only a very limited portion of this tributary was noted to contain base flow. This consisted of a very slight trickle in the lower reaches of the stream. In the upper reaches

of the stream, the bottom is very sandy and no free water was observed. The banks of the stream are highly variable because of the incised nature of this tributary. They range from a few feet in height to ten feet or greater. Above the banks, the native ground surface consists of gentle to moderate sloping, rolling terrain. Along much of the channel, especially in the upper part, surrounding terrain is moderately to heavily vegetated with grasses, scrub oak and pine. The total fall of the stream through the reach observed is on the order of 180 feet.

Our geologic research consisted of a review of aerial photography to provide an indication of local geologic units based upon landforms observed on the stereo photographs. The channel was then observed on foot and the materials identified in this field reconnaissance were compared to the units derived from the aerial photography research. Test borings previously drilled in the vicinity of the channel by GCI were reviewed to determine the type of soil and bedrock encountered at the test boring location.

GEOLOGIC SETTING

Bedrock underlying the Monument Branch Channel area consists of the Dawson Arkose of Tertiary age. Overlying the bedrock are various surficial deposits which have been deposited in more recent geologic times. The mapped and interpreted geologic units are shown on the enclosed Figure I.

The Dawson Arkose is the upper and youngest formation in the Dawson Group. The Dawson Group formations were deposited in ancient times in the Denver Structural Basin, during the uplifting and mountain building along the Front Range. The Dawson Arkose is exposed in several areas along the channels. These exposures indicate that the Dawson Arkose consists of a variable sequence of sandstones, siltstones and claystones. The layers within the Dawson Arkose are typically lensatic and exhibit a high degree of variability, both horizontally and vertically. This is a consequence of the fact that the Dawson was laid down by rivers and streams and in small bodies of standing water.

The various exposed bedrock materials indicate that most of the rock is only slightly cemented, but is typically very dense. Desiccation and ravelling of the claystone beds indicate that they contain expansive clay minerals.

Surficial Deposits: Bedrock along the stream channel is overlain by alluvial deposits of various ages on different terrace levels. The recent alluvium in the present flood plain is the youngest of these terraces, the highest terraces being the oldest. These alluvial terraces were deposited by actions of the Monument Branch Channels when they flowed at higher levels. In some

cases, it appears that the stream cut terraces, depositing only thin sediments. In most cases however, it appears that the stream deposited significant thicknesses of alluvial soils. During various episodes of stream erosion and deposition, the stream also cut benches within the flood plain of this stream at that time. Younger episodes of stream action (which have also been generally smaller with the passage of time) have served to modify the older terraces. That is, the older, higher terraces are partially or wholly disected by younger stream action. These terrace deposits are composed of a stratified sequence of sands, silts and clays.

Colluvium (slope wash) is unconsolidated surficial deposits which have been deposited as a result of wind, sheet wash, water and gravity. Along sizable portions of the stream channel, some of the stream banks and slopes are underlain by these surficial deposits. The colluvium mantles the underlying bedrock and possibly some older terrace deposits.

EROSION CHARACTERISTICS OF SOIL MATERIALS

The majority of the surficial materials in the channel banks and bed are unconsolidated deposits which will tend to erode rather rapidly. These would include the alluvial and colluvial soils of the Quaternary Period (most recent in terms of geologic time) described in the previous section. These materials contain a significant quantity of silt and fine sand which are susceptible to erosion. In most cases they will not contain an appreciable percentage of coarse gravel and cobbles which would improve the resistance to erosion and do not contain appreciable cementation or high plasticity binder which might also tend to reduce erosion. Generally speaking, we would expect these materials to erode a velocities of between two and three feet per second.

In a limited percentage of the streambed, the materials were noted to consist of weathered bedrock. The weathered bedrock materials will be somewhat more resistant to erosion than the unconsolidated surficial deposits. Of the materials within the Dawson Arkose formation, the siltstones will be most erosive. Cemented sandstones will be least erosive, and the claystone materials will be somewhere in between. Differentiation of the bedrock units is difficult at the scale and scope of this report, and much of the materials observed were combined rock types, for example, clayey siltstone. Therefore, we will not differentiate between weathered bedrock types in terms of permissive flow velocities. Generally speaking, the weathered bedrock materials should be capable of withstanding flow velocities of between four and five feet per second.

Areas where bedrock materials were exposed in the stream channel are indicated on Figure I. In all other areas, the channel bed and bank materials can be assumed to be unconsolidated surficial deposits.

Observation of the stream on foot will reveal that in many areas where the bedrock materials are exposed, active erosion is occurring. Conversely, in many areas where the unconsolidated surficial deposits are exposed, the soils are not eroding. This would lead the casual observer to conclude that the bedrock materials are more erosive than the surficial sands. However, we would point out that most areas of bedrock exposure are places where flow velocities are higher, such as in steep channel reaches where headward erosion is occurring, or on the outsides of channel bends. In these areas, the less erosive surficial deposits have been scoured off of the bedrock materials, resulting in bedrock exposure. When the flow velocities exceed the permissible velocities of the bedrock materials, erosion will continue to occur within the exposed bedrock.

