WINDMILL GULCH
Drainage Basin Planning Study

prepared for

El Paso County
Department of Public Works

January 1991
Revised June 1991
Revised February 1992
WCEA #89820

WILSON & COMPANY

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(719) 520-5800

SCANNED

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1580
ALBUQUERQUE, NEW MEXICO 87103-1580
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REPLY TO
ATTENTION OF:

DEC 9 1991

Construction-Operations Division
Regulatory Branch

Mr. Alan Morrice
El Paso County Department of Public Works
3105 North Stone
Colorado Springs, Colorado 80907

Dear Mr. Morrice:

Enclosed is a copy of the List of Categories of Activities (LCA) and Letter of Permission (LOP) Procedures issued for your Windmill Gulch Drainage Basin Planning Study in El Paso County, Colorado. You may include the LCA and LOP procedures in the final basin study, if you wish.

We will publish a public notice announcing the availability of the LCA and LOP procedures once we receive a copy of the final basin study. In that way, we can use correct drawings in the public notice. Also enclosed for your information is a copy of the decision document which was prepared.

If you have any questions, please contact Ms. Anita Culp at (719) 543-9459 or Ms. Jean Manger at (505) 766-2776.

Sincerely,

Michael J DeBow
Lieutenant Colonel, EN
District Engineer

3 Enclosures
1. LCA
2. LOP
3. Decision Document

RECEIVED

OCT 14 1992

City Engineering/Stormwater

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
SOUTHERN COLORADO PROJECT OFFICE
P.O. BOX 294, PUEBLO, COLORADO 81002

REPLY TO
ATTENTION OF:

LIST OF CATEGORIES OF ACTIVITIES

Action No. CO-OYT-0617 List of Categories of Activities (LCA) has been developed for the Windmill Gulch Basin. Activities included in this list are eligible for Section 404 authorization by a Letter of Permission (LOP).

1. General. Activities eligible for LOP authorization are those described in the Windmill Gulch Drainage Basin Planning Study (DBPS) preliminary design and which involve the placement of dredged or fill material into waters of the United States. Activities which deviate from those described in the preliminary design, are not eligible for a Letter of Permission authorization if the materials or design changes would involve extensive re-analysis of alternatives and impacts, even though the DBPS itself does not preclude the use of materials or designs differing from the DBPS's preliminary design so long as the deviation equals or increases hydraulic function and environmental benefits. In addition, the activities listed below, but which result in more than minor additional adverse environmental impacts, are not eligible for a Letter of Permission authorization.

2. Categories of Activities. Section 404 regulated activities in one or more of the following categories are eligible for an LOP authorization:

a. Channel features as described in the DBPS. These include grass-lined channels with riprap-lined overbanks; a meandering, porous, boulder low-flow diversion channel; riprap-lined channels with grass-lined freeboard; and riprap-lined channels.

b. Channel rehabilitation features as described in the DBPS. These include reconstruction of existing storm sewers, concrete channels, inlet structures, drop structures, and removal of a stilling basin.

c. Energy dissipators and water quality features as described in the DBPS. These include riprap armored scour holes, storm sewer outfalls, energy dissipators, desiltation facilities, sedimentation basins, drop structures, and grade control structures.

d. Detention pond features as described in the DBPS. These include straight and meandering porous, boulder, low-flow channels; embankment/berm construction; pond excavation and shaping; pond liners; control weirs; entrance weirs; inlets; and outlets.

e. Road crossings as described in the DBPS. These include reconstruction of existing culverted crossings and construction of new culverted crossings.

f. Canal No. 4 features which involve Section 404 activities or waters of the United States as described in the DBPS. These include construction of a culverted stream crossing and riprap-lined inlet, reconstruction of the earthen-bermed canal on top of the culvert, and concrete-lining the canal.

g. Wetland construction, replacement, or restoration features as described in the DBPS or as needed to meet the goal of no-net-loss of wetland functions and values within the basin. These include construction of backwater wetlands at drop structures, replacement of wetland vegetation disturbed by construction activities, planting wetland vegetation in channel bottoms downstream of drop structure plunge pools, planting wetland shrubs adjacent to drop structures, re-establishing wetland vegetation in natural bottoms of grass-lined channels, covering riprap sideslope protection with soil and planting willow shrubs along the lower portion of the slope, constructing a low-flow diversion channel along the fringe of wetlands, and selective grading to establish new or mitigation wetlands. Restoration sites must be in the same location and replacement sites must be within the same stream reach.

h. Riparian habitat construction, replacement, or restoration as described in the DBPS or as needed to meet the goal of no-net-loss of riparian functions and values within the basin. This includes replacement of riparian vegetation disturbed by construction activities and meandering of a diversion low-flow channel to avoid existing large trees and other significant features. Restoration sites must be in the same location and replacement sites must be within the same stream reach.

i. Aquatic habitat construction, replacement, or restoration as described in the DBPS or as needed to meet the goal of no-net-loss of aquatic habitat functions and values within the basin.

j. The placement of dredged or fill material for mitigation measures needed to meet other environmental or mitigation measures or goals described in the DBPS.

k. Temporary fills needed for construction of activities described in the DBPS. Fills must minimize wetland, riparian, and aquatic impacts. The fills include the placement of dredged or fill material for construction of temporary road crossings, access roads, construction pads, construction ramps, and cofferdams. (Any structure or fill remaining in place more than one year is not considered to be temporary.) The structure or fill must be culverted or otherwise designed to not restrict low streamflows, to allow passage of ordinary high water, and to not restrict or impede flows into or out of wetlands to be preserved. Fish passage will be allowed on perennial streams as appropriate. Temporary fills will be removed as soon as practical, the original streambed contours restored or post-project contours completed, and pre-existing streambed riffles and pools in perennial streams restored.

3. Special Conditions: The above activities must meet the following special conditions for an activity to be eligible for an LOP authorization:

a. All mitigation and environmental features recommended in the Windmill Gulch Drainage Basin Planning Study (Appendix A) will be done to meet the goal of no-net-loss of flood plain functions and values within the basin. These include as a minimum the preservation of natural channels, wetlands, and riparian areas to the maximum extent practicable. Impacts which cannot be avoided will be minimized to the maximum extent practicable. Impacts which cannot be avoided and minimized will be compensated in locations within the same stream reach.

b. All disturbed or unprotected areas will have soils restored and will be revegetated using erosion-controlling native species or equivalent cultivars. The use of native species is preferred.

c. Riparian areas disturbed by construction activities will be restored by: restoring the soils to at least original conditions, using plant types and composition similar to what originally existed, and using native species.

d. Wetlands disturbed by construction activities will be restored by: restoring the soils to at least original conditions, using plant types and composition similar to what originally existed, and using native species.

e. Revegetation and mitigation activities will be implemented concurrent with other project construction if practicable. If not, these measures will be implemented immediately following construction completion or, if after the growing season, in time for the next growing season. Short-term maintenance will be for two years including two growing seasons.

f. The activity will consist of suitable material free from toxic pollutants in toxic amounts. (Some common materials which contain toxic pollutants are bituminous surfacing materials (asphalt), fly ash, creosote, etc.)

g. Other materials not authorized include refuse and/or garbage, car or vehicle tires, demolition or other debris, construction waste, and waste metal including car or vehicle bodies.

h. If the State Historic Preservation Officer determines that an archaeological survey is required, you must coordinate the survey with the Corps of Engineers for their review, complete the required cultural resources work and allow the Corps to complete its Section 106 consultation before starting construction.

i. The activity will not jeopardize a federally-listed threatened or endangered species or destroy or adversely modify the critical habitat of such species. Activities which "may affect" such species or habitat are not authorized for this Letter of Permission and will require standard individual permit authorization.

4. General Conditions: The above activities must meet the following general conditions for an activity to be eligible for an LOP:

a. A time limit for completing the work authorized will be specified. If you find that you need more time to complete the authorized activity, submit your request for a time extension to the Corps of Engineers for consideration at least one month before the expiration date is reached.

b. You must maintain the activity including mitigation authorized by the permit in good condition and in conformance with the terms and conditions of the Letter of Permission permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below.

Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of the permit from the Corps of Engineers, which may require restoration of the area.

c. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by the permit, you must immediately notify the Corps of Engineers of what you have found. The Corps will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

d. If you sell the property associated with the Letter of Permission permit, the terms and conditions of the permit will continue to be binding on the new owner(s) of the property. To validate the transfer of the permit and the associated liabilities associated with compliance with its terms and conditions, you must obtain the signature of the new owner and forward a copy of the permit to the Corps of Engineers.

e. You must allow representatives from the Corps of Engineers to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of the permit.

f. The Letter of Permission permit does not obviate the need to obtain other Federal, state, or local authorizations required by law. The permit does not grant any property rights or exclusive privileges. The permit does not authorize any injury to the property or rights of others. The permit does not authorize interference with any existing or proposed Federal project. In issuing the permit, the Federal Government does not assume any liability for the following: damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes, damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest, damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by the permit, design or construction deficiencies associated with the permitted work, and damage claims associated with any future modification, suspension, or revocation of the permit.

g. The determination of the Corps of Engineers that issuance of the permit is not contrary to the public interest is made in reliance on the information you provide.

h. The Corps of Engineers may reevaluate its decision on the permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following: you fail to comply with the terms and conditions of the permit; the information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate; or significant new information surfaces which the Corps of Engineers did not consider in reaching the original public interest decision. Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by the Corps of Engineers, and if you fail to comply with such directive, the Corps of Engineers may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
SOUTHERN COLORADO PROJECT OFFICE
P.O. BOX 294, PUEBLO, COLORADO 81002

REPLY TO
ATTENTION OF:

LETTER OF PERMISSION PROCEDURES

The following special application procedures must be followed to obtain a Letter of Permission authorization for certain Section 404 activities in the Windmill Gulch Basin.

1. Special Application Procedures:

a. Application: A completed application (two copies) will be sent to the Corps of Engineers and will contain:

(1) Completed application for Department of the Army Permit (ENG FORM 4345) including descriptions of all permanent and temporary work for the proposed project.

(2) Estimated start and completion dates.

(3) Drawings (8-1/2" x 11" or no larger than 18" x 24") including: vicinity map; plan or site view showing stream, wetlands, riparian areas, ordinary high water mark, dimensions of the activity, scale, and north arrow; and elevational or cross sectional views.

(4) Mitigation and/or vegetation plan including construction and planting schedules.

(5) A written statement that the State Historic Preservation Office has been contacted and the proposed project will comply with provisions of the National Historic Preservation Act of 1966 as amended, the State Antiquities Act of 1973, and the State Register of Historic Places Act of 1975.

(6) The application will include information on the items listed at the end of this section and entitled "List of Application Items Needed for Project (final) Design."

b. Preliminary Determination: The Corps of Engineers will make a preliminary determination whether the proposed project is included in the List of Categories of Activities and could be authorized by a Letter of Permission. The determination will include whether the project's scope or design differs more than a minor amount from the recommended DBPS' action and mitigation, or will have more than minor additional adverse environmental impacts.

c. Coordination: The Corps of Engineers will coordinate the application with the City of Colorado Springs (when applicable), Colorado Division of Wildlife, Colorado Water Quality Control Division, El Paso County, Environmental Protection Agency, and U.S. Fish and Wildlife Service. A copy of the completed application and drawings will be electronically mailed to the above agencies within 10 days of receipt of completed

application. Comments within 20 days will be requested. A 10-day extension of the comment period may be granted if a valid request for extension is received within the comment period.

(1) Comments will be requested on the following:

(a) More than minor changes to the existing environment at the project site or in the basin since the initial Environmental Assessment (EA) was written.

(b) Changes in threatened and endangered species status since the initial EA was written.

(c) Changes in stream standards or other water quality factors since the initial EA was written and the categories of actions were certified by statute under Section 401 for state water quality.

(d) More than minor changes in the project proposal from the recommended DBPS's action and mitigation.

(e) Whether the work will have more than minor additional adverse environmental impacts than that recognized in the initial EA.

(f) Additional site-specific conditions needed to avoid, lessen, or compensate for adverse environmental impacts.

(2) If any of the coordinating agencies have substantial objections to an permit application after the Corps has considered or incorporated their comments, the Corps of Engineers' project manager will coordinate the project with the objecting agency's counterpart to resolve any concerns. In cases where the staff cannot agree, the Corps of Engineers' Regulatory Branch Chief and the objecting agency's counterpart will consult to resolve the concerns. If the differences cannot be worked out at either of these levels, a standard individual permit application will be required for the work.

d. Public Interest Review: The Corps of Engineers will prepare a supplemental public interest review including a supplemental environmental assessment and supplemental 404(b)(1) guidelines review for each LOP application.

e. Permit Decision: The Corps of Engineers will make a decision on issuance of a Letter of Permission for the work within 60 days of receipt of a completed application unless there are extenuating circumstances. If a decision is made to issue a permit, an LOP will be issued including the special and general conditions listed in the LCA.

2. Review and Enforcement of LOP Activities: The Corps of Engineers will prepare an annual report listing each DBPS activity permitted by LOP procedures, the status of each

activity, and a synopsis of any Corps' inspections. A copy of the report will be sent to the City of Colorado Springs, Colorado Division of Wildlife, Colorado Water Quality Control Division, El Paso County, the Environmental Protection Agency, and the U.S. Fish and Wildlife Service. The report will be available to other interested parties at the Corps offices listed in the final public notice. The Corps of Engineers will enforce all requirements and conditions of a LOP permit in coordination with El Paso County and its authority to require construction of drainage facilities.

3. List of Application Items Needed for Project (Final) Design: Items needed for project/final design will depend upon the specific work activities proposed. Only those items related to the proposed work and drainageway are needed. It is assumed that other items such as slope, thickness, material composition, etc. will normally be included in the design description of the project.

a. Vegetation Plantings
   (1) Planting windows
   (2) Soil treatment (fertilizer needs, substrate, and texture) and topsoil storage
   (3) Watering needs
   (4) Species (native species)
   (5) Planting densities
   (6) Plant size (trees and shrubs)
   (7) Mulch
   (8) Location (plan view)

b. Wetland/Riparian Construction
   (1) Water Source - existing and created
   (2) All factors under 'a'.

c. Erosion Control
   (1) Method
   (2) Timing

d. Aquatic Life Protection
   (1) Methods to allow fish passage, as appropriate
   (2) Timing to avoid fish spawning, as appropriate

e. General Channel Feature Construction
   (1) Actual fill area
   (2) Disturbed area
   (3) Construction access including roads, ramps, and pads
   (4) Cofferdams and other temporary fills

e. General Channel Feature Construction, cont.
   (5) Removal of temporary fills
   (6) Construction fencing
   (7) Staging area location

f. Specific Channel Feature – Buried Hard Lining
   (1) Depth of soil coverage
   (2) Method of planting (hydro spray, etc.)
   (3) All factors under 'a' and 'e'

g. Specific Channel Feature - Drop/Grade Control Structures
   (1) Maximum height on vertical structures (needed for evaluation of wildlife or fish passage, as appropriate)
   (2) Maximum slope on spillway-type structures (needed for evaluation of wildlife passage)
   (3) Concrete/soil cement surface texture
   (4) Siting to minimize impacts
   (5) All factors under 'e'

h. Specific Channel Feature - Storm Sewer Outfalls
   (1) Energy dissipation method
   (2) All factors under 'e'

i. Specific Channel Feature - Sediment/Stilling Basins
   (1) Maintenance dredging or inspection schedule
   (2) Location of maintenance dredging spoil area if known
   (3) Replanting/non-planting after maintenance dredging
   (4) Siting to minimize impacts
   (5) All factors under 'e'

EXECUTIVE SUMMARY

This is a summary of the results of the Windmill Gulch Drainage Basin Planning Study in El Paso County, Colorado. The study covered aspects of drainage basin planning in this 5.43 square mile basin. A number of drainage improvement alternatives were examined and discussed at several public meetings held during the course of this study. Preliminary design plans were developed for the selected alternative.

The final design flows used for sizing the drainage facilities and improvements in the basin were developed using the SCS TR-20 Computer Program for Project Formulation Hydrology. Peak flows for the 100-year and 10-year 24-hour storms in addition to the 100-year and 10-year 2-hour storms were examined and the highest peak was utilized for design purposes. The following information is a summary of the recommendations and subsequent costs of the proposed improvements.

A more detailed explanation of the items listed in this summary section can be found in the body of this report.

IMPROVEMENT COSTS SUMMARY

Reach	Estimated Cost
Fountain Creek Outfall to Bradley Road	$86,390
Bradley Road to Canal No. 4	119,000
Canal No. 4 to Drennan Road Pond	1,924,800
Powers Blvd. Tributary	489,000
Storm Sewer Adjacent to Canal No. 4 and Bradley Road	603,950
TOTAL CONSTRUCTION COSTS	$3,223,140
Study Cost	64,100
Claims Less Revenues	1,912,294.85
TOTAL DRAINAGE IMPROVEMENT COSTS	$5,199,534.85
TOTAL BRIDGE COST	$104,356.35
TOTAL DETENTION LAND COST	$509,600
Fees	
Drainage Basin Fee	$5,683
Bridge Fee	$ 115
Detention Land Fee	$ 557

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I. INTRODUCTION

A. Authorization

This Windmill Gulch Drainage Basin Planning Study was authorized under the terms of an agreement between the El Paso County Department of Public Works and Wilson & Company. This study covers drainage development alternatives within the Windmill Gulch drainage basin.

B. Purpose and Scope of Work

The purpose of this study is to develop the most feasible drainage and flood control plans for the Windmill Gulch drainage basin. The detailed scope of services is as follows:

1. Meet initially and biweekly or when requested by the County to:

    a. Insure compliance with the services required by this agreement.
    b. Obtain existing data and general information from participating entities.
    c. Solicit desires of participating entities and other interested agencies or groups in order to develop alternate plans.
    d. Procure current information relative to development plans in the basin.
    e. Procure information relative to right-of-way limitations and potential hazards due to flooding.
    f. Avoid duplication of effort whenever possible by utilizing existing information available from other agencies.
    g. Present findings of study segments and to acquire input from County and interested agencies and individuals.

2. Contact effected cities, individuals and agencies who have pertinent knowledge and an interest in the study area.

3. Utilize the City of Colorado Springs/El Paso County Drainage Criteria Manual as well as criteria requirements and policies of other applicable State or Federal agencies.

4. Perform a hydrologic study of the area for the 10-year and the 100-year recurrence intervals under existing and future basin conditions.