CHANNEL IMPROVEMENTS

We do not know the specific type of development proposed adjacent to the channel at all reaches, nor do we know the specific visual effect desired from the development. However, in keeping with our understanding of the development goals for Northgate as a whole, we assume that a "planned park" appearance with dressed slopes of variable gradient and grasses and vegetation which will be periodically mowed or otherwise maintained, will probably be used. In conjunction with this, it is possible that public or private trails and recreational use areas may be constructed, possibly with the placement of trees and other vegetation. We assume that a rigid "industrial" type of channel lining, such as concrete or grouted riprap is not desirable aesthetically for this development. We also assume that a "wild" appearance for the streambed is not aesthetically desirable, either.

In order to maintain the more natural "soft channel" appearance for the development, it will be necessary to selectively reduce the velocities to levels which are acceptable for the proposed channel bed and banks. The most straightforward method for accomplishing this is by the use of grade control structures, or "drops". These should, quite obviously, be constructed at areas where headward erosion is presently occurring. Drops also will be appropriate in other places where it is desirable to reduce flow velocities, such as in long, narrow reaches of flatter gradient. Grade control structures are probably not necessary in flatter, wider channel reaches where deposition is presently occurring.

Where developed velocities for 100-year peak flow conditions will be less than two to three feet per second, or where velocities are reduced to this magnitude by construction of grade control structures, no erosion protection is necessary. In these areas we would recommend seeding and mulching of disturbed or bare slopes to provide revegetation and protection against rain drop or rill erosion. In areas where shallow bedrock materials are exposed, the permissible velocity for unlined channels will be on the order of four feet per second for fully developed, 100-year peak flow conditions.

Where velocities are expected to be higher than the values specified in the preceeding paragraph, some form of channel protection will be required. Flow velocities can probably be reduced to the point where the establishment of grasses will provide suitable erosion protection. We would suggest that this be accomplished in conjunction with a suitable erosion control fabric or mat to retain the soil until the grass root system can be established, and to interlock with the root system to provide additional strength and erosion resistance. Two types of erosion control mat are Enkamat and Miramat. Based upon manuracturer's literature, these materials, when used in conjunction with grass revegetation, are capable of withstanding velocities on the order of ten feet per second or greater. However, we feel that an average velocity on the order of six feet per second or less is probably more realistic for most applications.

At the outside of bends in the stream, the flow velocity will be higher than the average stream velocity, and scour or accelerated erosion is a potential problem. The manufacturer's literature for the Enkamkat and Miramat products would seem to indicate that these products can withstand the higher velocity. However, extreme caution is required to obtain an acceptable toe depth for the material, and proper joints and transitions within the bank protection are necessary to prevent the channel lining from being "outflanked" by the flows. A more substantial lining, such as buried riprap could be used in these locations, but again the critical factor will be the depth of the lining at the toe. As an alternative to channel lining for bank protection at the outsides of bends, a series of small groins could be placed against the bank to deflect water away from the bank and, thereby, protect against erosion on the outside of bends.

As has been implied above, the crucial considerations in achieving satisfactory performance from erosion control products is the treatment of the edges and joints of the material, and proper anchorage of the material to the slope. Boundaries and transitions appear to be the weak link in any type of channel protection. The manufacturer will have details illustrating proper installation of various erosion control products, and the actural

construction should meet or exceed the requirements on these details.

While the use of grade control structures, the proper establishment of vegetation, and possible use of erosion control netting can serve to reduce or eliminate erosion resulting from flows within the stream channel, there is also a potential for concentrated flows entering the channel at various points and causing localized erosion. This can be seen to be the case now, as numerous small gullies and rills exist in the channel banks. This will become even more of a concern as the site is developed and concentrated discharges from drainage improvements are introduced into the channel. For these reasons, we recommend that drainage from the area adjacent to the channel be controlled in ditches or swales such that it does not enter the channel except at specific, planned locations. At these locations the flow should be discharged into the channel such that erosion does not occur. If stone or gabion drop structures are used, concentrated flows can probably be discharged onto these structures, thereby dissipating energy. Alternatively, some sort of riprap bed or energy disipating basin could be used for discharge of concentrated flows.

In addition to the concerns previously described for erosional stability, it will be necessary to develop the channel banks in such a manner that the gross stability against slope failure is acceptable. For these low banks, which typically are less than ten feet in height, a slope of three horizontal to one vertical should be acceptably stable for the surficial deposits. The weathered bedrock materials can probably stand at steeper slopes, with face slope angles of 1.5 horizontal to one vertical probably being acceptable for the claystone and siltstone materials. It may be possible to leave some weathered bedrock outcrops at steeper angles, providing any trails, drainage swales or other improvements are set back to a location well behind the 1.5 to 1 slope plane.

Numerous areas of active seepage were identified during our field reconnaissance. These seeps will probably not exert hydrostatic pressure against the channel lining, due to the open, permeable nature of the linings which will probably be used. However, the seeps are of concern from a slope stability standpoint. If an area of active seepage becomes blocked during construction activities, the buildup of hydrostatic pressures behind the blockage will reduce the stability of the slope. Small drains of crushed rock or synthetic drainage products may be necessary where fill is placed over the seep areas.

It is believed that this report covers the erosion and stability characteristics of this channel in brief, as well as stating our

interpretation of existing soil and geological conditions. While the discussion of the characteristics of various materials is somewhat general, application of our recommendations to the actual design of the channel should not be difficult. We request the opportunity to review and comment on the ultimate design, as well as the opportunity to inspect during construction to more accurately determine the extent of various soil and rock materials as grading is being performed.