5. Develop profile information from the contour maps and land field reconnaissance.

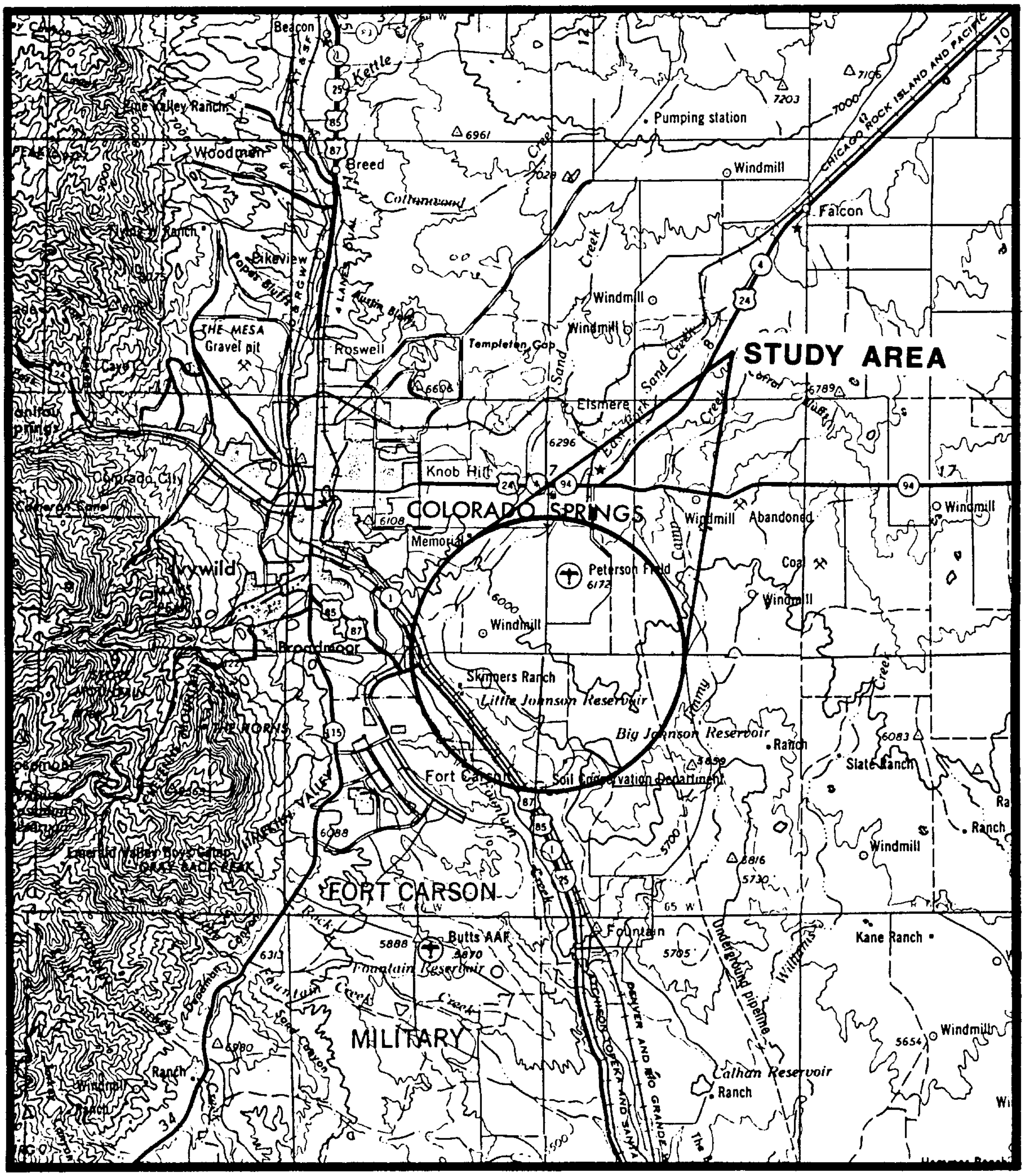
6. Develop and evaluate several improvement alternatives based on the following:

    A. Hydrologic considerations
    B. Stormwater management effectiveness
    C. Environmental impacts
    D. Construction Costs
    E. Land acquisition costs
    F. Cost of operations and maintenance

7. Perform hydraulic calculations for the conceptual design of the outfall drainageway system.

8. Evaluate operations and maintenance aspects of the alternative improvements.

9. Identify known wetland areas and other environmentally sensitive areas relative to stormwater facility preliminary design.



VICINITY MAP

NOT TO SCALE

WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY	FIGURE 1

10. Identify possible detrimental impacts to water quality and methods to improve it.

11. Provide specific detention requirements such as maximum allowable discharge, minimum volume, and surface area of each facility.

12. Participate and assist in the Letter of Permission (LOP) process in order to be in conformance with the requirements of the Section 404(b)(1) guidelines.

13. Prepare a written report detailing the items which were examined in the course of the study.

14. Assist in approvals process.

C. Previous Drainage Reports

There have been numerous private drainage studies of areas performed within the Windmill Gulch drainage basin. Although most of the studies have dealt primarily with specific subdivisions within the basin, a comprehensive study of the entire basin was performed in 1985. The majority of these reports, including the basinwide report, were completed utilizing the previous hydrologic criteria and do not reflect current City/County criteria. The following is a summary of those reports:

"Pheasant Run Filings No's. 1 & 2 Drainage Plan and Report", by Finn and Associates, Ltd, 1985.

Area: Pheasant Run Filings No's. 1 & 2 - 78.1 Ac.
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.6" and 4.4"/Hr. (24-Hr. duration)

"Pheasant Run Ranch Filing No. 3 Drainage & Erosion Control Plan and Report", by Finn and Associates, Ltd, 1988.

Area: Pheasant Fun Filing No. 3 & Revisions to Filings No's. 1&2 - 27.1 Ac.
Method: Rational Method
Criteria: 10-Year and 100-Year Storm

"Pheasant Run Filing No. 4 Drainage & Erosion Control Plan and Report", by Finn and Associates, Ltd, 1987.

Area: Pheasant Run Ranch No. 4 - 26.4 Ac.
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.6" and 4.4"/Hr. (24-Hr. duration)

"Garden Grove Pheasant Run Ranch Filing No. 6 Drainage & Erosion Control Plan and Report", by Finn and Associates, Ltd, 1987.

Area: Pheasant Run Ranch Filing No. 6 - 9.3 Ac.
Method: Rational Method
Criteria: 10-Year and 100-Year Storm

"Pheasant Run Ranch Master Drainage Study", by Wilson & Company, 1986.

Area: Pheasant Run Ranch - 271 Ac.
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.6" and 4.4"/Hr. (24-Hr. duration)

"Clearview Estates Subdivision No. 7 Drainage Report", by Oliver E. Watts, 1984.

Area: Clearview Estates Subdivision No. 7 - 54 Ac.
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.7" and 4.4"/Hr. (24-Hr. duration)

"Windmill Gulch Master Drainage Study", by Finn and Associates, Ltd, 1985.

Area: Windmill Gulch Basin - 3599 Ac.
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.6" and 4.4"/Hr. (24-Hr. duration)

"Windmill Gulch Stormwater Management Plan, Preliminary Design Report", by Simons, Li & Assoc. Inc., 1986. (Done in conjunction with the 1985 Windmill Gulch Master Drainage Study.)

Area: Windmill Gulch Basin - 3599 Ac.
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.6" and 4.4"/Hr. (24-Hr. duration)

"Fountain Valley Ranch, Final Drainage Report", by RBD, Inc., Engineering Consultants, 1986.

Area: Fountain Valley Ranch
Method: Modified SCS Method
Criteria: 5-Year and 100-Year Storm, 2.6" and 4.4"/Hr. (24-Hr. duration)

"Master Plan, Physical/Technical Report", by Greiner, Inc., 1986.

Area: Colorado Springs Municipal Airport

"Preliminary Flood Insurance Study, El Paso County Colorado", by the Federal Emergency Management Agency, 1983.

Area: Windmill Gulch Basin - 4.5 Sq. Mi.
Method: TP-20
Criteria: 10-Year and 100-Year Storms (2-Hr. duration)

Although some information concerning existing facilities construction within the basin as well as proposed development densities is very useful, the hydrologic and hydraulic information found in the aforementioned reports may no longer be valid due to changes in the drainage criteria which occurred in early 1987.

Some controversy arose during the original basin study between Finn & Associates and the Federal Emergency Management Agency (FEMA) due to a large discrepancy in flow peaks within the basin. Recently, FEMA completed a restudying of the area using the current City/County criteria, not in effect during their original study. It was the original intent of this DBPS study effort to coordinate hydrologic analysis between concurrent studies. The FEMA hydrologic results were actually submitted prior to the conclusion of this DBPS and vary somewhat from those presented here. This variance is based on differing assumptions regarding the degree of diversion of stormwater runoff due to the Fountain Mutual Irrigation Company's Canal No. 4.

D. Mapping

The Fountain and Elsmere, Colorado, 1:24,000 topographic quadrangle maps prepared by the U.S. Geological Survey were used as the basin map for this project. These maps use 20 feet contour intervals and were photorevised in 1975 and 1976. The maps were used for the general purposes of basin boundary delineation and for the establishment of principal tributary regions and subbasins within these regions. Recent road additions were added to the maps to reflect current conditions.

The mapping for the floodplain and channel improvement plans was developed utilizing both new and existing mapping. The existing mapping was provided by El Paso County and is a combination of several base maps done by local developers over the past several years. The existing aerial mapping was based on a USGS benchmark with the new aerial mapping also tied into the USGS benchmark. This mapping was developed at a 1"=200' scale with 2 feet contour intervals.

E. Field Reconnaissance

Field reconnaissance of the basin was performed in order to supplement existing roadway and site development plans, and existing drainage reports. Culvert locations, sizes and depths were field checked and subbasin flow patterns were analyzed. In addition, existing as well as potential problem areas were noted for a more in-depth evaluation.

II. PROJECT DESCRIPTION, LOCATION AND DRAINAGE

A. Basin Description and Location

The Windmill Gulch drainage basin is located just northeast of the community of Security in south-central El Paso County. It is situated in Township 15, Range 66 West of the 6th P.M., El Paso County, Colorado. The basin contains approximately 5.43 square miles, approximately 2.99 square miles of which is situated within the City of Colorado Springs. A majority of the lands are currently platted, but not yet developed. The basin is bounded on the north by the Peterson Field basin, on the east by the Jimmy Camp Creek and the Big Johnson/Crews Gulch basins and on the south and west by the Little Johnson, Security Creek and Widefield basins (see location map exhibit).

The runoff from the Windmill Gulch drainage basin flows in a south and southwesterly direction and crosses U.S. Highway 85/87 in a 144" storm sewer, which empties directly into Fountain Creek. The topography varies with moderate slopes of approximately 4% to 5% in the central portion of the basin and slopes of less than 1% in the upper portion of the basin. The upper area also contains several natural sump areas or "buffalo wallows". The vegetation consists primarily of native rangeland grasses with some trees and wetland vegetation along portions of the main channel reach.

The Windmill Gulch channel begins in the upper reach as little more than a natural swale which is dry except during rainfall events. As the channel progresses southward from Drennan Road, isolated stretches of wet areas are encountered until a significant area of wetlands is found just north of Bradley Road. From Bradley Road south, the channel passes through a detention basin, then into a concrete lined channel and finally passes through a 144" storm sewer.

B. Major Drainageways and Facilities

The Windmill Gulch drainage basin is predominantly drained by one main channel, carrying runoff from the basin in a southerly direction from the Colorado Springs Municipal Airport into Fountain Creek. The northern reaches of the channel flow through undeveloped rangeland areas and consist of broad swales with relatively sparse vegetation. As the channel progresses south past

JIMMY CAMP CREEK BASIN

COLORADO SPRINGS CITY LIMIT

WINDMILL GULCH BASIN

PETERSON FIELD BASIN

CREWS GULCH/ BIG JOHNSON BASIN

LITTLE JOHNSON BASIN

SECURITY CREEK BASIN

WIDEFIELD BASIN

SCALE: 1"=2000'

PIPELINE

ROAD

DRENNAN

Powers Blvd.

Big Johnson Reservoir

Big Johnson Reservoir

Substation

Fontaine Blvd.

Grinnell Dr.

Bradley Rd.

CITY LIMIT

COLORADO SPRINGS

Hancock Exp.

Trailer Park

Widefield High Sch.

Widefield Jr. High Sch.

Wilson Jr. High Sch.

Sproul Jr. High Sch.

Fountain Valley Golf Course

Athletic Fields

Drive-in Theater

Water Well

CANAL

ATCHISON

ABANDONED

SECURITY

FOUNTAIN

REVISION	DATE	BY

WILSON & COMPANY

WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY
LOCATION MAP

DESIGN	
DRAWN	
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FILE NO.	
SHEET NO.	6

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FIGURE 2

Drennan Road, vegetation increases and some wet areas are encountered. From approximately 2,000 feet south of Drennan Road to Bradley Road, stretches of wetlands can be found. Development and associated channel improvements have changed the nature of the channel south of Bradley Road. Beginning at Bradley Road and continuing southward approximately 1,200 feet, Windmill Gulch is enclosed within a 144" storm sewer. This conduit empties directly into a detention facility, constructed in 1986. Flows from this detention facility outlet into the 8 feet wide bottom, concrete lined Aspen Channel. This channel runs from the detention facility to approximately 200 feet south of Grand Boulevard, where the channel is again enclosed in a pipe. The 120" storm sewer travels due south to Crawford Avenue. From that point it turns westerly and increases in size to a 144" pipe. The storm sewer crosses Security Boulevard, the AT&SF Railroad, U.S. Highway 85/87 and then empties directly into Fountain Creek.

The Fountain Mutual Irrigation Canal No. 4 flows across the Windmill Gulch basin. This canal carries approximately 67 cfs of adjudicated flow, passing through the basin on its way to agricultural lands in southern El Paso County. The canal has intercepted minor storm runoff within this basin since it was constructed in the late 1800's, with higher runoff overtopping the canal at many locations. Recent developments of Clearview Estates and Pheasant Run discharge increased concentrated storm flows directly into the canal. Subbasins 16, 18, 20, 22, 23, 33, and 34 were historically tributary to the Little Johnson and Security Creek drainage basins (as acknowledged in the Little Johnson and Security Creek Drainage Basins Planning Study). Canal No. 4 currently diverts minor storm runoff, about 50 cfs, into the Windmill Gulch drainage basin. Higher runoff discharges from these subbasins will overflow Canal No. 4 and continue to drain within the Little Johnson basin under existing conditions. In 1986 the Bradley Road improvement project required the relocation of a portion of the canal. The canal relocation also included improving a portion of the canal from just west of Marabou Way to the location where the canal turns north from Bradley Road.

In addition to these canal improvements, a siphon and overflow structure were proposed to be built at the location where the canal crosses Windmill Gulch to control runoff crossing and overflowing the canal to allow development of a portion of the property downstream of the canal. However, this facility has not been constructed and the storm flows continue to overflow the canal uncontrolled.

The entire basin is tributary to Fountain Creek which is located about 1,000 feet west of State Highway 85/87. Fountain Creek is a wide, natural stream which drains approximately 460 square miles above this confluence point. Since developed flows from the Windmill Gulch basin will be maintained at or below existing levels, there should be no adverse effects on the existing Fountain Creek channel.

C. Existing Surface Water Impoundments

Other than a few apparent wetland areas described in the Environmental Inventory section, no significant permanent surface water impoundments are found along the main channel reach. Several existing sump areas are found in the northern portion of the basin. These areas have been identified on the Basin Discharge Map. Due to the very porous soils in these areas, no permanent water exists. However, these low areas do capture and retain all existing flows from a significant portion of the upper drainage area. Approximately 1.67 square miles of drainage area is tributary to these sumps and therefore does not contribute flow to the Windmill Gulch channel.

III. HYDROLOGIC EVALUATION

A. Basin Hydrology

The hydrologic model used to determine peak flows and volumes throughout the Windmill Gulch drainage basin was the TR-20 Computer Program for Project Formulation Hydrology developed by the Soil Conservation Service. The TR-20 program was used in compliance with the City/County Drainage Criteria Manual for computing flows for areas larger than 100 acres.

The overall basin was divided into tributary basins and then into smaller subbasins. A few of the subbasins within the airport property remained large due to the natural topography in the area. The subbasins were then numbered and design points designated with letters (see the Basin Discharge Map in the back pocket of this report). The subbasins were chosen with respect to the natural topography, roadway crossings and development considerations. The subbasins were then field verified and modified where necessary. Peak flows for these subbasins were then calculated for existing as well as fully developed conditions.

According to current City/County criteria, peak flows for the 100-year and 10-year 24-hour storms, and the 100-year and 10-year 2-hour storms, were calculated and evaluated. The storm generally producing the most critical values was used to evaluate existing and future drainageways and other stormwater facilities.

B. Time of Concentration

The time of concentration (Tc) used in the TR-20 calculations was determined by first calculating an initial overland flow time from the subbasin boundary to the naturally occurring swales and channels. Then a travel time was calculated in these natural swales to the bottom of the subbasin and added to the initial overland flow time to determine the overall time of concentration for existing conditions. For future developed conditions, the channel travel times were adjusted to reflect improved conditions and therefore a shorter time of concentration.

C. Rainfall

Rainfall amounts for the Windmill Gulch basin were determined from the National Oceanic and Atmospheric Administration Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume III-Colorado, 1973, as detailed in the City/County Drainage Criteria Manual, Figures 5-4a through 5-4e.

Precipitation for the 100-year, 24-hour and the 10-year, 24-hour storms were 4.5 inches and 3.0 inches, respectively. The precipitation amounts for the 100-year, 2-hour and the 10-year, 2-hour storms were calculated by the procedures as outlined in the criteria manual. The calculated amounts were 3.05 inches for the 100-year storm and 2.22 inches for the 10-year storm.

The Type IIA rainfall distribution curves used for the 24-hour storm were developed by the National Weather Service and are in conformance with the criteria manual, Table 5-3. The distribution curve used for the 2-hour storm is similar to that used for the Colorado Urban Hydrograph Procedure. The cumulative rainfall event percentages are shown in the following table:

TABLE 1
2-HOUR RAINFALL DISTRIBUTION

TIME (MIN)	10-YEAR STORM RAINFALL DIST. (%)*	10-YEAR STORM ACCUM. DIST. (%)	10-YEAR STORM CUMULATIVE RAINFALL (%)	100-YEAR STORM RAINFALL DIST. (%)*	100-YEAR STORM ACCUM. DIST. (%)*	100-YEAR STORM CUMULATIVE RAINFALL (%)
5	2.0	2.0	0.0173	1.0	1.0	0.0087
10	3.7	5.7	0.0493	3.0	4.0	0.0346
15	8.2	13.9	0.1201	4.6	8.6	0.0744
20	15.0	28.9	0.2498	8.0	16.6	0.1436
25	25.0	53.9	0.4659	14.0	30.6	0.2647
30	12.0	65.9	0.5696	25.0	55.6	0.4810
35	5.6	71.5	0.6180	14.0	69.6	0.6021
40	4.3	75.8	0.6551	8.0	77.6	0.6713
45	3.8	79.6	0.6880	6.2	83.8	0.7249
50	3.2	82.8	0.7156	5.0	88.8	0.7682
55	3.2	86.0	0.7433	4.0	92.8	0.8028
60	3.2	89.2	0.7710	4.0	96.8	0.8374
65	3.2	92.4	0.7986	4.0	100.8	0.8720
70	3.2	95.6	0.8263	2.0	102.8	0.8893
75	3.2	98.8	0.8539	2.0	104.8	0.9066
80	2.5	101.3	0.8755	1.2	106.0	0.9170
85	1.9	103.2	0.8920	1.2	107.2	0.9273
90	1.9	105.1	0.9084	1.2	108.4	0.9377
95	1.9	107.0	0.9248	1.2	109.6	0.9481
100	1.9	108.9	0.9412	1.2	110.8	0.9585
105	1.9	110.8	0.9576	1.2	112.0	0.9689
110	1.9	112.7	0.9741	1.2	113.2	0.9792
115	1.7	114.4	0.9888	1.2	114.4	0.9896
120	1.3	115.7	1.0000	1.2	115.6	1.0000
	115.7			115.6		

* % OF 1-HOUR RAINFALL

D. Land Use

Existing land uses in the Windmill Gulch drainage basin were determined by examining current development plans supplemented with field reconnaissance. Currently most of the development is occurring in the western and southern portion of the basin with the eastern and northern areas remaining in their natural state or currently being developed as airport land. Presently, only about 15% of the basin is fully developed.

Proposed land use for the area was determined through examination of current development plans and through discussions with El Paso County Planning Department officials and City of Colorado Springs officials. The properties currently owned by the City of Colorado Springs were assumed to be developed into airport uses which included commercial/business developments in addition to runway and open space. All other undeveloped areas were assumed to be fully developed using projected densities. The land use map is a composite of this land use information. There is not a time frame or date associated with this ultimate projected land use.

NOTE:
THIS DRAWING WAS USED TO IDENTIFY FUTURE HYDROLOGIC PARAMETERS AND THEREBY PREDICT "DEVELOPED" STORMWATER RUNOFF CONDITIONS. IT IS NOT INTENDED TO BE CONSIDERED AS A LAND USE PLANNING DOCUMENT.

N

SCALE: 1"=2000'

LEGEND

- 1-2 DU/AC
- 3-4 DU/AC
- 4-5 DU/AC
- > 6 DU/AC
- MULTI-FAMILY
- INDUSTRIAL
- COMMERCIAL / BUSINESS PARK
- AIRPORT
- SCHOOL
- OPEN SPACE

PETERSON FIELD
Powers Blvd.
Hancock Expy.
Grinnell Dr.
Fontaine Blvd.
Big Johnson Reservoir
Little Johnson Res
Trailer Park
Wilson Jr High Sch
Sprgul Sch
Widefield
ATCHISON
TOPEKA
ABANDONED

FIGURE 3

REVISION	DATE	BY

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WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY
LAND USE MAP

DESIGN	
DRAWN	
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SHEET NO.	10

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E. Soil Characteristics

The soils information contained in this report is derived from the "Soil Survey of El Paso County Area, Colorado", published by the USDA Soil Conservation Service in 1981. Of the twelve soils classifications found within the Windmill Gulch drainage basin, eleven belong to hydrologic soil group B, and one belongs to hydrologic soil group A (see the Soils Map for location). The following is a table of the soils located within the basin:

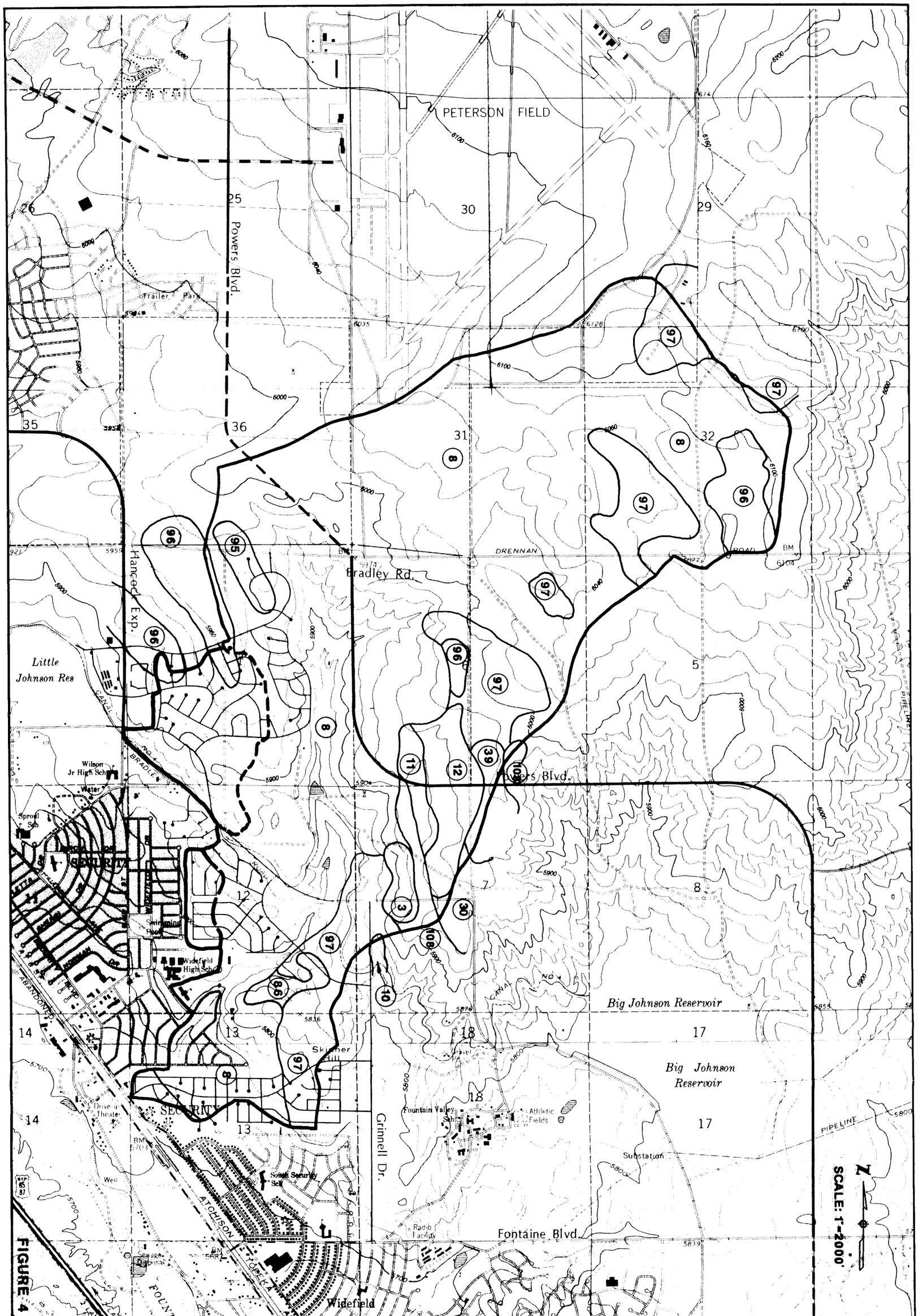
TABLE 2
SOILS CLASSIFICATIONS

S.C.S. Soils Map Number	Soil Classification	Hydrologic Soil Group
3	Ascalon sandy loam	B
8	Blakeland loamy sand	A
10	Blendon sandy loam	B
11/12	Bresser sandy loam	B
30	Fort Collins loam	B
39	Keith silt loam	B
86	Stoneham sandy loam	B
95	Truckton loamy sand	B
96/97	Truckton sandy loam	B
108	Wiley silt loam	B

Although eleven of the twelve soil types are within the hydrologic soil group B, most of the area of the basin falls within the hydrologic soil group A. As specified by the Drainage Criteria Manual, hydrologic soil group B soils were used where overlot grading has, or is anticipated to occur. All soils south of Bradley Road were assumed to be hydrologic soil group B due to the overlot grading which has occurred in that area.

F. Curve Numbers

Curve numbers (CN's) were determined for the basin by utilizing soils and land use information described in previous sections. Curve numbers for existing conditions were developed by examining existing development densities for developing properties. Curve numbers for the undeveloped portions of the basin were developed based on existing rangeland conditions. According to the El Paso County office of the Soil Conservation Service, most of the range land in the basin is in fair to poor condition.



WILSON & COMPANY COLORADO SPRINGS, COLORADO	SHEET NO. 12	FILE NO.	DATE	DRAWN	DESIGN	WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY SOILS MAP

WILSON & COMPANY

REVISION	DATE	BY

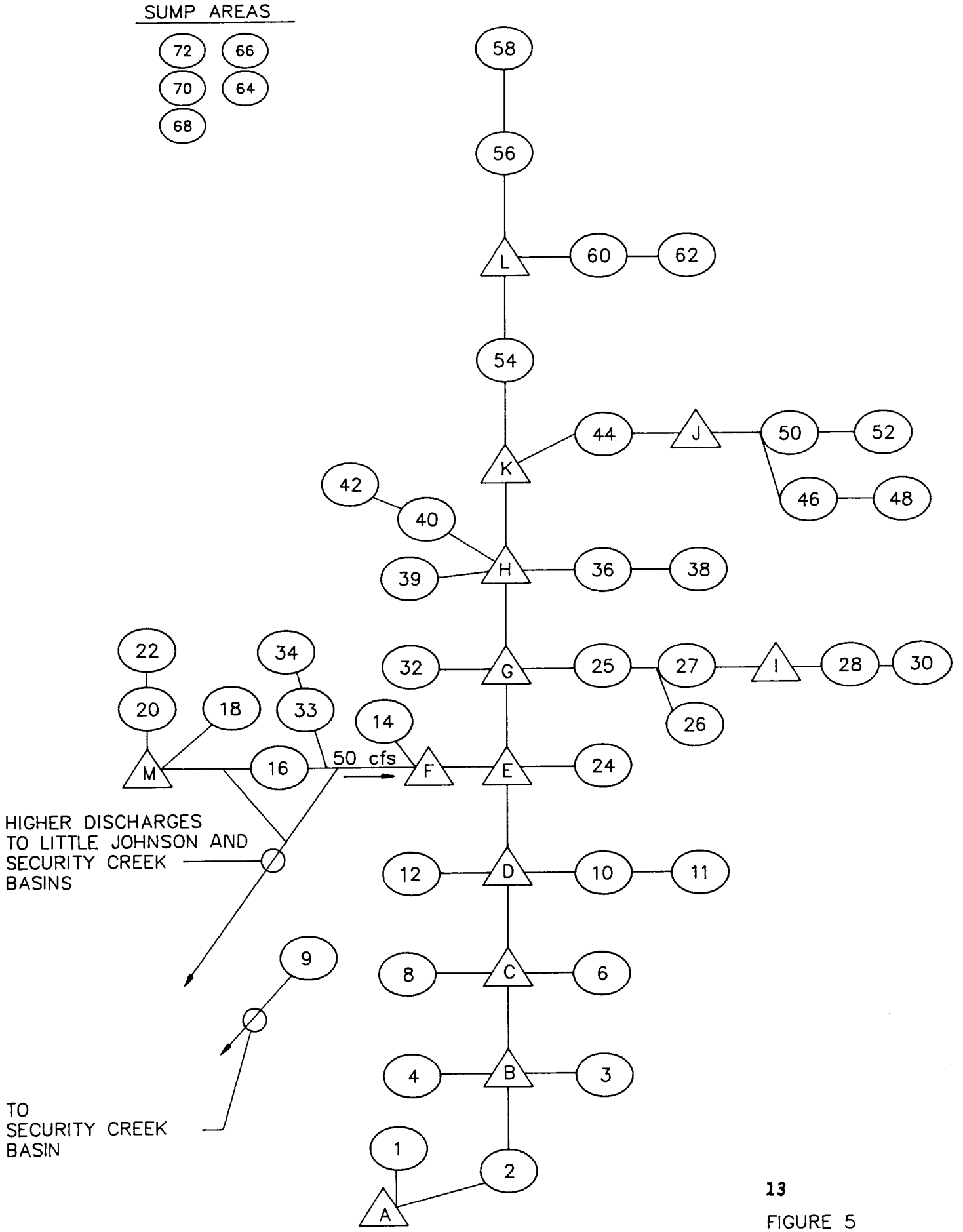


FIGURE 5
TR-20 FLOW DIAGRAM
EXISTING CONDITIONS

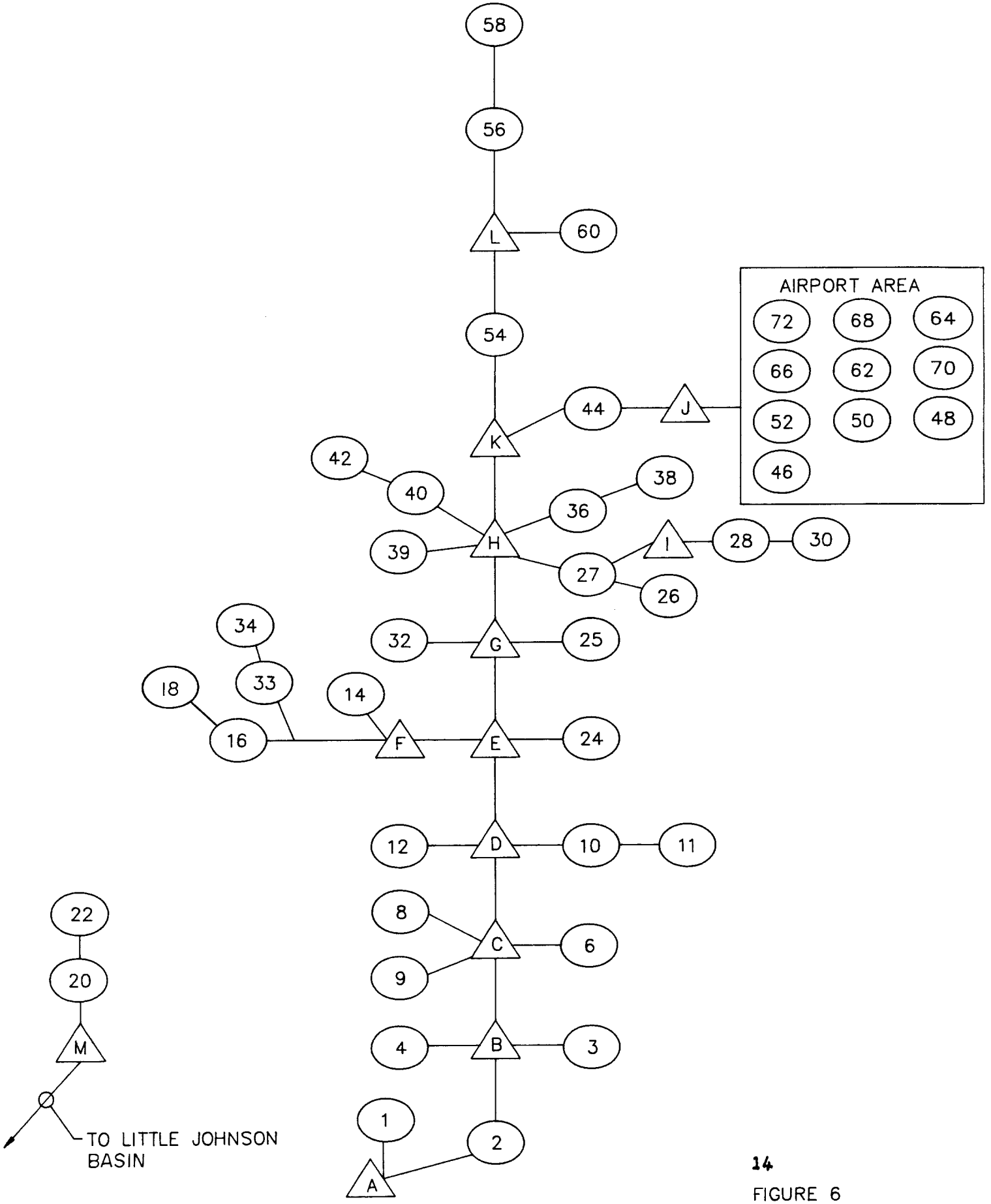


FIGURE 6
TR-20 FLOW DIAGRAM
FUTURE CONDITIONS

TABLE 3

CURVE NUMBER (CN) EXISTING CONDITIONS

Basin No.	Basin Area (Ac)	Basin Area (SqMi)	Basin Soil A (Ac)	Basin Soil B (Ac)	1-2 DU/Ac CN=70 (Ac)	3-4 DU/Ac CN=75 (Ac)	4-5 DU/Ac CN=78 (Ac)	>6 DU/Ac CN=85 (Ac)	Multi-Family CN=87 (Ac)	Industrial CN=88 (Ac)	Commercial CN=92 (Ac)	Airport CN=90 (Ac)	School CN=83 (Ac)	Open Space CN=60/74 (Ac)	Basin CN Ave
1	27.60	0.0431		27.60			27.60								78.00
2	98.88	0.1545		98.88			98.88								78.00
3	54.09	0.0845		54.09			54.09								78.00
4	53.68	0.0839		53.68			29.61						24.07		80.24
6	54.03	0.0844		54.03			48.53							5.50	77.59
8	53.85	0.0841		53.85			37.05						8.90	7.90	78.24
10	55.21	0.0863		55.21					33.69		21.52				88.95
11	20.64	0.0323		20.64							20.64				92.00
12	65.26	0.1020		65.26				29.42	35.84						86.10
14	43.41	0.0678	28.90	14.51										43.41	64.68
16	41.40	0.0647		41.40										41.40	74.00
18	69.75	0.1090		69.75		63.55					6.20				76.51
20	28.84	0.0451		28.84		12.90			11.40		4.54				82.42
22	92.83	0.1450		92.83						29.63				63.20	78.47
24	91.39	0.1428	26.25	65.14										91.39	69.98
25	32.02	0.0500	32.02											32.02	60.00
26	69.85	0.1091	5.28	64.57										69.85	72.94
27	22.42	0.0350	22.42											22.42	60.00
28	68.90	0.1077	11.58	57.32										68.90	71.65
30	88.63	0.1385	20.90	67.73										88.63	70.70
32	52.90	0.0827	26.50	26.40									7.42	45.48	69.25
33	51.95	0.0812		51.95				20.66						31.29	78.37
34	40.70	0.0636		40.70		40.70									75.00
36	63.34	0.0990	63.34											63.34	60.00
38	56.56	0.0884	56.00	0.56										56.56	60.14
39	27.40	0.0428	27.40										15.25	9.45	74.20
40	90.38	0.1412	11.96	78.42	3.11	77.18								10.09	74.51
42	53.98	0.0843	20.23	33.75	29.60									24.38	69.44
44	13.53	0.0211	13.53											13.53	60.00
46	58.77	0.0918	44.56	14.21										58.77	63.39
48	54.32	0.0849	18.65	35.67										54.32	69.19
50	132.71	0.2074	121.25	11.46										132.71	61.21
52	48.37	0.0756	47.70	0.67										48.37	60.19
54	74.77	0.1168	51.57	23.20	30.55	4.61								39.61	67.31
56	94.58	0.1478	82.38	12.20										94.58	61.81
58	40.40	0.0631	40.40											40.40	60.00
60	53.42	0.0835	53.42											53.42	60.00
62	145.68	0.2276	145.68											145.68	60.00
64	119.67	0.1870	119.67											119.67	60.00
66	47.13	0.0736	47.13											47.13	60.00
68	174.89	0.2733	174.89											174.89	60.00
70	100.99	0.1578	87.46	13.53										100.99	61.88
72	628.43	0.9819	417.98	210.45										628.43	64.69