Should you have any questions, or should additional discussion be required on any of the points covered in this report, please feel free to contact GCI at your convenience.

Respectfully submitted,

GEOTECHNICAL CONSULTANTS, INC.

By: John W. Himmelreich, Jr.
Professional Geologist

By: Robert L. Bass, P. E.

COLORADO REGISTERED
ROBERT L. BASS
18669
PROFESSIONAL ENGINEER

JWH/RLB/kk
GCI Job No. 2844

NORTHGATE MASTER DEVELOPMENT DRAINAGE PLAN

APPENDIX C: DRAINAGE BOARD MINUTES FOR SEPTEMBER 17, 1987

M I N U T E S

City of Colorado Springs/El Paso County

Drainage Board

for September 17, 1987

The City of Colorado Springs/El Paso County Drainage Board held its regularly scheduled meeting at 2:20 PM on September 17, 1987 in the City Council Chambers, City Administration Building, 30 South Nevada Avenue.

MEMBERS PRESENT	MEMBERS ABSENT	OTHERS PRESENT
Richard Dailey, Chairman	Fred Gibson	Gary Haynes
Roland Obering		Chris Smith
Ron Waldthausen		Tom Woodbury
Mike Mallon		Alan Morrice
Rick Brown		Kevin Walker, The Olive Co.
Guenther Polok		Tom Taylor, Peregrine JR Engineering

Mr. Dailey informed the Board that Item 8 has been withdrawn by the applicant for action at this meeting. Mr. Dailey also informed the Board that Item 10 on the agenda will be moved up and replace Item 8 as listed on the agenda. Items 9 and 11 as shown on the agenda would be heard after Item 10. Items 2 through 7 as listed on the agenda would still be heard as consent items.

Item 1

Approval of the minutes of the August 20, 1987 Board Meeting. The minutes were previously mailed out. Mr. Waldthausen stated to the Board that the minutes of the August 20, 1987 Board Meeting accurately reflected his motion on Item 5. The motion, as presented by Mr. Waldthausen, was to approve the agreement per staff recommendation.

Mr. Waldthausen made a motion to approve the minutes as presented. Mr. Obering seconded the motion. The motion passed with a unanimous vote.

Items 2 through 7 were heard as consent items by the Board.

Mr. Mallon abstained from discussion and voting on Items 3 and 7. Mr. Obering abstained from discussion and voting on Items 5, 6 and 7.

Item 2

Request for cash reimbursement for construction of drainage facilities within Auto Center Filing No. 1, Bear Creek Basin, Langford-Delay & Associates, Inc., Developer, 5360 North Academy Boulevard, Colorado Springs, CO, 80918.

Item 3

Request for cash reimbursement for construction of drainage facilities within Mount Washington Industrial Park Filings 1 through 4, Miscellaneous Basin, Fifteen Limited, Developer, 2110 Hollowbrook Drive, Colorado Springs, CO, 80918.

Item 4

Request for cash reimbursement for construction of drainage facilities within Old Farm Center Subdivision, Templeton Gap Basin, Langford-Delay & Associates, Inc., Developer, 5360 North Academy Boulevard, Colorado Springs, CO, 80918.

Item 5

Request for cash reimbursement for construction of drainage facilities within Pinehurst Station Filings 1 through 4 and 6, Miscellaneous Basin, RMC Corporation, Developer, P. O. Box 908, Colorado Springs, CO, 80901.

Item 6

Request for cash reimbursement for construction of drainage facilities within Pinehurst Station Filings 1, 3, 4, 5, & 7, Peterson Field Basin, RMC Corporation, Developer, P. O. Box 908, Colorado Springs, CO, 80901.

Item 7

Request for cash reimbursement for construction of drainage facilities within Briargate Subdivision Filing No. 37, Cottonwood Drainage Basin, Briargate Joint Venture, 7710 North Union Boulevard, Colorado Springs, CO, 80918.

Mr. Brown made a motion to approve the staff recommendations for Items 2 through 7. Mr. Waldthausen seconded the motion. The motion passed with a unanimous vote.

Item 8 was postponed per request of the applicant.

Item 10

Presentation to the Board for action of the Middle Tributary and Monument Branch Master Drainage Basin Reports as prepared by URS Corporation for The Olive Company.

Mr. Morrice recommended to the Board that concurrence of the Colorado State Highway Department and the adjacent landowners be obtained for both the Middle Tributary and Monument Branch Drainage Studies prior to County Board action. County staff also recommended that the City park land dedication fee be used as a basis for the detention pond land reimbursement.

City staff recommendations were the same as the County staff recommendations.

City staff recommended to the Board that the Middle Tributary Master Drainage Basin Study and Monument Branch Master Drainage Basin Study be acted upon separately.