TABLE 4

CURVE NUMBER (CN) FUTURE CONDITIONS

Basin No.	Basin Area (Ac)	Basin Area (SqMi)	Basin Soil A (Ac)	Basin Soil B (Ac)	1-2 DU/Ac CN=70 (Ac)	3-4 DU/Ac CN=75 (Ac)	4-5 DU/Ac CN=78 (Ac)	>6 DU/Ac CN=85 (Ac)	Multi-Family CN=87 (Ac)	Industrial CN=88 (Ac)	Commercial CN=92 (Ac)	Airport CN=90 (Ac)	School CN=83 (Ac)	Open Space CN=60/74 (Ac)	Basin CN Ave
1	27.60	0.0431		27.60			27.60								78.00
2	98.88	0.1545		98.88			98.88								78.00
3	54.09	0.0845		54.09			54.09								78.00
4	53.68	0.0839		53.68			29.61						24.07		80.24
6	54.03	0.0844		54.03			48.53							5.50	77.59
8	53.85	0.0841		53.85			37.05						8.90	7.90	78.24
9	33.29	0.0520		33.29			16.07	17.22							81.62
10	55.21	0.0863		55.21					33.69		21.52				88.95
11	20.64	0.0323		20.64							20.64				92.00
12	65.26	0.1020		65.26				29.42	35.84						86.10
14	43.41	0.0678	7.46	35.95				35.95						7.46	82.70
16	41.40	0.0647		41.40					17.02		24.38				89.94
18	62.45	0.0976		62.45		59.48					2.97				75.81
20	34.14	0.0533		34.14		14.97			11.40		7.77				82.88
22	92.83	0.1450		92.83		8.86				83.97					86.76
24	91.39	0.1428	14.23	77.16							77.16			14.23	88.86
25	32.02	0.0500	5.92	26.10							26.10			5.92	88.19
26	69.85	0.1091		69.85							69.85				92.00
27	22.42	0.0350		22.42							22.42				92.00
28	68.90	0.1077		68.90								68.90			90.00
30	88.63	0.1385		88.63								88.63			90.00
32	52.90	0.0827	5.39	47.51				40.09					7.42	5.39	83.45
33	51.95	0.0812		51.95				51.95							85.00
34	42.70	0.0667		42.70		42.70									75.00
36	63.34	0.0990	11.53	51.81							51.81			11.53	89.26
38	56.56	0.0884		56.56								56.56			90.00
39	27.40	0.0428	6.84	20.56				5.31					15.25	6.84	80.27
40	90.38	0.1412	10.09	80.29	3.11	77.18								10.09	74.54
42	53.98	0.0843		53.98	29.60					24.38					78.13
44	13.53	0.0211	0.43	13.10							13.10			0.43	91.41
46	58.77	0.0918		58.77								58.77			90.00
48	54.32	0.0849		54.32								54.32			90.00
50	132.71	0.2074		132.71								132.71			90.00
52	48.37	0.0756		48.37								48.37			90.00
54	74.77	0.1168	9.72	65.05	30.55	4.61					29.89			9.72	79.39
56	94.58	0.1478		94.58						94.58					88.00
58	40.40	0.0631		40.40						40.40					88.00
60	53.42	0.0835		53.42						53.42					88.00
62	145.68	0.2276		145.68								145.68			90.00
64	119.67	0.1870		119.67								119.67			90.00
66	47.13	0.0736		47.13								47.13			90.00
68	174.89	0.2733		174.89								174.89			90.00
70	100.99	0.1578		100.99								100.99			90.00
72	628.43	0.9819		628.43								628.43			90.00

TABLE 5

SUMMARY OF DISCHARGES - SUBBASIN

Subbasin No.	Existing Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr	Future Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr
1	85	40	95	50	85	40	95	50
2	300	145	325	180	300	145	325	180
3	170	80	190	100	170	80	190	100
4	180	90	190	110	180	90	190	110
6	160	80	175	95	160	80	175	95
8	160	80	175	95	160	80	175	95
9	---	---	---	---	115	60	125	70
10	260	155	285	190	260	155	285	190
11	105	65	110	75	105	65	110	75
12	250	140	255	160	250	140	255	160
14	40	10	60	25	150	80	155	90
16	65	30	75	35	190	110	200	130
18	175	80	185	95	155	70	165	85
20	95	50	95	55	---	---	---	---
22	175	80	190	95	---	---	---	---
24	135	50	160	75	405	235	430	275
25	30	5	45	15	150	85	165	110
26	120	50	135	65	340	205	350	235
27	25	5	30	10	110	65	115	75
28	110	45	130	60	315	185	325	210
30	115	45	145	65	390	230	385	250
32	85	30	105	45	175	90	175	100
33	160	80	175	95	205	110	225	130
34	105	45	115	60	110	50	120	65
36	40	10	65	25	220	125	210	125
38	40	10	65	25	275	165	295	200
39	70	30	80	40	100	50	120	70
40	175	75	195	95	195	85	215	105
42	65	25	85	40	165	80	180	100
44	15	5	20	10	70	40	70	50
46	65	20	85	35	---	---	---	---
48	65	25	85	40	---	---	---	---
50	105	25	165	60	---	---	---	---
52	30	5	50	20	---	---	---	---
54	90	30	115	50	240	120	255	145
56	85	20	125	45	415	240	450	285
58	25	5	45	15	175	100	185	115
60	40	10	65	25	220	125	225	140
62	90	20	155	60	---	---	---	---

TABLE 6

SUMMARY OF DISCHARGES-DESIGN POINTS

Design Point	Existing Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr	Future Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr
A	1160	545	1230	750	1305	635	1240	750
B	835	365	1190	705	935	535	1020	705
C	1145	535	1405	790	1600	840	1535	870
D	925	405	1365	745	1165	675	1140	700
E	935	300	1535	695	1220	610	1180	660
F	80	50	100	65	435	195	475	245
G	830	230	1375	590	570	365	555	410
H	615	140	1045	420	1540	770	1425	745
I	205	75	255	115	705	395	720	415
J	230	60	345	135	150	110	130	110
K	515	115	825	310	495	285	445	295
L	230	50	370	135	780	440	770	475
M	370	165	375	190	---	---	---	---

Structure Number	Existing Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr	Future Conditions Peak Flows (CFS) 24-Hour 100-Yr	24-Hour 10-Yr	2-Hour 100-Yr	2-Hour 10-Yr
1	835	365	1190	705	935	535	1020	705
2	835	365	1190	705	935	535	1020	705
3	815	330	1170	675	885	525	980	670
4	815	330	1170	675	885	525	980	670
5	890	300	1315	685	915	530	985	615
6	225	45	375	135	240	165	230	165
7	150	65	195	95	250	155	230	150
8	20	5	35	15	150	90	160	110
9	5	---	10	5	40	25	45	30
10	15	5	20	5	85	50	90	60
11	230	60	345	135	150	110	130	110
12	50	50	50	50	435	195	475	245
13	50	50	50	50	485	250	490	270
14	50	50	50	50	205	115	210	130

NOTE: Future condition flows incorporate detention facilities as depicted on the preliminary design drawings.

Curve numbers for developed conditions were calculated based on the projected land use information found on the Land Use Map. The curve number for the airport was derived from the Colorado Springs Municipal Airport Master Drainage Study by Greiner, Inc., and represents a composite of land uses.

IV. HYDRAULIC DESIGN EVALUATION

A. Existing Drainageway Evaluation

As outlined in the Major Drainageway and Facilities section, most of the major drainageways within the Windmill Gulch drainage basin are natural, unimproved channels, except in the southern one-third of the basin. In the upper reaches of the basin, the channels are typically wide, grassed swales with little or no signs of erosion. The only channel exhibiting notable evidence of erosion is a tributary channel draining a portion of land within the City of Colorado Springs east of Powers Boulevard, about 2,000 feet south of Drennan Road. Even in this channel, minor erosion is evident only along the lower portion of the channel reach.

The existing capacities of major channel reaches within the basin were estimated using normal depth flow analysis. An evaluation chart was developed to summarize existing conditions for the major channel within the basin. The following is a list of abbreviations used in the chart:

D.P. A - Design Point A as shown on the Basin Discharge Map
b - Channel bottom width
z - The reciprocal of the channel side slope (i.e. 2H to 1V slope, z=2)
Q_{100} - Peak stormwater flow for a 100-year storm
S - Channel slope
D_n - Normal flow depth
V_n - Velocity in the channel for normal flow depth
L - Length of the channel

The evaluation chart is based on existing channel conditions as observed in the field. Velocities within the wetland areas were determined using an n=0.045, based on the possible long term changes within the wetlands. Peak flows were determined using the results of the Hydrologic Evaluation. The 2-hour 100-year storm was used for the existing condition evaluation since it produced the highest runoff peaks at most design points.

B. Existing Structure Evaluation

Only the existing structures which transport flows out of major subbasins have been examined in this report. These structures vary from a 36" CMP to a double 9' x 7' RCB. The culverts were analyzed using the guidelines presented in the City/County Drainage Criteria Manual. An allowable headwater of 6" below the edge of pavement was utilized to calculate maximum culvert capacities. The existing capacities of these structures were estimated using primarily inlet control analysis.

The analysis revealed that a portion of the existing structures throughout the basin are unable to effectively handle the existing 100-year, 2-hour storm without overflowing the roadways. An existing structure evaluation chart was developed to summarize these findings.

TABLE 7
MAJOR DRAINAGEWAY EVALUATION CHART
EXISTING CONDITIONS

CHANNEL LOCATION	CHANNEL DESCRIPTION	Q_{100} (CFS)	S (%)	D_N (Ft.)	V_N (Ft.)	L (Ft.)
Main Channel Fountain Creek to Security Blvd. (D.P. A)	144" CMP, n=0.027	1230*	0.82	10.5	11.8	1200
Security Blvd. (D.P. A) TO 200' S. of Grand Blvd.	144" CMP, n=0.027 120" CMP, n=0.027	1230* 1190*	1.39 2.54	8.2 7.7	15.0 18.4	1220 400
200' S. of Grand Blvd. to Grand Blvd. (D.P. B)	Concrete channel, b=20 ft, z=0, n=0.013	1190	0.19	5.2	11.4	190
Grand Blvd. (D.P. B) to Detention Basin #5 (D.P. C)	Concrete channel, b=8 ft, z=1, n=0.013	1170	1.48	3.9	25.2	2100
Detention Basin #5 (D.P. C) to Wageman Dr. (D.P. D)	Grassed bottom trickle channel, b=29 ft, z=50, n=0.045	1365	0.5	2.7	3.1	1400
Wageman Dr. (D.P. D) to Bradley Rd. (D.P. E)	120" CMP, n=0.027	1315	1.59	10.0	16.8	1350
Bradley Rd. (D.P. E) to D.P. G)	Wide grassed swale, b=50 ft, z=10, n=0.045	1375	1.0	3.1	5.6	1250
(D.P. G) to Canal #4 (D.P. H)	Wide grassed swale, b=50 ft, z=10, n=0.045	1045	1.1	2.6	5.4	1250
Canal #4 (D.P. H) to Powers Blvd. Tributary D.P. K)	Grassed swale, b=50 ft, z=10, n=0.045	825	0.86	2.4	4.6	3400
(D.P. K) to Drennan Rd. (D.P. L)	Grassed swale, b=30 ft, z=10, n=0.045	370	1.93	1.6	5.1	2380

* Entrance to this storm sewer system has only 1045 cfs capacity before overflow begins.

TABLE 8
EXISTING STRUCTURE EVALUATION CHART

STRUC. NO.	SUBBASIN NO.	SIZE/DESCRIPTION	LOCATION	MAX CAPACITY (CFS)	EXIST Q_{100} (CFS)	REMARKS
1	2	120" CMP Drop Inlet Structure	190' S. of Grand Blvd.	1045	1190	Inadequate
2	2	Dbl. 9' X 7' RC Box Culvert	Grand Blvd.	1350	1190	Adequate
3	4	18' X 4' RC Box Culvert	Aspen Dr./Hackberry Dr.	540	1170	Inadequate
4		Dbl. 8' X 6' RC Box Culvert w/conc. weir	Out of detention pond	2715	1170	Adequate
5	10/12	Dbl. 10' X 6' RC Box Culvert	Bradley Road	1640	1315	Adequate
6	56	43" X 27" CMPA	Drennen Road	35	375	Inadequate
7	28	Dbl. 8' X 3' RC Box Culvert	Powers Blvd., Approx 5800 ft S. of Drennen Road	320	195	Adequate
8	38	60" CMP	Powers Blvd., Approx 4250 ft S. of Drennen Road	145	35	Adequate
9	38	36" CMP	Powers Blvd., Approx 3750 ft S. of Drennen Road	45	10	Adequate
10	38	42" CMP	Powers Blvd., Approx 3150 ft S. of Drennen Road	65	20	Adequate
11	46/50	Dbl. 8' X 6' RC Box Culvert	Powers Blvd., Approx 2000 ft S. of Drennen Road	800	345	Adequate
12	14	10 X 6' RC Box Culvert	Canal #4 under Bradley Road	490	520*	Canal System Inadequate

TABLE 8 (Cont.)
EXISTING STRUCTURE EVALUATION CHART

STRUC. NO.	SUBBASIN NO.	SIZE/DESCRIPTION	LOCATION	MAX CAPACITY (CFS)	EXIST Q_{100} (CFS)	REMARKS
13	16	10' X 6' RC Box Culvert	Canal #4 under Marabou Way	530	515*	Canal System Inadequate
14	16	Dbl. 8' X 4' RC Box Culvert	Canal #4 under Alturas Drive	465	380*	Canal System Inadequate

* The existing 100-year peak discharge shown is based on Canal No. 4 diverting Subbassins 16, 18, 20, 22, 33 and 34 respectively from the Little Johnson and Security Creek Basins. The actual existing capacity of Canal No. 4 is limited to 67 cfs adjudicated irrigation flow plus approximately 50 cfs storm runoff. Storm runoff in excess of this approximately 50 cfs overflows Canal No. 4 at various locations between Marabou Way and Hancock Expressway, and continues through the Little Johnson and Security Creek Basins under existing conditions. The existing structure is adequate for the actual total discharge that reaches it of 67 cfs adjudicated irrigation flow plus the approximately 50 cfs storm runoff that is diverted from Subbasins 16, 18, 20, 22, 33 and 34 respectively.

C. Environmental Inventory

Wetlands and other sensitive areas were identified during the course of this study, see the Environmental Inventory exhibit. Since environmental concerns were identified as an integral part of the design criteria, the development of regional detention and channel alternatives was performed to lessen the impact of development on the environment. Detention basin locations were evaluated not only for site constructability but also for their effect on wetlands and riparian areas.

The areas shown on the Environmental Inventory exhibit were located based on information provided by the U.S. Fish and Wildlife agency, from aerial photography and also from field observations. The wetland locations shown on this map are general in nature and will require future study and delineation at the time of construction plan development. The following definitions were used to describe the different zones along the channel:

1. Agricultural Channel - irrigation channel
2. Backwater Wetland - expanded pond areas above obstructions
3. Herbaceous Wetland - marshes, pondmargins, cattails
4. Shrub Wetland - willow in and along channel (no tree overstory)
5. Wetland Swale - low lying grassy and weedy depressions along drainages
6. Cottonwood - fringe area
7. Wetland Margins - weedy vegetation, thistles
8. Grasslands - rangelands

The existing environmentally sensitive area begins approximately 1,200 feet south of Drennan Road. At this point, the rangeland swale transitions into a riparian area with cottonwood trees and a flowing channel fed by springs. The area can be described as a narrow strip of herbaceous wetland surrounded by several groves of cottonwood trees. This type of vegetation extends for about 2,000 feet. Below this area, another stretch of herbaceous wetland is encountered. This 900 feet section of the channel is divided by a 400 feet area of wetland swale with its low lying grasses.

The area adjacent to the man made dike, which was constructed to protect the borrow pit operation, has developed into a wetland swale for a reach length of over 1,500 feet. The wetlands in this reach quickly transition back into the rangeland grasses a short distance from the channel bottom. At this point, the Windmill Gulch channel is crossed by the Fountain Mutual Irrigation Canal No. 4. The area just below the canal crossing has developed into a densely vegetated herbaceous wetland, with cattails and willows covering a wide area of this channel reach. The herbaceous wetland in this area is surrounded by wetland margins which are identifiable by weedy vegetation and thistles. This type of condition continues for about 1,200 feet where it transitions into a shrub wetland just upstream of a small quarter acre pond. A natural riparian area has developed below this pond with cottonwood trees and willows within the channel limits.

The area just upstream of the Bradley Road culvert is a herbacious wetland with marsh grasses growing within the natural stream flow. The area around the wetlands varies from a wetland margin on the west side to a shrub wetland on the east side. These areas quickly transition back into the native rangeland grasses once the terrain climbs above the existing water table. This occurs rather quickly since the natural slopes leading into the channel are within the 5% - 7% range. The area along the trickle channel within the existing detention pond south of Wageman Drive is also a herbacious wetland.

D. Floodplain Delineation

Hydraulic calculations were performed along the major flow routes to determine the extent of the existing and future floodplains in the area. These water surface profiles and boundaries were delineated using the U.S. Army Corps of Engineers HEC-2 Water Surface Profile computer program. Channel cross section and length information was obtained from existing storm sewer and channel construction plans for Fountain Valley Ranch prepared in 1985 and 1986 by RBD, Inc. (provided by and returned to El Paso County), and from the aerial mapping done in conjunction with this project as well as from mapping provided by El Paso County. Channel roughness coefficients were determined from aerial photographs and from field reconnaissance. The floodplain maps are included in the Technical Addendum for this study, which is available for review at the El Paso County Department of Public Works. The HEC-2 input and output are also included in the Technical Addendum for this study.

N

SCALE: 1"=2000'

LEGEND

1. AGRICULTURAL CHANNEL
2. BACKWATER WETLAND (0.27 Ac.)
3. HERBACEOUS WETLAND (6.17 Ac.)
4. SHRUB WETLAND (0.33 Ac.)
5. WETLAND SWALE (2.71 Ac.)
6. COTTONWOOD (4.40 Ac.)
7. WETLAND MARGINS (1.54 Ac.)
8. GRASSLANDS

PETERSON FIELD

Powers Blvd.

Bradley Rd.

Hancock Exp.

Grinnell Dr.

Fontaine Blvd.

Widefield

Little Johnson Res

Big Johnson Reservoir

DRENNAN

BRADLEY CANAL

ATCHISON

TOPEKA

SANTA FE

ABANDONED

PIPELINE

Trailer Park

Wilson Jr High Sch

Sprout Sch

Widefield High Sch

Swimming Pool

Fountain Valley Golf Course

Athletic Fields

Skinner

Stratton

Well

Water

FIGURE 7

REVISION	DATE	BY

WILSON & COMPANY

WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY
ENVIRONMENTAL INVENTORY

DESIGN	
DRAWN	
DATE	
FILE NO.	
SHEET NO.	25

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

V. ALTERNATIVE DRAINAGE SYSTEMS

A. Alternative Development Policies

The policies for the development of alternative stormwater systems were compiled from a number of sources, primarily the City/County Drainage Criteria Manual. In addition, an initial study conference, held on July 8, 1988, was a source for specific recommendations from involved agencies and individuals interested in the basin planning process. The following policies were among those utilized in developing and evaluating alternative drainage systems:

A. Develop detention basin scenarios to reduce projected future flow to historic levels or below prior to discharging into the Aspen Channel.

B. Address specific concerns of County officials, governmental agencies and interested citizens.

C. Develop facilities compatible with projected land uses.

D. Compare conceptual construction and land acquisition cost estimates of the possible alternatives.

E. Avoid significant environmental impacts, utilizing the following requirements set forth in the Section 404(b)(1) guidelines, including:

1. Avoidance
2. Minimization
3. Mitigation

F. Incorporate nonstructural means of erosion protection where technically feasible.

Channel alternatives were evaluated based on existing, as well as long term effects of several factors:

-- Effect of long term drought on wetlands.
-- Effect of eliminating canal seepage on wetlands.
-- Effect of increase of base flows from sprinklers, etc.
-- Maintenance accessibility.
-- Probability of channel degradation due to channel slopes of one percent or greater.

Based on the examination of these factors, it was determined that a total "do nothing" approach was not practical. Although current vegetation within the channel is very dense, climatic as well as developmental changes could reduce the wetland vegetation to a narrow band, as existed a few years ago. Should a large storm event occur at a time when the vegetation has receded, severe erosion could take place in a short amount of time, damaging or even destroying the remaining wetlands. The following wetland and riparian impact categories were established for the evaluation of the possible alternatives:

Minimal	0-30%
Moderate	30-60%
Significant	60-100%

Based on the above mentioned criteria, a number of detention and channel improvement alternatives were developed to mitigate the storm peaks for future development conditions. Those

alternatives are presented in this section. The size and outflow amounts from alternative detention areas were dependent on the amount of projected inflow and the location within the drainage basin. In some cases it was necessary to reduce flows below historic levels based on existing outflow constraints. Channel evaluations were, in general, not greatly affected by the detention basin scenarios. For those few channels which were affected by detention alternatives, a cost and channel description was added to the detention basin analysis. It should be noted that certain design items were not included in the cost analysis but will be incorporated into the design of all storm facilities in the area. One of the critical items will be the design and installation of energy dissipation and sedimentation facilities wherever storm sewers discharge into natural channels. All drop/grade controls will be selectively located in order to provide the optimum hydraulic results while avoiding, wherever possible, or minimizing impacts to environmentally sensitive areas. The 24-hour 100-year storm was used for future improved conditions since it produced the highet runoff peaks at most design points. For each alternative proposed improvements are summarized on basin maps, and evaluations are summarized on an "alternative matrix", included in Appendix A.

B. Airport Property Improvements

Most of the Colorado Springs Municipal Airport improvement recommendations were obtained from the "Colorado Springs Municipal Airport Master Drainage Study" by Greiner, Inc. This study modeled all except the lower portion of the Airport property. For the purposes of this study, the recommended facilities were utilized in the modeling of the basin with the resultant hydrograph added into the Windmill Gulch routing.

In addition to the detention facilities recommended in the master drainage study, it was necessary to add an additional 18.1 acre feet detention facility adjacent to Powers Boulevard approximately 5,700 feet south of Drennan Road. The addition of this facility will reduce the overall developed flow from the property to the predevelopment levels. The alternative maps indicate two detention basins on the Airport property. It should be noted that the one east of Powers Boulevard represents a conceptual combination of the Greiner planned improvements, and the other one to the south, north of Powers Boulevard represents this additional 18.1 acre feet facility. Each alternative was evaluated using these proposed Airport detention basins.

C. Alternative 1

This alternative evaluates the detention facilities proposed by the 1985 Simons, Li & Associates "Windmill Gulch Stormwater Management Plan". In this alternative as well as all of the others, the flows from the Colorado Springs Municipal Airport property are modeled as described above such that there is no increase in flows from the historic conditions.

Under this alternative, future undetained flows would need to be conveyed under Drennan Road through a new 11' x 6' RCB and then transported to a proposed 85 acre feet detention facility. A grass lined channel, 50 feet wide with 5 drop structures, would convey runoff from the planned RCB to the planned detention pond.

The location of this detention facility (Pond No. 2) was chosen, in the original study, to intercept flows from a channel which drains much of the Airport property. The runoff flows from the Airport property have been reduced as described previously. From Pond No. 2, the flow continues south for 5,700 feet through a 50 feet wide grass lined channel with 6 drop structures until it reaches a detention facility at Bradley Road (Pond No. 4). This proposed 108 acre feet detention basin would reduce the developed flows by over 50% prior to crossing under Bradley Road and entering an existing 144" storm sewer. This storm sewer transports the flows from Bradley Road to an existing 71 acre feet detention facility (Pond No. 5).

Beyond Pond No. 5, outfall improvements are in place. These improvements include an 8 feet bottom, concrete lined channel which continues for about 2,300 feet until it enters a 120" storm sewer. It is recommended that the transition from the channel to the storm sewer be reconstructed to improve its hydraulic characteristics. However, the downstream system appears to function adequately, although under pressure, from this point on to Fountain Creek.

This alternative, as presented in the Simons, Li & Associates report, would cause a significant impact on the existing wetlands in the area. Implementation of this scheme would require the mitigation of impacts to most of the wetland within the channel reach from Drennan Road to Bradley Road.

The total cost for constructing these facilities is $1,800,000. This cost does not include any improvements which may be required along the Fountain Mutual Irrigation Canal No. 4 since those improvements and associated costs are relatively independent of the major drainageway alternatives.

D. Alternative 2

Under this alternative, the flows from industrial land above Drennan Road are routed through a proposed 20.7 acre feet detention facility upstream of Drennen Road to reduce the flow to historic levels. This would decrease the required improvement of the Drennan Road crossing to a 60" RCP culvert. From Drennan Road south for approximately 1,350 feet, the flows can be enclosed by a 60" RCP storm sewer, or can be contained within a riprap lined channel. At this point, the character of the main channel changes from a rangeland swale to an environmentally significant area. Due to the sensitive nature of this portion of the channel, about 2,200 feet should be left in its natural state except for a meandering low flow channel and the addition of 2 grade control structures and 3 drop structures to prevent stream degradation. Although this will eliminate some additional land from development, it will help lower the overall basin costs, promote better water quality within the basin, and avoid significant impact to existing wetlands. If the storm sewer is used, an energy dissipator will be needed and a sedimentation basin should be designed upstream of the sensitive areas.

Below this point and continuing for about 1,500 feet, a grass channel with 2 drop structures should be constructed. This would extend the channel to a point adjacent to an existing gravel pit operation. It is at this existing depression that a 78.8 acre feet side channel detention facility with sedimentation provisions can be built. This type of facility would permit low flows to continue through the existing channel while detaining higher peak flow. By utilizing the existing depression, only about 130,000 cubic yards of earthwork will be required. In addition, environmentally significant land will only be minimally disturbed. It is also possible to construct a diversionary channel from southeast of this facility to detain developed flows from some of the commercially zoned property in that area.

After leaving the proposed facility, the flow again enters another environmentally significant reach of the channel, just downstream of the existing irrigation canal. Due to the existing channel characteristics and reduced flows out of the detention facility, only minor improvements need be made in this reach and therefore the natural channel can be used. In order to prevent future channel degradation in this portion of the channel, 4 grade control structures should be constructed.

It is possible that the existing culvert under Bradley Road be extended and modified so that the current outflow from the area is decreased by 30%. This would create a natural detention area of 21.6 acre feet. The reduced flow will then cross under Bradley Road through the existing double 10' x 6' RCB. It will then enter an existing 144" storm sewer which transports it to the existing detention facility (Pond No. 5) as outlined in Alternative 1.

The recommendations presented in this alternative attempt to avoid wetlands wherever feasible. The placement of a porous low flow channel along the wetland fringe, with an invert elevation approximately equal to the existing wetlands invert elevation so as not to contribute to dewatering, will enhance rather than be detrimental to the wetlands. In addition, the strategically placed drop structures will create backwater wetlands behind them while the grade control structures will minimize the possibilities of degradation of the channel invert.

Although the above mentioned improvements will serve to protect and enhance the wetlands, it will initially cause some minimal disturbance during construction. If the disturbed area within the wetlands cannot be re-established in the same location, the possibility exists to mitigate them in the proposed detention pond located in the abandoned gravel pit.

The remainder of the system is also the same as Alternative 1. The estimated cost for this alternative is $1,347,000.

E. Alternative 3

This alternative contains many of the same conceptual detention facilities and channel improvements as Alternative 2. However, in lieu of creating a natural detention basin at Bradley Road, the existing Pond No. 5 would be enlarged by about 75%. The enlargement of the existing pond would require the relocation of an existing sanitary trunk sewer in addition to redesign of a number of residential lots in the area. The remainder of the system is the same as Alternative 2.

Since the channel recommendations for this alternative are the same as in Alternative 2, the wetland impacts are also minimal.

The cost for constructing these facilities is $1,582,000.

F. Alternative 4

This alternative is also similar to Alternative 2. The same facilities are recommended except that a detention facility and diversionary channel would not be placed in the gravel pit area. These modifications to Alternative 2 would also necessitate upgrading the channel improvements from the canal to Bradley Road. In order to accommodate the higher flows, it will be necessary to construct a 50 feet wide grass channel with 5 drop structures prior to the Bradley Road crossing.

A detention facility would need to be constructed in the vicinity of Bradley Road, as in Alternative 2. This detention facility would be about 90% larger than the natural detention proposed in Alternative 2. Additionally, existing Pond No. 5 would need to be enlarged by about 70% in order to lower the developed peak flows adequately.

This alternative would impact the wetlands the same amount as alternatives 2 and 3 between Drennan Road and the existing gravel pit area. However, south of this area the impacts would be greatly increased due to the additional flows which would have to be protected against. Also, the construction of a detention facility adjacent to Bradley Road would still cause disturbance to the existing wetlands. Therefore, the overall impact to the wetlands area would be considered as minimal.

An estimated cost of $1,742,000 will be needed in constructing these improvements.

G. Canal No. 4 Alternatives

The Fountain Mutual Irrigation Company is a corporation which owns Canal No. 4, which flows through the Windmill Gulch basin. The canal which begins at Fountain Creek eventually winds its way to the southern portion of El Paso County, servicing agricultural users along the way. From the time the canal was originally constructed in the late 1800's, until the present, it has intercepted and diverted minor stormwater flows along its reach. The runoff quantities that the canal intercepts are limited by the capacity of the canal and roadway crossings. Essentially, flows from only very small storms are diverted while larger storms cause the canal to overtop and be breached in some instances.

In the past, El Paso County and the Fountain Mutual Irrigation Company have allowed runoff flows from developments to be discharged directly into the canal system provided assurances were given that the canal system and downstream properties would not be damaged or otherwise adversely affected. This was the case when the construction of Clearview Estates, Pheasant Run and the relocation of Bradley Road led to improvement of the existing canal system. As a result of an agreement reached between the developer, the County, and the irrigation company; improvements were made to the existing canal which included realignment, widening and placement of clay lining within the new canal. In addition, an inverted syphon and overflow structure were planned at Windmill Gulch but never constructed.

Since these improvements were made, several problems have been identified, which need to be addressed. These include:

1. The canal does not have capacity for major storm runoff, even in the reach already improved.

2. Construction of facilities which will permit the canal to cross the Windmill Gulch channel in an acceptable manner has not been completed.

3. Control of sedimentation caused by erosion of overlot grading areas of the developments must be addressed.

4. Responsibility for maintenance of any dual purpose facilities (i.e., storm water management vs. irrigation requirements) should be resolved.

The canal alternatives are separated into two sections: the Bradley Road Canal Reach and the Windmill Gulch Crossing. These will be addressed as independent issues.

Bradley Road Canal Reach

The limits of this reach are from the Hancock Expressway crossing to the location where the canal turns north from Bradley Road about 2,100 feet east of the Marabou Way crossing. Improvement of the canal cross-section and lining was investigated, but found to be hydraulically unfeasible due to the limited depth and slope available for the canal. The only feasible alternative identified is to construct a storm sewer trunkline adjacent to the canal and Bradley Road from the Cantrell Drive and Bradley Road intersection to the Windmill Gulch crossing of Bradley Road. This storm sewer trunkline would pick up runoff from the subbasins of Windmill Gulch that currently overflow the canal. The estimated construction cost of the portion of this storm sewer trunkline that is addressed in the drainage basin fee calculation is $1,080,000.

Windmill Gulch Canal Crossing

The current canal crossing occurs approximately 2,400 feet north of Bradley Road and has no provision for stormwater to cross the canal. The initial crossing alternative was to construct a 54" inverted syphon at Bradley Road. In conjunction with the syphon, an overflow structure will also need to be constructed to separate the stormwater and transport it to the Windmill Gulch channel. The estimated cost for this alternative is $230,000.

The second alternative would leave the canal in its existing location, although some type of overflow structure would need to be built to remove any stormwater and transport it to the Windmill Gulch channel. The crossing of the Windmill Gulch channel would be accomplished by constructing an aerial crossing by enclosing the canal in a 60" pipe and placing it on piers. The channel under the crossing should be riprap lined to protect against erosion. The cost of this facility would be approximately $140,000.

The third alternative would require the construction of an aerial crossing just upstream of Bradley Road. Although the same size pipe would be needed, it would have to be built about 20 feet above Bradley Road in order to maintain gravity flow. The cost of this alternative is over $500,000.

The fourth alternative evaluated is a 4' x 4' RCB culvert under the canal for the Windmill Gulch channel at the existing crossing location. Concrete lining would be provided for the canal over the culvert crossing. The construction cost for this alternative is estimated to be about $85,000.

H. Summary of Alternatives

Evaluation of the alternatives was based on a number of factors including:

1. Environmental Impacts
2. Impacts on Existing Facilities
3. Impacts on Existing Utilities
4. Constructability
5. Land Uses
6. Construction Costs
7. Land Acquisition Costs
8. Operations and Maintenance Costs

Based on the above factors and additional considerations, Alternative 2 appears to be the most prudent choice. The combination of avoidance of wetland areas where possible, minimal disturbance in significant areas, and mitigation where disturbance could not be avoided generate a scheme which will benefit the entire basin.

The recommended improvements to the Canal No. 4 reach include the construction of a storm sewer adjacent to Canal No. 4 and Bradley Road. This system would cross Canal No. 4 and discharge directly into Windmill Gulch north of Bradley Road. The Windmill Gulch/Canal No. 4 crossing improvement recommended is as discussed in the fourth alternative. This improvement, which allows flows in Windmill Gulch to pass under Canal No. 4, limits the impact to Canal No. 4, minimizes wetland impact, and is most cost effective.

VI. PRELIMINARY DESIGN

A. General

Based on the results of the alternatives evaluation and comments from the public meetings and the County, the concepts from the chosen alternative were developed into preliminary designs. Each major system in the Windmill Gulch drainage basin is delineated on the preliminary plans contained in Appendix B with the associated costs for the facilities included in a summary table in the Economic Analysis section.

Although specific types of erosion protection and drop structures are delineated on the preliminary plans, that does not preclude the use of other design materials or design schemes that will serve the intended purpose as well as or better than those presented herein both hydraulically and environmentally. The designs presented in this study represent one method of stabilizing the channel. Other methods of stabilization are permitted as long as they meet with the approval of the El Paso County Department of Public Works and other affected agencies. It must also be noted, however, that any additional costs for an alternate protection system, above those costs listed in this study, must be borne solely by the individual developing the channel. Also it should be noted that any significant change in materials or design schemes may require additional coordination and review time to the L.O.P. approval process.

As mentioned in the Alternative Drainage System section, wetland and riparian areas will be preserved throughout the basin. In those areas where some disturbance occurs, the disturbed areas shall be restored as closely as possible to their natural state. In areas where wetlands cannot be restored in the exact location, such as where riprap is placed below drops, they shall be mitigated in locations within the same stream reach. In order to prevent unnecessary disturbance to the area, drop structures should be constructed prior to the placement of the low flow channels.

As stated previously, the recommendations presented in the Colorado Springs Municipal Airport Master Drainage Study by Greiner, Inc. have been utilized as the summary document for those airport improvements. No specific costs or recommendations have been delineated in the Preliminary Design section. It is imperative therefore that the detention and culvert improvements be in place prior to the development of the property. Currently, some flows from the existing airport property are flowing west across Powers Boulevard at Drennen Road. These flows will need to be redirected south across Drennan Road and into a detention facility as depicted on the master plan before actual development takes place on the site.

B. Fountain Creek Outfall to Bradley Road

This reach of the drainage system is presented on Sheet Nos. 1 and 2 of the preliminary design plan/profile sheets. The existing Windmill Gulch outfall consists of a 144" corrugated metal storm sewer which discharges into Fountain Creek. The storm sewer outlet currently sits approximately 3 feet above the Fountain Creek water surface. Most of the riprap which was placed when the storm sewer was constructed has been eroded out leaving behind a 3-4 feet deep scour hole. An armored scour hole using 36"-48" riprap should be constructed at the site of the existing scour hole.