Mr. Kevin Walker, representing The Olive Company, stated to the Board that only two remaining issues required discussion for both the Monument Branch and the Middle Tributary Basin Studies. The first issue was that of reimbursement for land used in connection with detention pond facilities. Mr. Walker stated that he has revised the land fee discussion in both the Middle Tributary and Monument Branch Drainage Studies to reflect a fee reimbursement based upon the City park land dedication fee of $15,600 per acre. The second item remaining to be resolved was the concurrence of the major property owners adjacent to the Northgate Development in both the Middle Tributary and Monument Branch Basins. Mr. Walker presented to the Board Members a letter from Thomas W. Blake, a major landowner to the east of the Northgate Development, concurring with the two drainage reports on the agenda today (see attachments). Mr. Walker also introduced Mr. Bob Stout, private landowner in the Monument Branch Basin, who was present at the meeting to answer any questions the Board may have concerning this item. Mr. Stout owns approximately 60 acres of ground downstream of the Northgate property within the Monument Branch Basin. Mr. Walker also stated that the United States Air Force Academy is reviewing the study at present and indicated that they would accept historic flows only onto their property. Mr. Walker also informed the Board that Mr. Ray Brown of the Colorado State Highway Department indicated that they are reviewing both master drainage basin studies and that they will accept only historic flows onto the right-of-way. Both the Monument Branch and the Middle Tributary use detention to assure that no flow over historic enters the state right-of-way or the United States Air Force Academy.

Mr. Bob Stout, representative and part owner of the 60 acres of land adjacent to the Northgate Development, addressed the Board

concerning master drainage basin studies. Mr. Stout stated that he concurred with the master drainage basin study with the stipulation that no flow over historic enters his property.

At the staff's request, Mr. Kevin Walker stated that no flow over historic would enter the 60 acres of ground presently owned by Mr. Bob Stout.

Mr. Tom Woodbury, from the City Attorney's Office, and Mr. Gary Haynes indicated to the Board that a revision to the drainage ordinance regarding reimbursement for land used for public detention ponds would have to precede both the Monument Branch and Middle Tributary Studies prior to Council action. Specifically, an ordinance amending the existing drainage ordinance approving the reimbursement for land for detention ponds must precede the Council actions on the approval of the Monument Branch and Middle Tributary Drainage Studies. All three items can be heard at the same Council meeting.

Mr. Walker agreed that the ordinance change needs to precede Council approval of both Monument Branch and Middle Tributary Drainage Basin Studies. Mr. Walker stated that he understood this may entail a time delay on the submittals of the two drainage reports to Council.

City/County Drainage Board and staff discussed the collection, accounting, and reimbursement of the proposed land fee used in connection with detention ponds. Both the Board Members and staff agreed that the fees for the detention pond land and the drainage fee would be calculated and adjusted as separate items, but would be collected and deposited as a single fee. Reimbursements for the total of land and drainage structures would be disbursed on a prorata basis dependent upon the funds available in the basin accounts.

Mr. Brown made a motion to approve the Middle Tributary Master Drainage Basin Report with the drainage basin fee comprised of two components; drainage construction costs set at $2,766.00 per acre and drainage land costs at $228.00 per acre, for a total of $2,994.00 per acre. Mr. Polok seconded the motion. Mr. Brown amended the motion to include the condition that City Council and the Board of County Commissioners change their respective ordinance and resolution to include the reimbursement of land for detention facilities. Mr. Polok seconded the amended motion. The motion passed with a unanimous vote. The Board heard a motion by Mr. Brown to approve the Monument Branch Master Drainage Study with the drainage fee at $3,737.00 per acre and a land fee set at $181.00 per acre, resulting in a total fee of $3,918.00 per acre conditioned on City Council and the Board of County Commissioners' approval of a new ordinance and/or resolution allowing for the reimbursement of land costs for detention facilities. Mr. Polok seconded the motion. The motion

passed with a unanimous vote.

The Board then heard a motion by Mr. Obering that as part of the ordinance change for the City and resolution change for the County the drainage land category be established in addition to the unit drainage fee; that they be separately collected on a per acre basis, deposited in one account, and disbursed from that account on a priority, funds-available, prorate basis. Mr. Mallon seconded the motion. The motion passed with a unanimous vote.

Item 9

Mr. Mallon and Mr. Obering excused themselves from the meeting for Items 9 and 11 as shown on the agenda.

Presentation to the Board for action of the North Basin Master Drainage Plan as prepared by JR Engineering, Ltd. for Peregrine Joint Venture.

Mr. Tom Taylor, representing Vintage Properties, addressed the Board and requested that the North Basin be a closed basin. Vintage Properties proposes to use regional detention within the North Basin to insure that flows leaving the site are at or below historic. The concept of regional detention is in conformance with the KKBNA master basin drainage report and the revision to the KKBNA master drainage report as prepared by JR Engineering.

Mr. Morrice stated to the Board that he has at this time not had an opportunity to review the study. Based upon the information presented at this meeting, Mr. Morrice was in general agreement with the concept of detaining to historic levels within this basin provided County staff has an opportunity to review the study including the detailed plans for the pond and outfall structure.

After further discussion, the Board heard a motion by Mr. Waldthausen to approve the staff's recommendation for this item with the condition that the County staff has an opportunity to review and approve the construction plans for the detention pond to include the outfall rate and form. The motion was seconded by Mr. Guenther Polok. The motion passed with a unanimous vote.

Item 11

Presentation to the Board for action of the Pine Creek Master Drainage Basin Report as prepared by Obering, Wurth & Associates for Briargate Development Group.