The storm sewer system continues across U.S. Highway 85/87, the AT&SF Railroad and Security Boulevard. It then travels up Crawford Avenue to Libby Court where the pipe size decreases from 144" to 120", and turns 90 degrees. Although the bend occurs within a small manhole, rather than a junction chamber, the small decrease in junction loss gained by enlarging the junction does not warrant reconstruction of the junction. The storm sewer then continues for another 350 feet where the concrete Aspen Channel enters the storm sewer. The existing drop inlet should be reconstructed to improve the hydraulic characteristics of the storm sewer entrance. The proposed

inlet structure should be modeled to more accurately design the hydraulic performance of the structure. In conjunction with the drop inlet redesign, the entrance channel should also be reconstructed to provide a smoother transition into the 120" storm sewer. Included in the entrance channel rework would be the lowering of the channel downstream of Grand Boulevard and the elimination of the stilling basin upstream of Grand Boulevard. By performing a hydraulic model study of the drop inlet, a more accurate capacity rating can be developed. In addition, refinements to the structure design can result in construction cost savings.

The existing concrete lined Aspen Channel, which extends from Grand Boulevard to the existing detention pond, has an 8 feet wide bottom with 1:1 side slopes. Hydraulic calculations, performed using the HEC-2 water surface program, show that the existing channel will not handle the existing 100-year flow of 1,190 cfs. However, once the detention ponds are in place upstream, the projected 100-year flows will decrease to a level of 935 cfs, which can be contained within the existing channel.

The existing 18' x 4' RCB culvert crossing of Hackberry Drive/Aspen Drive is also undersized. An additional 10' x 4' RCB barrel must be constructed to provide adequate capacity for the future condition peak 100-year discharge of 885 cfs. New transitions of the concrete lining of the Aspen Channel will be required both downstream and upstream of this enlarged culvert crossing. Alternative design options, including channel modifications and additional upstream detention may be considered during final design.

Proceeding upstream, Detention Pond No. 5 appears to be functioning adequately except for some concerns about maintenance of the low flow channel and other minor construction deficiencies. The construction of meandering porous boulder low flow channels through the detention facility should alleviate the maintenance concerns, while still providing an environmentally sensitive design. Also, in order to intercept flows from Subbasin No. 9, approximately 800 feet of 48" RCP will be needed to direct the flows into the detention pond. The 48" RCP is considered an initial system by El Paso County.

Between the detention facility inlet and Bradley Road, a 144" corrugated metal storm sewer is in place. This system is connected to the double 10' x 6' reinforced concrete box culvert under Bradley Road through a large junction chamber. The hydraulic losses at the junction chamber reduce the capacity of the box culvert, however, the ponding upstream of Bradley Road is a foot below the road prior to any future detention upstream. No improvements are proposed in this section of the channel reach.

C. Bradley Road to Canal No. 4

This portion of the drainage system is located on Sheet No. 2 of the preliminary design plan/profile sheets. Beginning at Bradley Road, the existing double 10' x 6' culvert should be extended an additional 15 feet in order to construct an embankment beyond the Bradley Road right-of-way. In order to further restrict the future flows and thereby increase the detention capacity of the facility without significantly disturbing the existing environmentally sensitive area, a 10' x 5' drop inlet, 7.6 feet deep, should be built on the west barrel of the culvert. The area west of the drop inlet should be excavated to provide for a sedimentation basin for the Bradley Road ditch flows as well as the Canal No. 4 overflow channel.

In order to prevent stream degradation and preserve an existing wetlands pond, a drop structure should be built at the site of an existing embankment (Station 91+20) to protect against failure during a 100-year event.

Proceeding upstream from the existing pond, several grade control structures should be strategically placed along the stream reach to the existing canal crossing location to protect the channel bottom from severe erosion. The three proposed grade control structures can be constructed with little disturbance to the surrounding vegetation.

It is estimated that work in this reach will cause the following amount of disturbance:

ZONE	TOTAL AREA	AREA OF DISTURBANCE	AREA OF REPLANTING	AREA OF NET LOSS
#2 - Backwater Wetland	0.27 Ac.	0.27 Ac.	0.27 Ac.	---
#3 - Herbaceous Wetland	1.52 Ac.	0.29 Ac.	0.25 Ac.	0.04 Ac.
#4 - Shrub Wetland	0.33 Ac.	0.08 Ac.	0.04 Ac.	0.04 Ac.
#5 - Wetland Swale	---	---	---	---
#6 - Cottonwood	0.50 Ac.	0.34 Ac.	0.34 Ac.	---
#7 - Wetland Margins	1.54 Ac.	0.09 Ac.	0.09 Ac.	---
Total	4.16 Ac.	1.07 Ac.	0.99 Ac.	0.08 Ac.

D. Canal No. 4 to Drennan Road Detention Pond

This channel reach is presented on Sheet Nos. 2 and 3 of the preliminary design plan/profile sheets. The current Fountain Mutual Irrigation Company Canal No. 4 crossing does not allow the Windmill Gulch flows to cross. In order to provide an adequate opening for Windmill Gulch flows to pass under the canal, a 4' x 4' reinforced concrete box culvert with a slope-tapered inlet will be provided. The proposed 60" RCP outlet of Detention Pond No. 3 will discharge through an energy dissipator structure at the same location as the outfall of the culvert under Canal No. 4. Riprap erosion protection will be placed at these outfalls. Concrete lining of Canal No. 4 will be provided over these conduits. Since only a portion of the 100-year flow, limited to 185 cfs, will bypass Detention Pond No. 3 and continue in the existing channel to the canal crossing, the existing natural grass lining will be adequate for this channel reach.

At the pond entrance, most of the storm flows will be diverted from the existing channel due to a control weir placed within the existing channel. The existing channel section should be restricted by placing a concrete weir with an 8 foot long opening in the channel causing the majority of the flow to be diverted into the detention facility which is to be built at the site of an abandoned gravel pit. A riprap lined entrance weir into the detention facility should be elevated 2 feet above the existing channel to keep normal channel low flows from entering the facility. A sedimentation basin should be constructed immediately downstream of the entrance weir into the detention pond to prevent damage to the spillway embankment and pond bottom. A porous boulder low flow channel should be constructed through the remainder of the detention facility to facilitate adequate maintenance of the facility. This facility will require approximately 160,000 CY of excavation over the 15.2 acre site, and provide 78.8 acre feet of storage during the 100-year discharge to reduce the peak flow from 1,540 cfs to 315 cfs.

From the detention facility entrance upstream for approximately 1,140 LF, a grass channel with a riprap lined low flow channel should be constructed to handle the 100-year flow of 1,150 cfs. At the upstream end of this channel reach, a grade control structure should be placed to stabilize the channel invert.

Beginning at the grade control structure and continuing upstream, a meandering porous boulder low flow channel should be constructed to divert the anticipated nuisance flows (i.e., sprinkler overspray, etc.) and keep this increased base flow from damaging the existing wetlands. The low flow channel, as shown on the preliminary plan/profile Sheet No. 3, can be strategically located such that it does not encroach on the herbaceous wetlands but instead skirts the fringe of the main wetlands with an invert which is approximately at the same elevation of the wetlands. The total length of the low flow channel is approximately 2,500 feet.

As the low flow channel meanders through the channel reach, it should connect back into the main channel at the proposed drop structure and grade control structure locations. As in the previous channel reach, the drops and grade control structures are placed to control channel degradation while enhancing and encouraging the further development of wetlands behind the structures. A total of three drop structures and five grade control structures are proposed within this reach.

Just upstream of the last grade control structure, at station 157+00, a combined energy dissipator/sedimentation basin should be constructed to transition the storm flows from the proposed riprap channel into the downstream wetlands. The riprap channel will transport the storm flows from the proposed 84" RCP detention pond outlet to the existing wetlands area. Due to the existing steep channel slope of 1.9%, a riprap channel is needed to prevent severe erosion from occurring. With a bottom width of 8 feet and 2.5:1 side slopes, the riprap would only have to extend up approximately 2.5 feet at which point a milder 6:1 grassed side slope area could be used for the freeboard area. This riprap channel is proposed in an area which currently contains no riparian or wetland areas and would be better suited for the proposed commercial land uses in the area, yet still maximize aesthetics.

An 84" RCP outlet is proposed to transport flows out of the Detention Pond No. 2 which is proposed to be built just north of Drennan Road. The proposed 20.7 acre feet facility will reduce the 100-year peak flow from 780 cfs to 240 cfs. A 10' x 10' drop inlet with a 5 feet diameter orifice plate should be constructed upstream of the Drennan Road right-of-way. The orifice plate will restrict the pond outflow while the inlet grate will be utilized as an emergency spillway with the 84" RCP outlet sized to accommodate most of the storm peak should the orifice plate area become clogged. Construction of the detention facility will require approximately 180,000 CY of excavation.

It is estimated that this alternative will cause the following amount of disturbance:

ZONE	TOTAL AREA	AREA OF DISTURBANCE	AREA OF REPLANTING	AREA OF NET LOSS
#2 - Backwater Wetland	---	---	---	---
#3 - Herbaceous Wetland	3.25 Ac.	0.76 Ac.	0.38 Ac.	0.38 Ac.
#4 - Shrub Wetland	---	---	---	---
#5 - Wetland Swale	2.71 Ac.	1.29 Ac.	0.60 Ac.	0.69 Ac.
#6 - Cottonwood	3.90 Ac.	0.75 Ac.	0.55 Ac.	0.20 Ac.
#7 - Wetland Margins	---	---	---	---
Total	9.86 Ac.	2.80 Ac.	1.53 Ac.	1.27 Ac.

E. Powers Boulevard Tributaries

The major flow routes which cross Powers Boulevard and enter the Windmill Gulch channel occur at two locations. The first major tributary crosses Powers Blvd. approximately 5,700 feet south of Drennan Road. At this location an 18.1 acre feet detention facility will be required on the Airport property to reduce the peak flow from 705 cfs to 250 cfs. Once the flow crosses under Powers Boulevard it should be intercepted by a 10 feet wide riprap channel which will flow for about 1,400 feet until it is intercepted by a riprap diversion channel. The 1,200 feet riprap diversion channel will convey the developed runoff from this area into the Detention Pond No. 3. By diverting the developed flows into the detention basin, it will eliminate a crossing of the canal as well as reduce the amount of flow into the environmentally sensitive areas.

The second major tributary crosses Powers Boulevard approximately 2,000 feet south of Drennan Road. This location is the outlet for most of the proposed airport improvements. In accordance with the Colorado Springs Municipal Airport Master Drainage Study prepared by Greiner, Inc., a series of detention facilities will be developed throughout the airport site to reduce the outflow from the entire developed land tributary to this location to only 150 cfs.

The culvert under the Powers Boulevard west frontage road should be a 60" RCP with an energy dissipator to accommodate this flow. The downstream channel should be a riprap lined channel, with a 10 feet wide bottom. A sedimentation basin should be built on the channel prior to the confluence with Windmill Gulch.

F. Storm Sewer Adjacent to Canal No. 4 and Bradley Road

The storm sewer that currently discharges into Canal No. 4 just downstream of the Hancock Expressway crossing (from the northeasterly corner of Bradley Road and Hancock Expressway) will be intercepted by a 54" RCP draining westerly in Bradley Road across Hancock Expressway as proposed in the El Paso County Hancock Expressway widening project. All storm runoff from Subbasins 20 and 22 will be carried in this 54" RCP. From this location downstream, only irrigation flow will remain in Canal No. 4. No improvement of the canal is proposed, however; routine periodic maintenance of the canal by the Fountain Mutual Irrigation Company is recommended.

A 48" RCP storm sewer trunkline will begin at the intersection of Cantrell Drive and Bradley Road and cross southerly and easterly through Subbasin 16 to the northerly side of Canal No. 4 about 350 feet east of Alturas Drive. This trunkline is sized to carry the 100-year peak discharge from all the drainage areas tributary to it. At Cantrell Drive and Bradley Road the peak discharge is 155 cfs from Subbasin 18. At Alturas Drive the trunkline will increase to a 60" RCP for the total peak discharge of 205 cfs due to the addition of Subbasin 16, the future development area between Bradley Road and Canal No. 4 west and east of Alturas Drive. The 60" RCP storm sewer trunkline will continue along the northerly side of Canal No. 4 to about 1,100 feet east of Alturas Drive. This upper portion of the trunkline is considered an initial system by El Paso County, and is not included in the cost analysis of this study.

At this location about 1,100 feet east of Alturas Drive, the trunkline will increase to a 72" RCP. The 72" RCP storm sewer trunkline will cross Bradley Road and join the existing 42" RCP storm sewer lateral in Bradley Circle about 400 feet west of Marabou Way, within the development area north of Bradley Road that is partially constructed. At this location the trunkline will increase to a 90" RCP for the total peak discharge of 445 cfs.

The 90" RCP storm sewer trunkline will continue easterly in Bradley Circle and Marabou Way, and along the northerly side of Bradley Road toward the Windmill Gulch channel. An energy dissipator and a sedimentation basin will be provided at the outfall of the storm sewer trunkline on the

westerly side of the Windmill Gulch channel. The storm sewer adjacent to Canal No. 4 and Bradley Road will convey the 100-year storm runoff from Subbasins 16, 18, 33, and 34 into the Windmill Gulch drainage basin.

G. Environmental Impact Mitigation Guidelines

As stated previously, every attempt was made to avoid disturbing existing wetlands, however, some areas could not be totally avoided. Of the total estimated wetland area of 14 acres which exist at the time of this study, only 3.9 acres is estimated to be disturbed. It is estimated that most of the disturbed wetlands can be replanted in the same location with only a minimal amount of mitigation required.

It will be the responsibility of the owner who disturbs the existing wetlands to do whatever is necessary to mitigate the wetland disturbance within the same channel reach as the disturbance occurs.

The drop structures, grasslined channels and low flow channels shown on the plans were designed to minimize impacts to wetlands by providing opportunities for mitigation within their designs. The following are guidelines which were used to determine potential areas of mitigation:

Drop Structures -

- Set top of wall one foot above natural channel flow line to promote the establishment of a backwater wetland which may be considered as a "value enhancement" and credited against the placement of new wetlands.

- Plant willows and other wetland shrubs adjacent to the drop structure where disturbed during construction.

- Replant channel bottom with wetland vegetation downstream of riprap lined plunge pool.

Grass Lined Channels -

- Re-establish wetland vegetation within the natural bottom of the channel.

- Cover sideslope protection riprap with soil and plant willows along the lower portion of the side slope.

Low Flow Channels -

- Construct channel along the fringe of the wetlands, only bringing it into the main wetlands where necessary at proposed drop structures or grade control structures.

- Meander channel in such a manner as to avoid existing large cottonwood trees as well as other significant features where possible.

- Perform selective grading between the low flow channel and the wetland area to lower the existing ground so new enhanced wetland areas can be established.

The List of Categories of Activities and Letter of Permission Procedures for the Windmill Gulch Drainage Basin Planning Study was issued by the U.S. Army Corps of Engineers in December 1991. Copies of these are included in the Appendix C.

VII. WATER QUALITY

A. General

Concern regarding storm water quality has been growing through the past decade. Recently the Environmental Protection Agency (EPA) has been working on regulations for monitoring and the use of best management practices to control stormwater. The actual design for any necessary control facilities will vary according to the type of pollutants present.

Pollutants enter stormwater in many ways, among which are the following:

1. Pollutants are absorbed as the raindrops pass through the atmosphere.
2. Pollutants are washed off the paved and unpaved surfaces by stormwater runoff.
3. Pollutants that have accumulated since the last storm in sewers, ditches, and channels are picked up by the stormwater.

B. Airport Treatment

Since the airport facility is predominantly tributary to the Windmill Gulch basin, the quality of the runoff has a direct bearing on the entire stream quality. In order to address the airport recommendations, the following summary is being included from the Colorado Springs Municipal Airport Master Drainage Study by Greiner, Inc., 1988:

> Contaminated stormwater runoff may occur in areas such as parking facilities, maintenance areas, cargo areas, fuel storage facilities, equipment storage areas and aircraft gate areas. To maintain the water quality of the existing basins, the contaminated runoff will require treatment prior to being released back into the drainage basin. In addition, runoff which contains ethylene glycol, used in the deicing of aircraft, must be kept separate from other stormwater, as a different method of treatment is required. During final design, a thorough examination of stormwater facilities required for the treatment of contaminated water should be undertaken. The design of these facilities should be addressed in the final drainage studies for individual sites. It should also be noted that water quality must be maintained during the period of time in which construction of new airport facilities is occurring. Temporary sedimentation ponds and other facilities will be required for these interim conditions.

C. Channel Treatments

Most of the pollutants expected to reach the main stem of the channel should be of the suspended solid variety. However, it may be necessary to sample and analyze the stormwater to determine the exact control measures to implement in water quality control facilities. Several of these facilities have been located at stormwater discharge points along the main channel reach.

Dry basins should be designed in areas where the main pollutants are suspended solids which simply settle out in the basin when the channel velocity drops. However, if dissolved solids, nitrates and nitrites, and soluble phosphorus are present, a wet pond will need to be constructed to reduce these pollutants.

VIII. ECONOMIC ANALYSIS

A. General

The economic analysis of the channel improvements listed in this study was derived from current construction prices for materials and labor in the Colorado Springs, El Paso County area. In

addition, the 1989 edition of the Colorado Department of Highways "Cost Data" was utilized. Estimated probable construction costs were determined for each channel reach for the selected alternative utilizing the protection scheme delineated in the Alternative Drainage Systems section and on the preliminary plans located in Appendix B. The following table, Unit Construction Costs, lists the specific unit costs used in determining the estimated probable construction costs:

TABLE 9

UNIT CONSTRUCTION COSTS

Item Description	Unit	Estimated Unit Cost
Riprap	CY	$ 35
Heavy riprap	CY	45
Granular bedding material	CY	20
Class 6 base course (maintenance road)	CY	15
Reinforced concrete	CY	265
Concrete channel lining	CY	180
Structural backfill	CY	8
Structural excavation	CY	5
Unclassified excavation and embankment	CY	1.50
Seeding (native)	Acre	1,000
Wetland revegetation	Acre	5,000
18" CMP (pipe and installation)	LF	25
48" RCP (pipe and installation)	LF	75
60" RCP (pipe and installation)	LF	110
72" RCP (pipe and installation)	LF	130
84" RCP (pipe and installation)	LF	185
90" RCP (pipe and installation)	LF	210
Box base manhole (10' depth)	Each	2,500
Box base manhole (15' depth)	Each	3,500
Box base manhole (20' depth)	Each	4,000
Box base manhole (25' depth)	Each	4,500

NOTE: Pipe and culvert costs do not include utility relocation costs.

B. Preliminary Estimate of Probable Construction Costs

As previously stated, the proposed improvements are illustrated on the Preliminary Design Plan/Profile sheets that are included in the Appendix. Preliminary probable construction costs were estimated for each improvement based on the unit construction costs provided in this section. Typical improvement details can also be found in the Appendix of this report.

Costs have been divided into creditable costs and other costs. Creditable costs are those which are included in the drainage basin fee calculation. Other costs are those which are the responsibility of private owners or developers of land within the Windmill Gulch drainage basin according to prior obligations, cost sharing policies and criteria for existing inadequacies, or pertaining to facilities classified as minor/initial systems.

TABLE 10
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

Location	Improvement Description	Estimated Probable Construction Cost	
		Creditable	Other
Fountain Creek Outfall to Bradley Road			
At Outfall	Heavy riprap lined scour hole		$13,800*
At drop inlet to 120" CMP storm sewer	Reconstruct drop inlet		67,700*
Drop inlet to Grand Blvd.	Concrete channel, b=20', z=0, d=8'		101,500*
At Hackberry Dr./Aspen Dr.	Add'l 10' X 4' RCB Culvert barrel with conc. channel transitions D/S and U/S		49,300*
Detention Pond No. 5	Porous boulder low flow channel from east and through pond B=8', d=2'	$56,500	
	Porous boulder low flow channel, from west b=8', d=2'		17,100*
	48" RCP storm sewer from west		76,000
	Sloping riprap drop structure to east of Sta. 66+00	18,300	
	TOTAL CONSTRUCTION COSTS	$ 74,800	$325,400

* The responsibility of the owners of the Fountain Valley Ranch.

TABLE 10 (Cont.)
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

Location	Improvement Description	Estimated Probable Construction Cost	
		Creditable	Other
Bradley Road to Canal No. 4			
At Bradley Road	Double 10′ X 6′ RCB ectension (Bridge Cost)	($ 12,800)	
	10′ X 5′ X 7.6′ drop inlet	5,800	
	Sedimentation basin	32,700	
Sta 89+00 to Sta 91+20	Natural channel improvement	2,500	
	3′ drop structure (TW=100′) with 30′ riprap stilling basin and 10′ riprap apron U/S	35,300	
Sta 91+20 to Sta 106+70	3-grade control structures (TW=80′ Ave.)	26,700	
	TOTAL CONSTRUCTION COST	$103,000	
	TOTAL BRIDGE COSTS	$ 12,800	

TABLE 10 (Cont.)
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

Location	Improvement Description	Estimated Probable Construction Cost	
		Creditable	Other
Canal No. 4 to Drennan Road Detention Pond			
Sta 106+70 to Sta 109+50	4' X 4' RCB culvert under Canal No. 4 with slope-tapered inlet and riprap lining D/S	$ 84,600	
Sta 118+10	Concrete control weir	22,500	
At Detention Pond No. 3	Pond improvements	479,200	
Entrance of Detention Pond No. 3 to Sta 129+00	Grass channel riprap low flow, b=20', d=3.75', z=2.5 Grass overbank, d=3.25', z=4	131,800	
Sta 129+00 to Sta 132+00	Sedimentation basin to west of Sta 123+00	27,200	
Sta 132+00 to Sta 138+00	Transition from grass channel to porous boulder low flow channel	32,300	
	Porous boulder low flow channel b=8', d=2	34,500	
	2-grade control structures (TW=110' Ave.)	24,200	
	Natural channel improvement	3,600	

TABLE 10 (Cont.)
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

Location	Improvement Description	Estimated Probable Construction Cost	
		Creditable	Other
Canal No. 4 to Drennan Road Detention Pond (continued)			
Sta 132+00 to Sta 138+00 (continued)	Sedimentation basin to west of Sta 137+00	$ 8,700	
	3′ Drop structure (TW=150′) with 30′ riprap stilling basin and 10′ riprap apron U/S	50,800	
Sta 138+00 to Sta 141+80	Porous boulder low flow channel, b=8′, d=2′	21,600	
	Natural channel improvement	2,600	
	Sedimentation basin to west of Sta 141+00	24,500	
	3′ Drop structure (TW=140′) with 30′ riprap stilling basin and 10′ riprap apron U/S	47,800	
Sta 141+80 to Sta 151+35	Porous boulder low flow channel, b=8′, d=2′	53,600	
	Grade control structure (TW=120′)	12,600	
	Natural channel improvement	2,000	
	3′ Drop structure (TW=140′) with 30′ riprap stilling basin and 10′ riprap apron U/S	47,800	

TABLE 10 (Cont.)
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

Location	Improvement Description	Estimated Probable Construction Cost	
		Creditable	Other
Canal No. 4 to Drennan Road Detention Pond (continued)			
Sta 151+35 to Sta 157+00	Porous boulder low flow channel b=8', d=2'	$ 31,900	
	2-grade control structures (TW=130' Ave.)	26,800	
Sta 157+00 to Sta 158+00	Energy dissipator/sedimentation basin	24,700	
Sta 158+00 to Sta 168+65	Riprap lined channel (b=8', z=2.5, d=2.5')	88,500	
	Energy dissipator	8,300	
Sta 168+80 to Sta 170+80	84" RCP	48,800	
At Detention Pond No. 2	Pond improvements	325,600	
	TOTAL CONSTRUCTION COSTS	$1,666,500	

TABLE 10 (Cont.)
PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST SUMMARY

Location	Improvement Description	Estimated Probable Construction Cost	
		Creditable	Other
Powers Blvd. Tributaries			
Detention Pond No. 3 to Powers Blvd.	Riprap lined diversion channel (b=20', z=2.5, d=5.5')	$220,000	
	Riprap lined channel (b=10', z=2.5, d=3.5')	148,700	
Sedimentation basin to Powers Blvd.	Sedimentation basin	13,300	
	Riprap lined channel (b=10', z=2.5, d=3.0')	20,700	
	Energy dissipator	6,500	
	60" RCP	14,200	
	TOTAL CONSTRUCTION COSTS	$423,400	
Storm Sewer Adjacent to Canal No. 4 and Bradley Road			
Sta 0+00	Energy dissipator	$ 8,400*	$ 9,100
Sta 0+00 to Sta 29+75	90" RCP storm sewer	465,500*	498,900
Sta 29+75 to Sta 33+00	72" RCP storm sewer	49,000*	53,100
	TOTAL CONSTRUCTION COSTS	$522,900	$561,100

* Cost split is based on proportion of stormwater runoff due to an increase in basin development.

TABLE 11

DETENTION LAND COST

Location	Unit	Unit Price	Quantity		Cost
Detention Pond No. 2	Acre	$14,000	8.7		$121,800
Detention Pond No. 3	Acre	14,000	15.2		212,800
Detention Pond No. 4	Acre	14,000	12.5		$175,000
				TOTAL	$509,600

$14,000 per acre for detention land cost is based on the 1991 City of Colorado Springs park land dedication fee.

TABLE 12

SUMMARY OF COSTS (CREDITABLE)

Reach	Estimated Cost
Fountain Creek Outfall to Bradley Road	$ 74,800
Bradley Road to Canal No. 4	103,000
Canal No. 4 to Drennan Road Pond	1,666,500
Powers Blvd. Tributary	423,400
Storm Sewer Adjacent to Canal No. 4 and Bradley Road	522,900
Construction Cost	$2,790,600
Contingencies (5% of Construction Cost	139,530
Engineering (10% of Const. Cost & Cont.)	293,010
Total Construction Cost	$3,223,140
Study Cost	64,100
Anticipated Basin Outstanding Claims	1,936,224.79
Present Outstanding Claim	14,232.30
Anticipated Basin Revenue (Deduct)	-38,162.24
Total Improvement Costs	$5,199,534.85

Bridge Costs

Bradley Road

Construction Cost	$12,800
Contingencies (5% of Construction Cost)	600
Pheasant Run/Bradley Road Local Improvement District Box Culvert Construction Cost	103,783.41
Engineering (10% of Construction Cost & Cont.)	11,700
Total Construction Cost	$128,883.41
Existing Bridge Fund Balance (Deduct)	-3,558.61
Bridge Fees Due (Fountain Valley Ranch) (Deduct)	- 107.98
County Arterial Roadway Bridge Participation (Percentage per previous Planning Study and B.O.C.C. Resolution) (Deduct)	-20,860.47
Total Bridge Costs	$104,356.35

C. Drainage Basin Fee Calculations

As prescribed by the City/County Drainage Criteria Manual, drainage basin fees have been calculated for the Windmill Gulch Drainage Basin. This fee has been calculated by dividing the total costs of all major improvements within the drainage basin by the total acres of developable acreage within the basin. Since the drainage improvements within the airport land will not be included in the construction costs, the acreage within the airport land has also been excluded. In addition, the platted lands within the Fountain Valley Ranch Development have been excluded. Major improvements are defined as those facilities which have approximately 100 acres tributary to them. The recommended drainage fee is computed as follows:

Area

Total Developable Land - 915 Acres

Fees

$$\text{Drainage Fee} = \frac{\$5,199,534.85}{915} = \$5,682.55 \text{ or } \$5,683/\text{Acre}$$

$$\text{Bridge Fee} = \frac{\$104,356.35}{915} = \$114.05/\text{Acre or } \$115/\text{Acre}$$

$$\text{Detention Land Fee} = \frac{\$509,600}{915} = \$556.94 \text{ or } \$557/\text{Acre}$$

IX. MAINTENANCE REQUIREMENTS

A. Access

Maintenance access must be provided along all major drainageways. The typical channel sections developed for this study all contain a 12 feet wide maintenance road adjacent to the channels. The specific location of the maintenance road should be determined at the time of final plan design since adjustment of the location of the maintenance road may have to be made due to field conditions. In addition, in some instances it may be necessary to construct ramps down into the channel for proper access.

B. Right-of-Way

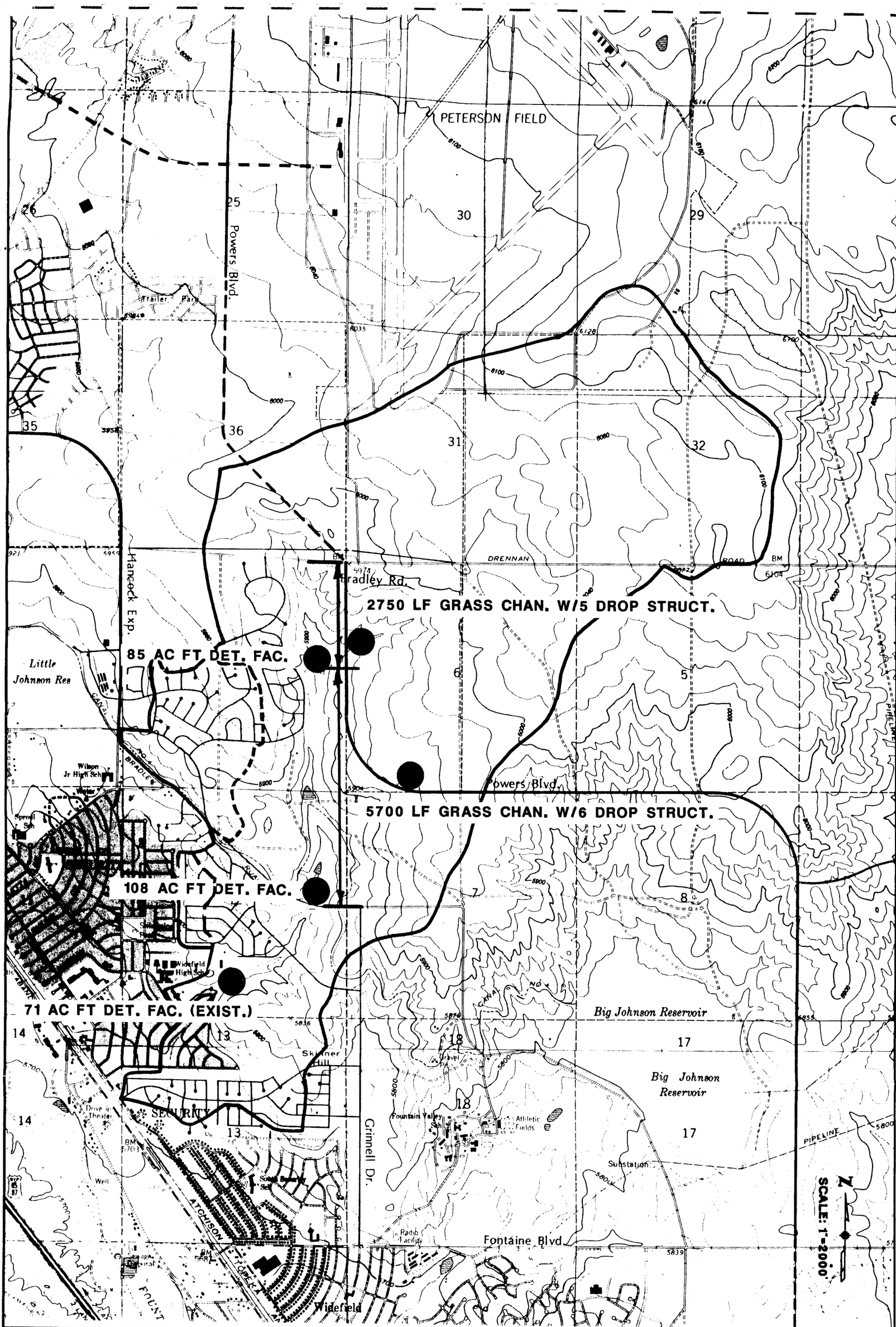
El Paso County shall maintain major drainageways and detention facilities within the basin which have been designed and constructed according to applicable County standards, approved and accepted by the County, and properly dedicated free of encumbrance to El Paso County. For major drainageways this right-of-way dedication shall include the limits of the channel side slopes subjected to the 100-year flow and an additional freeboard depth, plus the maintenance road area. For detention facilities, this right-of-way shall include the entire basin area in addition to an appropriate maintenance road which will provide proper access around the entire facility.

C. Costs

The costs for maintaining these accepted public channels and detention facilities shall be borne by El Paso County unless other specific arrangements acceptable to the County are made prior to final platting. Should the owner of the property on which the facility is located wish to maintain the facility to a level greater than required by El Paso County, that additional cost shall be paid by that owner.

Some of the existing and proposed facilities within the Windmill Gulch drainage basin may be subject to a joint maintenance responsibility between El Paso County and the Fountain Mutual Irrigation Company. These facilities may include the proposed Windmill Gulch Canal Crossing, located approximately 2400 feet north of Bradley Road. Any agreement regarding shared responsibility or maintenance provision will be as a result of future discussions between the El Paso Board of County Commissioners and the Fountain Mutual Irrigation Company and is not addressed in this study.

APPENDIX A

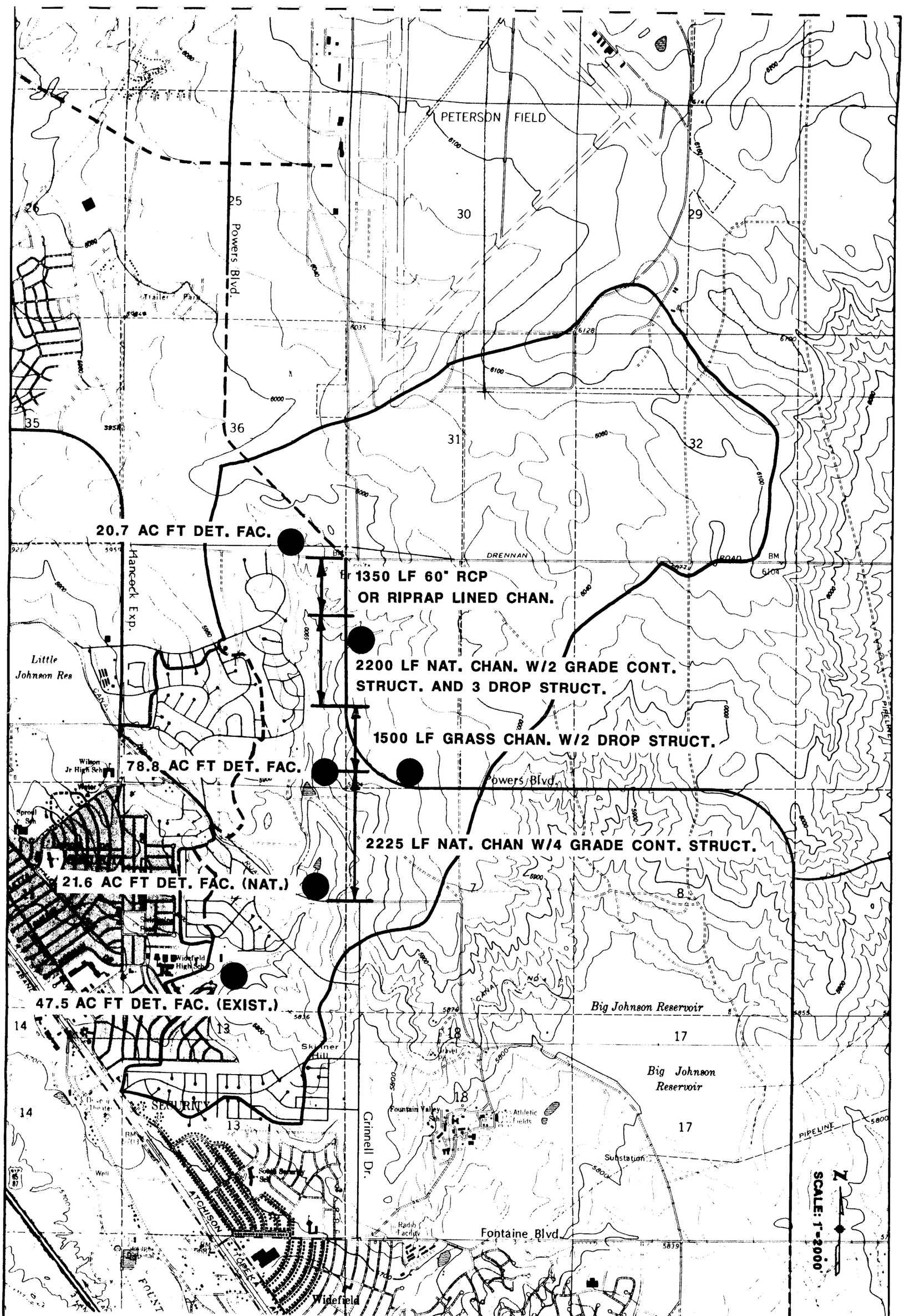


WILSON & COMPANY COLORADO SPRINGS, COLORADO	SHEET NO.	FILE NO.	DATE	DRAWN	DESIGN	WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY ALTERNATIVE 1	WILSON & COMPANY