Mr. Haynes stated to the Board that two policy issues were in contention at this time. The first issue relates to the use of 35% on-site detention and the second issue was the proposed

Academy Boulevard box culvert crossing funding as shown in the Pine Creek Master Drainage Report. Mr. Haynes stated that, in the staff's opinion, neither of these two issues were Drainage Board responsibilities. Mr. Haynes stated that the 35% on-site detention and the Academy Boulevard box culvert crossing funding are administrative and City Council responsibilities. Mr. Haynes indicated to the Board that, if the two items in contention were removed from the Pine Creek Master Drainage Report, staff could support the technical merits of the study.

Mr. Waldthausen asked City staff if the two major issues discussed were omitted from the plan, what impact on the study would this have?

Mr. Haynes stated that the facilities as shown on the existing master plan would have to be enlarged to handle the new design flows and that the funding for the Academy Boulevard box culvert could be resolved separately. Mr. Haynes stated that the staff is in agreement with the use of the five year criteria for this master drainage study due to the fact that the study was initiated over two years ago prior to the introduction of a new ten year criteria.

Mr. Morrice addressed the Board and stated it was the County staff's opinion that the proposed 35% on-site detention should not be utilized because it is not in conformance with present policies. The County staff recommended that any ponds used be in general conformance with the new City/County Drainage Manual which proposes regional detention. Mr. Morrice also stated that the County has concerns regarding the proposed funding for the box culvert crossing under Academy Boulevard.

Mr. Dailey, Board Chairman, stated, in his opinion, he believed the issues as brought forth by both City and County staff and developer should at least be heard by the Board at this time. Mr. Dailey stated the Board may or may not take action on the item dependent upon presentation and any legal advice presented by the City Attorney's Office. All Board Members concurred with Mr. Dailey's opinion.

Mr. Lew Christiansen, President of Vintage Communities, addressed the Board and presented a brief description of the Pine Creek Master Drainage Basin and its impact on the Cottonwood Creek Master Drainage Basin as well as the United States Air Force Academy. Mr. Christiansen stated that the United States Air Force Academy has been very specific in their review of the Pine Creek Master Drainage Study to the extent that, if any flow over historic crosses their property, adequate facilities to convey this flow would have to be constructed prior to the issuance of any building permits that would increase the flow over historic.

Mr. Christiansen stated that it was Briargate's opinion that the

Drainage Board gave concept approval of the 35% on-site detention and detention at five public ponds in the March 1986 Board Meeting. Mr. Christiansen explained to the Board that Briargate's position on this issue regarding the 35% on-site detention was that any reduction in flow saves dollars downstream throughout the basin. Mr. Christiansen stated their hydrologic studies indicate that the 100 year developed flow without any detention at all within the Pine Creek Basin would be 4,753 cfs at the Academy box culvert crossing. If only the five public detention ponds were incorporated in the master drainage study, a flow of 2,759 cfs would reach the Academy box culvert. Utilizing the five public ponds plus 35% on-site detention, the flow at the Academy box culvert would be 2,094 cfs. Per their study, this indicates that a reduction of 665 cfs, or 24%, would be detained at the Academy box culvert if the 35% on-site detention was utilized.

Mr. Haynes stated to the Board that it was his understanding that the annexation agreement for Briargate indicated that no flow over historic was to enter the Air Force property.

The Board, City staff, and Briargate representatives had a general discussion regarding the existing Birtcher-Kraus drainage system located at the Briargate Business Campus, the box culvert funding proposed by Briargate at the Academy Boulevard intersection, and the Briargate Annexation Agreement as it relates to flows entering the United States Air Force Academy.

Mr. Waldthausen stated to the Board that he felt he would be able to support the drainage plan if the 35% on-site detention was omitted.

Mr. Christiansen replied that is not what they wish to happen today but, if that were to be the case, it would allow them to move forward with that portion of the plan through the City administration and on to City Council if necessary.

Board Members, City/County staff, and a developer then held a general discussion regarding the use of the old five year criteria for the minor systems within Pine Creek versus the new ten year storm criteria for minor systems as outlined in the new City/County Drainage Criteria Manual. It was noted that the effective date for use of the new criteria manual is October 1, 1987. Mr. Haynes and Mr. Christiansen both relayed to the Board that, as the separate plats for subdivisions within the Pine Creek Drainage Basin are submitted to the City after the effective date of the new criteria manual, they will be designed in accordance with the new City/County Drainage Criteria Manual for the minor systems.

Mr. Haynes again stated to the Board that it was the staff's opinion that the Drainage Board does not have jurisdiction over

the 35% on-site detention issue and that this matter must be forwarded through the City administration and on to City Council if necessary.

Mr. Christiansen stated to the Board that, if the Pine Creek Master Drainage Report is approved deleting the 35% on-site detention, modifications to the report would be necessary. Mr. Christiansen suggested to the Board that an action be taken on the item either approving it with on-site detention or approving it with modifications deleting it to enable them to proceed further either administratively or to Council if necessary. After further discussion, the Board heard a motion by Mr. Waldthausen to approve the Pine Creek Master Drainage plan as a closed basin subject to the deletion of the private 35% on-site detention. Mr. Brown seconded the motion. The vote was 2 to 1 in favor of the motion. Mr. Brown and Mr. Waldthausen voting for the motion; Mr. Polok voting against the motion.

There being no further business, the meeting adjourned at 4:15 PM.

DeWitt Miller
Director of Public Works

DM/CS/dg

Attachments

cc: Drainage Board Members
Larry Blick, City Manager
Jim Colvin, City Attorney
Jack Smith, Asst. City Attorney
DeWitt Miller, Director of Public Works
Hugh King, Deputy Director of Public Works for Planning and Administration
Max Rothschild, County Dir. of Transportation
Alan Morrice, County Drainage Engineer
Chris Smith, Subdivision Administrator
Bev Dustin, Land Development Specialist
Public Relations
Bob Brockman, Planning
Bill Ruskin, Park & Recreation
Don Steger, HBA, 3730 Sinton Road, #110, COS, 80907
Berge/Brewer & Associates, 6755 Earl Drive, Suite 100, COS, 80918
Langford-Delay, Attn: Donn Hume, 5360 North Academy Blvd., COS, 80918
Mallon Development, Attn: Ron O'Canna, 3455 Briargate Blvd., COS, 80918

cc: (Continued on Page Nine)

cc: (cont.)
Leigh Whitehead & Associates, Attn: David Whitehead, 5 West Las Vegas, COS, 80903
Mallon Development, Attn: Bill Wier, 3455 Briargate Blvd., COS, 80918
Briargate Joint Venture, Attn: Joe Kostka, 7710 North Union Blvd., COS, 80918
RMC Corporation, Attn: Allyn Brown, P. O. Box 908, COS, 80901
The Olive Company, Attn: Kevin Walker, 5450 Tech Center Drive, Suite 400, Colorado Springs, CO, 80919

LEGEND

- MAJOR ROADWAY
- CITY LIMITS
- NORTHGATE BOUNDARY
- STREAM
- DRAINAGE BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- MINOR BASIN DESIGNATION/ACREAGE
- DESIGN POINT
- PROPOSED PARTIALLY LINED CHANNEL
- PROPOSED SUBREGIONAL DETENTION FACILITY
- PROPOSED DIVERSION
- PROPOSED CULVERTS
- EXISTING CULVERTS
- PROPOSED INITIAL SYSTEM ROUTING

GLENEAGLE
NORTH ENTRANCE TO USAFA
MINING MUSEUM FILING NO. 1
SMITH CREEK
SMITH CREEK BASIN
MONUMENT BRANCH BASIN
NORTHGATE ROAD
PROPOSED POWERS BOULEVARD
CULVERT TO BE REMOVED
REACH 7
REACH 8
REACH 10
CITY COUNTY
UNPLATTED
REACH 6 40'x4.5' PARTIALLY LINED CHANNEL
REACH 13
NORTHGATE
48"RCP
CITY USAFA
REACH 12
REACH 11 50'x4.5' PARTIALLY LINED CHANNEL (MIN.ESMT.100')
REACH 9(DIVERSION) 8'x3' PARTIALLY LINED CHANNEL (MIN. ESMT. 50')
REACH 6 40'x4.5' PARTIALLY LINED CHANNEL (MIN. ESMT. 90')
MONUMENT BRANCH MAIN CHANNEL
6'x7'CBC
CITY COUNTY
REACH 5 40'x4' PARTIALLY LINED CHANNEL (MIN.ESMT 85')
MONUMENT BRANCH BASIN
MIDDLE TRIBUTARY BASIN
(12'x12')x10'CBC
USAFA
MONUMENT BRANCH
POSSIBLE EXTENSION
UNPLATTED
REACH 3
REACH 2
(10'x10')x10'CBC
REACH 4
MINOR ARTERIAL
BLACK SQUIRREL CREEK PARKWAY
PROPOSED
CITY USAFA
POSSIBLE LOCATION FOR INTERCHANGE
CITY COUNTY
MIDDLE TRIBUTARY MAIN CHANNEL
REACH 1 25'x4' PARTIALLY LINED CHANNEL (MIN.ESMT.70')
VOYAGER PARKWAY
UNPLATTED
48"CMP
COUNTY USAFA
REACH 1 25'x4' PARTIALLY LINED CHANNEL (MIN.ESMT 70')
MIDDLE TRIBUTARY BASIN
BLACK SQUIRREL CREEK BASIN
PROPOSED LOOP ROAD
12'x8' CBC
INTERSTATE HIGHWAY 25
BLACK SQUIRREL CREEK
CITY COUNTY
STATE HIGHWAY 83
FORD

SCALE: 1"=500'
0 500 1000

NORTHGATE DEVELOPMENT
DESIGN PEAK FLOWS FOR PRESENT AND RECOMMENDED CONDITIONS 24-HOUR STORM

DESIGN POINT	PRESENT CONDITIONS 5-YR (cfs)	PRESENT CONDITIONS 100-YR (cfs)	RECOMMENDED CONDITIONS 10-YR (cfs)	RECOMMENDED CONDITIONS 100-YR (cfs)
1	142	441	142	445
2	177	546	177	560
3	177	546	177	560
4	9	39	9	27
5	30	55	56	104+
6	12	45	12	35
7	48	161	48	161
8	41	202	41	223
9	37+	68+	108+	199+
10	26	129	26	123
11	252	755	252	757
12	254	797	265	777
13	469	1448	469	1312
14	469	1448	469	1312
15	43	106	43	86
16	56	143	85	152
17	32	58	32	80
18	33	85	33	80
19	141	378	141	152
20	470	1454	470	1454
21	45	116	45	94
22	261	730	261	384
23	42	115	80	267++
24	453	1391	453	1290

+ Calculated by the Rational Method, all others based on SCS/TR20.
++ Flows in excess of 80 cfs are diverted to detention facility at DP23.

Note:1) Present conditions include routed flows without existing "stockponds" or proposed detention facilities. Present conditions are assumed to represent historic conditions.

2) Recomended conditions include routed flows through proposed detention facilities.

3) For calculation of peak flows refer to Monument Branch and Middle Tributary Drainage Basin Studies.

NOTES:
1) REFER TO TABLES 3 & 4 FOR SUB-BASIN HYDROLOGY. SEE NORTHGATE DR. 2 DRAINAGE REPORT FOR MORE DEPTH DETAILS OF VOYAGER PARKWAY.
2) TOP OF ROADWAYS ARE NOT PERMITTED TO BE USED AS EMERGENCY SPILLWAYS.
4) ENERGY DISSIPATION STRUCTURES SHALL BE REQUIRED AT ALL POINTS OF CONCENTRATED DISCHARGE FROM THE NORTHGATE SITE.

NORTHGATE DEVELOPMENT
PROPOSED PUBLIC DRAINAGE FACILITIES

DESIGN POINT	REACH	FACILITY	DESIGN FLOW (cfs)
1	-	DETENTION FACILITY (OFFSITE)	443 (out)
-	1	25' I 4' I 3400' PLC, 8 DROPS	445
2	-	DETENTION FACILITY	162 (out)
		8' I 8' I 160' CBC	560
3	-	BOUNDARY	560
4	-	DETENTION FACILITY	27 (out)
5	-	54" I 160' RCP	104 +
6	-	DETENTION FACILITY	35 (out)
-	2	100 YEAR OVERFLOW PROVISION	323 +
7	-	DETENTION FACILITY	98 (out)
		66" I 160' RCP	161
-	3	100 YEAR OVERFLOW PROVISION	376
8	-	DETENTION FACILITY	202 (out)
9	-	5' I 5' I 160' CBC	199 +
-	4	100 YR OVERFLOW PROVISION	451
10	-	DETENTION FACILITY	123 (out)
11	-	BOUNDARY/DET. FAC. (OFFSITE)	755 (out)
-	5	40' I 4' I 3500' PLC, 16 DROPS	777
12	-	10' I 8' I 160' CBC	777
13	-	BOUNDARY	1312
-	6	40' I 4.5' I 1060' PLC, 2 DROPS	1312
14	-	12' I 10' I 240' CBC	1312
15	-	BOUNDARY/DET. FAC. (OFFSITE)	86 (out)
		42" I 120' RCP	86
-	7	100 YEAR OVERFLOW PROVISION	152
16	-	5' I 4' I 240' CBC	152
-	8	100 YEAR OVERFLOW PROVISION	152
17	-	DETENTION FACILITY	80 (out)
		48" I 120' RCP	80
-	9	8' I 3.0' I 800' PLC, 5 DROPS	152
18	-	36" I 120' RCP	63 +
-	10	100 YEAR OVERFLOW PROVISION	63
19	-	DETENTION FACILITY	152 (out)
		48" I 240' RCP	152 (out)
-	11	50' I 4.5' I 2800' PLC, 7 DROPS	1454
20	-	BOUNDARY	1454
21	-	DETENTION FACILITY/BOUNDARY	94 (out)
22	-	DETENTION FACILITY/BOUNDARY	384 (out)
23	-	DIVERSION STRUCTURE (PASS)	80
		DIVERSION STRUCTURE (DIVERT)	167
-	12	100 YEAR OVERFLOW PROVISION	376
-	13	5' I 4.5' I 1750' PLC, 0 DROPS	167
24	-	DETENTION FACILITY (OFFSITE)	1290 (out)
		11' I 10' I 280' CBC	1391

+ Calculated by the Rational Method.

NOTE:1) All flows from Middle Tributary and Monument Branch Drainage Basin Planning Studies.
2) All construction subject to final design requirements.

NORTHGATE DEVELOPMENT
SUMMARY OF PROPOSED DETENTION FACILITIES (PUBLICALLY OWNED AND MAINTAINED)

D.P.	LOCATION	TYPE	PEAK INFLOW (cfs)	PEAK OUTFLOW (cfs)	PEAK HISTORIC (cfs)	SURFACE AREA (ac)	VOLUME (ac-ft)	ONSITE TRIBUTARY AREA (subbasins)	CORRESPOND. FIGURE APPENDIX A
1	CITY/COUNTY BNDRY.	ONSTREAM	1045	441	441	3.7	22.4	A	16
2	VOYAGER PKWY.	OFFSTREAM	359	162	162	1.3	6.0	B	9
4	BSC PKWY.	OFFSTREAM	107	27	39	0.9	2.3	G	11
6	VOYAGER PKWY.	OFFSTREAM	139	35	45	1.0	3.0	F	10
7	VOYAGER PKWY.	ONSTREAM	278	98	98	1.2	5.7	K,H	12
8	CITY/COUNTY BNDRY.	ONSTREAM	376	202	202	1.4	6.3	I	13
10	USAFA BNDRY.	ONSTREAM	461	123	129	2.2	10.3	J-M	14
11	CITY/COUNTY BNDRY.	ONSTREAM	1384	755	755	4.6	30.4	OFFSITE	23,24
15	CITY/COUNTY BNDRY.	OFFSTREAM	163	86	106	0.6	2.9	R	21
17	VOYAGER PKWY.	OFFSTREAM	167	80	85	1.1	3.9	W	20
19	VOYAGER PKWY.	OFFSTREAM	817	152	378	5.8	29.2	Y	19
21	USAFA BNDRY.	OFFSTREAM	220	94	116	1.4	5.0	Q	18
22	USAFA BNDRY.	ONSTREAM	1046	384	730	5.3	29.9	Y1,Y2,I	22
24	POWERS BLVD.	ONSTREAM	2008	1290	1391	6.0	39.9	O,P,S,R+O/S	17

NOTE: DATA FROM MIDDLE TRIBUTARY AND MONUMENT BRANCH DRAINAGE BASIN PLANNING STUDIES

REFER TO FIGURE 4 FOR DESIGN POINTS

BASINS A,C,D,R AND I ULTIMATELY ARE PROPOSED TO BE ROUTED TO HISTORIC LEVELS DUE TO DELAYED PEAK. TEMPORARY DETENTION IS REQUIRED UNTIL FULL DEVELOPMENT. SEE FIGURES 15 AND 23, APPENDIX A.

FIGURE 4
PRESENT & DEVELOPED CONDITIONS

NORTHGATE
MASTER DEVELOPMENT DRAINAGE PLAN (MONUMENT BRANCH & MIDDLE TRIBUTARY BASINS)

PREPARED BY:
URS CONSULTANTS
MAKING TECHNOLOGY WORK™

DATE: DEC. 87 JOB NO. 5206

APPROXIMATE BOUNDARY NORTHGATE

7 | 8
18 | 17

Qes
Qs
Qc - Tda
Qac
Qs
Qes
Qs
Qs
Qc
Qac
Fill
Qc - Tda
TRIBUTARY
NORTH
Fill
Pond
Qs
Qc-Tda
Qac
Tda
Qlo
MIDDLE
Pond
Qac
Tda
Qp
Qac
Qc-Tda
Qlo
Qal
Fill
Qaf
Qal
Qp
Qac
Qt
Tda
Qc-Tda
Qaf
Pond
Qp
as
Tda
Qlo
Qp
Qal
Qp
as
Fill
Qlo
Qp
Qaf
Qac Tda
Qaf
Qaf
Qaf
Qc-Tda
Qal
Qc-Tda
Qs
Qc-Tda
Qp
Qal
Qc-Tda
Qp
Qp
Qc-Tda
Qp
Qs-Tda
Tda
Qp
Tda
Qp
Qc-Tda
Qal
Tda
Tda
MIDDLE
Qac
Qac
Qaf/Qal
Tda
Qc-Tda
APPROX. BOUNDARY NORTHGATE
APPROX. BOUNDARY NORTHGATE

LEGEND

Fill	MAN MADE FILL
Qal	RECENT ALLUVIUM
Qaf	ALLUVIAL FAN DEPOSITS
Qc	COLLUVIUM (SLOPEWASH)
Qac	ALLUVIUM AND COLLUVIUM
Qes	EOLIAN SAND
Qp	PINEY CREEK ALLUVIUM
Qt	ALLUVIAL TERRACE (UNDIFFERENTIATED)
Qlo	LOUVIERS ALLUVIUM
Qs	SLOCUM ALLUVIUM
Tda	DAWSON ARKOSE
as	ACTIVE SEEPAGE
	EXPOSED BEDROCK
]	APPROXIMATE LOCATION OF HEADWARD EROSION
	APPROXIMATE CHANNEL FLOWLINE
7 | 8 / 18 | 17	APPROXIMATE SECTION CORNER, TOWNSHIP 12 SOUTH, RANGE 66 WEST

NORTH

200 100 0 200
SCALE: 1" = 200'

REVISED 2/17/88

PRELIMINARY GEOLOGIC MAP
MIDDLE TRIBUTARY CHANNEL

Geotechnical Consultants, Inc.

JOB NO. 2845	DRAWN BY GK
DATE 12-3-87	CHECKED BY RLB / JWH
SCALE AS SHOWN	FIGURE NO. 1

LEGEND

DA	DISTURBED AREA
Fill	MAN MADE FILL
Qal	RECENT ALLUVIUM
Qc	COLLUVIUM (SLOPEWASH)
Qp	PINEY CREEK ALLUVIUM
Qt	ALLUVIAL TERRACE (UNDIFFERENTIATED)
Qs	SLOUGH ALLUVIUM
Tda	DAWSON ARKOSE
as	ACTIVE SEEPAGE
	EXPOSED BEDROCK
	APPROXIMATE CHANNEL FLOWLINE
7 | 8 / 18 | 17	APPROXIMATE SECTION CORNER, TOWNSHIP 12 SOUTH, RANGE 66 WEST

APPROX. BOUNDARY NORTHGATE

APPROXIMATE BOUNDARY NORTHGATE

MONUMENT BRANCH

7 | 8
18 | 17

REVISED 2/17/88

PRELIMINARY GEOLOGIC MAP
MONUMENT BRANCH CHANNEL

Geotechnical Consultants, Inc.

JOB NO 2844	DRAWN BY GK
DATE 12-2-87	CHECKED BY RLB/JWH

NORTH

200 100 0 200