REVISION	DATE	BY

ALTERNATIVE 1

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Drennan Rd. to 1300' S. (170+50 to 157+00)	150 LF-11'x6' RCB and 1200 LF-Grass lined channel	$ 265,000		803		Routine culvert constr. & complete channel reconstruction	Commercial along Pwrs. & Drennan. open space for drainage-way, and residential to west	70'± easement/ ROW for channel (2± Ac)	None	No wetlands or habitats affected	Existing 43"x27" CMP culvert to be replaced w/60" RCP culvert
1300' South of Drennan Rd. to Pond 2 (157+00 to 142+00)	2750 LF-Grass channel w/4 grade control structures	25,000		1094		Minor excavations for grade control structures	Commercial along Pwrs., open space for drainage-way, and residential to west	270'± easement/ ROW for drainage-way (9.5± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
Pond 2	85 AF pond with 9'x6' RCB outlet	705,000		1094	407	Complete pond excavation and embankment	Open space multi-use basin	ROW for Pond area (14± Ac)	None	Mitigation efforts needed for Pond area	None
Pond 2 to 3500' S. of Drennan Rd. (141+00 to 135+00)	600 LF-Grass channel w/2 grade control structures	15,000		407		Minor excavations for grade control structures	Commercial to east, open space for drainage-way, and residential to west	220'± easement/ ROW for drainage-way (3± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
3500' S. of Drennan Rd. to Canal No. 4 crossing (135+00 to 105+00)	3000 LF-grass lined channel w/4 drop structures (3.5' high)	175,000		1028		Complete channel reconstruction	Commercial to east, open space for drainage way, and residential to west	110'± easement/ ROW for drainage-way (8± Ac)	None	No wetlands or habitats affected	None
Canal No. 4 crossing to Bradley Rd. (105+00 to 84+25)	2075 LF-Natural channel w/4 grade control structures	25,000		2907		Minor excavations for grade control structures	Commercial to east, open space for drainage-way, and residential to west	280'± easement/ ROW for drainage-way (7.5± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
Bradley Rd. (Pond 4)	108 AF Pond U/S Roadway	490,000		2907	1508	Pond excavation	Open space multi-use basin	ROW for Pond Area (14.5± Ac)	None	Mitigation efforts needed for Pond area	None
Bradley Rd. to Pond 5	No change	-------		2063		N/A	N/A	N/A	N/A	N/A	N/A
Pond 5	71 AF pond No change	-------		2063	1209	N/A	N/A	N/A	N/A	N/A	N/A
Pond 5 to inlet of 120" CMP storm sewer	No change	-------		1233		N/A	N/A	N/A	N/A	N/A	N/A
Inlet of 120" CMP storm sewer	Improve transition structure	100,000		1256		Minor excavation for transition structure	Residential	N/A	N/A	No wetlands or habitats affected	New transition structure between existing 120" CMP storm sewer and 144" CMP storm sewer
		$1,800,000									

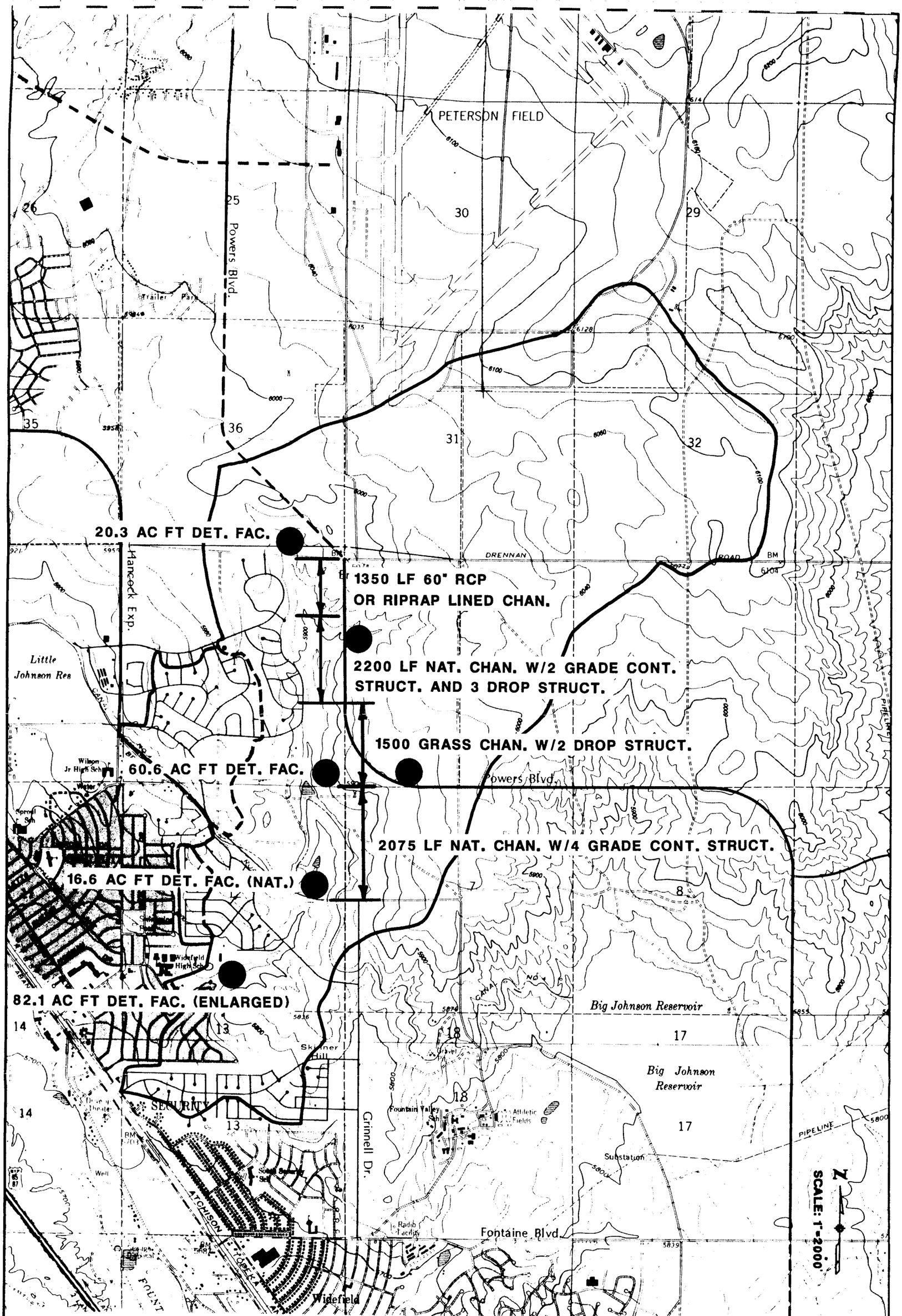


WILSON & COMPANY COLORADO SPRINGS, COLORADO	SHEET NO.	FILE NO.	DATE	DRAWN	DESIGN	WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY ALTERNATIVE 2	WILSON & COMPANY

REVISION	DATE	BY

ALTERNATIVE 2

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Pond 1 at Drennan Rd.	20.7 AF pond w/84" RCP outlet	$ 390,000		780	240	Pond excavation	Open space multi-use dry basin	ROW for Pond area (9.5± Ac)	None	No wetlands or habitats affected	Existing 43"x27" CMP culvert to be replaced w/60" RCP culvert
Pond 1 to 1300' S. of Drennan Rd. (170+50 to 157+00)	1350 LF-Grass storm sewer or riprap lined channel	175,000		240		Routine pipeline construction	Commercial along Pwrs., and residential to west	40'± easement/ ROW for pipeline (1.5+ Ac)	None	No wetlands or habitats affected	None
1300' S. of Drennan Rd. to 3500' S. (157+00 to 135+00)	2200 LF-Natural channel w/2 grade control structures and 3 drop structures	42,000		495		Minor excavations for grade control structures	Commercial along Pwrs. open space for drainage-way, and residential to west	230'± easement/ ROW for drainage-way (12± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
3500' S. to Pond 3 (135+00 to 120+00)	1500 LF-Grass lined channel w/2 drop structures (2.5' High)	100,000		1150		Complete channel reconstruction	Commercial along Pwrs. open space for drainage-way, and residential to west	120'± easement/ ROW for channel (4.5± Ac)	None	No wetlands or habitats affected	None
Pond 3	78.8 AF pond w/60" RCP outlet	430,000		1540	315	Pond excavation	Open space multi-use dry basin	ROW for Pond area (22.5± Ac)	None	No wetlands or habitats affected	None
Pond 3 to Bradley Rd. (106+50 to 84+25)	2225 LF of natural channel w/4 grade control structures	25,000		570		Minor excavations for grade control structures	Commercial to east, open space for drainage-way, and residential to west	250'± easement/ ROW for drainage-way (7.5± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
Bradley Rd. (Pond 4)	21.6 AF pond U/S roadway (natural)	85,000		1220	915	Minor excavations for outlet structure modification	Commercial to east, open space for drainage-way, and residential to west	ROW for Pond area (10.5+ Ac)	None	Minimal disturbance of existing wetland/ riparian area	Reduce Bradley Road crossing to single barrel 10'x6' RCB
Bradley Rd. to Pond 5	No change	---		915		N/A	N/A	N/A	None	N/A	N/A
Pond 5	47.5 AF pond-No change	---		1600	885	N/A	N/A	N/A	N/A	N/A	N/A
Pond 5 to inlet of 120" CMP storm sewer	No change	---		935		N/A	N/A	N/A	N/A	N/A	N/A
Inlet of 120" CMP storm sewer	Improve transition structure	100,000		935		Minor excavations for transition structure	Residential	N/A	N/A	No wetlands or habitats affected	New transition structure between existing 120" CMP storm sewer and 144" CMP storm sewer
		$1,347,000									



WILSON & COMPANY
ENGINEERS
COLORADO SPRINGS, COLORADO

SHEET NO.
FILE NO.
DATE
DRAWN
DESIGN

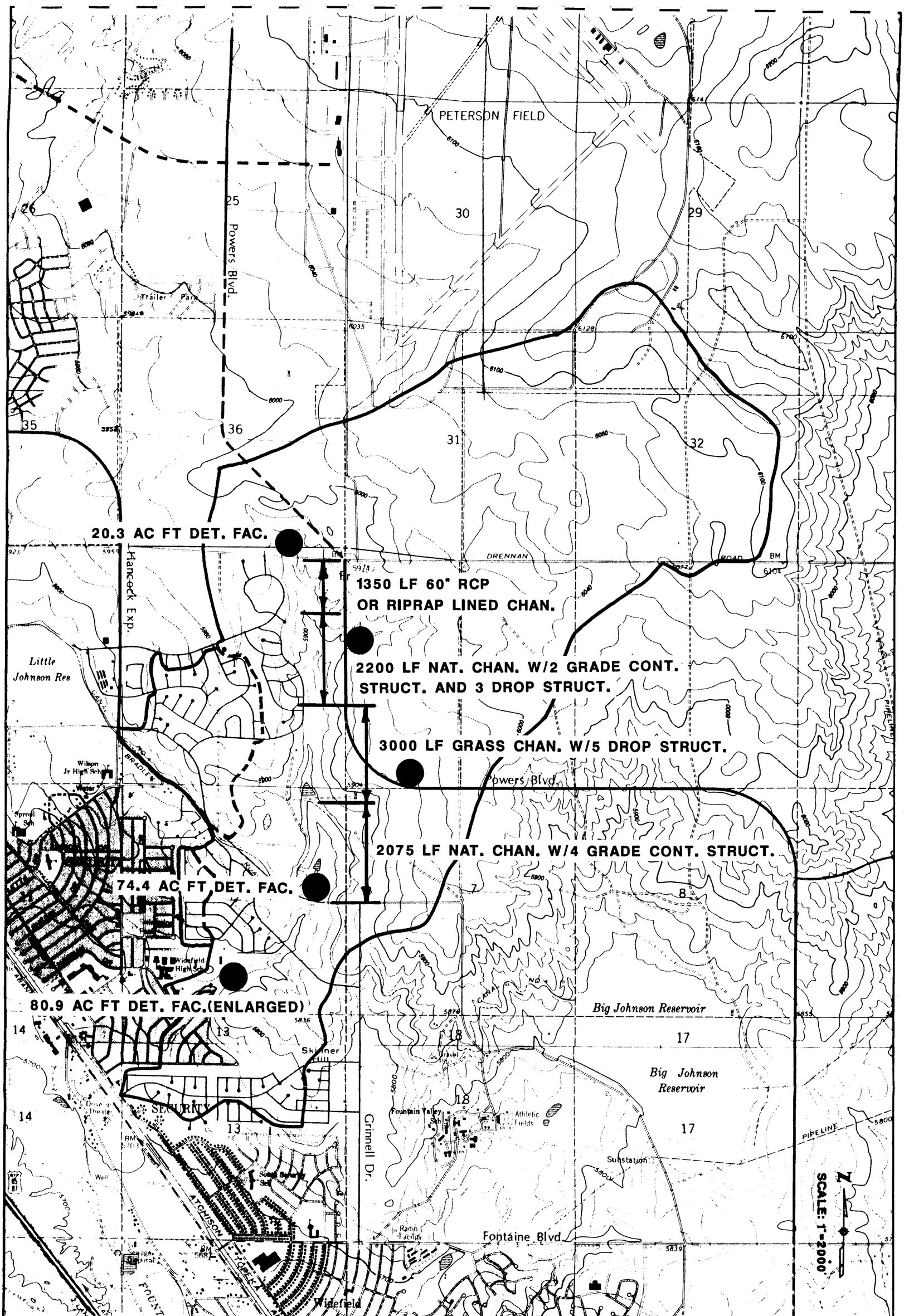
WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY
ALTERNATIVE 3

WILSON & COMPANY

REVISION	DATE	BY

ALTERNATIVE 3

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Pond 1 at Drennan Rd.	20.3 AF pond w/60" RCP outlet	$ 390,000		803	275	Pond excavation	Open space multi-use dry basin	ROW for Pond area (9.5± Ac)	None	No wetlands or habitats affected	Existing 43"x27" CMP culvert to be replaced w/60" RCP culvert
Pond 1 to 1300' S. of Drennan Rd. (170+50 to 157+00)	1350 LF-60" RCP storm sewer or riprap lined channel	175,000		275		Routine pipeline construction	Commercial along Pwrs., and residential to west	40'± easement/ ROW for pipeline (1.5+ Ac)	None	No wetlands or habitats affected	None
1300' S. of Drennan Rd. to 3500' S. (157+00 to 135+00)	2200 LF-Natural channel w/2 grade control structures and 3 drop structures	42,000		503		Minor excavations for grade control structures	Commercial along Pwrs. open space for drainage-way, and residential to west	230'± easement/ ROW for drainage-way (12± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
3500' S. to Pond 3 (135+00 to 120+00)	1500 LF-Grass lined channel w/2 drop structures (2.5' High)	100,000		1231		Complete channel reconstruction	Commercial along Pwrs. open space for drainage-way, and residential to west	120'± easement/ ROW for channel (4.5± Ac)	None	No wetlands or habitats affected	None
Pond 3	60.6 AF pond w/60" RCP outlet	430,000		1231	295	Pond excavation	Open space multi-use dry basin	ROW for Pond area (22.5± Ac)	None	No wetlands or habitats affected	None
Pond 3 to Bradley Rd. (105+00 to 84+25)	2075 LF of natural channel w/4 grade control structures	25,000		1929		Minor excavations for grade control structures	Commercial to east, open space for drainage-way, and residential to west	250'± easement/ ROW for drainage-way (12± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
Bradley Rd. (Pond 4)	16.6 AF pond U/S roadway (natural)	---------		1929	1514	N/A	N/A	N/A	N/A	N/A	N/A
Bradley Rd. to Pond 5	No change	---------		2464		N/A	N/A	N/A	N/A	N/A	N/A
Pond 5	Enlarge pond to 82.1 AF	320,000		2464	1091	Pond excavation	Open space multi-use dry basin	Additional ROW for Pond area (5.5± Ac)	Reconstr. 900 LF of sanitary sewer	No wetlands or habitats affected	None
Pond 5 to inlet of 120" CMP storm sewer	No change	---------		1127		N/A	N/A	N/A	N/A	N/A	N/A
Inlet of 120" CMP storm sewer	Improve transition structure	100,000		1331		Minor excavations for transition structure	Residential	N/A	N/A	No wetlands or habitats affected	New transition structure between existing 120" CMP storm sewer and 144" CMP storm sewer
		$1,582,000									



WILSON & COMPANY COLORADO SPRINGS, COLORADO	SHEET NO.	FILE NO.	DATE	DRAWN	DESIGN	WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY ALTERNATIVE 4	WILSON & COMPANY

REVISION	DATE	BY

ALTERNATIVE 4

LOCATION	DESCRIPTION	COST	EXIST Q (CFS)	INFLOW CFS	OUTFLOW CFS	CONSTRUCTABILITY	LAND USE	LAND ACQUISITION	IMPACT ON EXIST UTILITIES	WETLAND & RIPARIAN CONSIDERATIONS	IMPACTS ON EXISTING CULVERTS
Pond 1 at Drennan Rd.	20.3 AF pond w/60" RCP outlet	$ 390,000		803	275	Pond excavation	Open space multi-use dry basin	ROW for Pond area (9.5± Ac)	None	No wetlands or habitats affected	Existing 43"x27" CMP culvert to be replaced w/60" RCP culvert
Pond 1 to 1300' S. of Drennan Rd. (170+50 to 157+00)	1350 LF-60" RCP storm sewer or riprap lined channel	175,000		275		Routine pipeline construction	Commercial along Pwrs., and residential to west	40'± easement/ ROW for pipeline (1.5+ Ac)	None	No wetlands or habitats affected	None
1300' S. of Drennan Rd. to 3500' S. (157+00 to 135+00)	2200 LF-Natural channel w/2 grade control structures and 3 drop structures	42,000		503		Minor excavations for grade control structures	Commercial along Pwrs. open space for drainage-way, and residential to west	230'± easement/ ROW for drainage-way (12± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
3500' S. of Drennan Rd. to Canal No. 4 Crossing (135+00 to 84+25)	3000 LF-Grass lined channel w/5 drop structures (3.4'± High)	210,000		1231		Complete channel reconstruction	Commercial along Pwrs. open space for drainage-way, and residential to west	120'± easement/ ROW for channel (4.5± Ac)	None	No wetlands or habitats affected	None
Canal No. 4 Crossing to Bradley Rd. (105+00 to 84+25)	2075 LF-Natural channel w/4 grade control structures	25,000		2956		Minor excavations for grade control structures	Commercial to east, open space for drainage-way, and residential to west	280'± easement ROW for drainage-way (7.5 ± Ac)	None	Minimal disturbance of existing wetland/ riparian area	None
Bradley Rd. (Pond 4)	74.4 AF pond U/S roadway (natural)	485,000		2956	1190	Pond excavation	Open space multi-use dry basin	ROW for Pond area ((14.5± Ac)	None	Mitigation efforts needed for pond area	Reduce Bradley Road crossing to single barrel 10'x6' RCB
Bradley Rd. to Pond 5	No change	---------		1999		N/A	N/A	N/A	N/A	N/A	N/A
Pond 5	Enlarge Pond to 80.9 AF	315,000		1999	1074	N/A	N/A	N/A	Reconstr. 900 LF of sanitary sewer	N/A	N/A
Pond 5 to inlet of 120" CMP storm sewer	No change	---------		1090		N/A	N/A	N/A	N/A	N/A	N/A
Inlet of 144" CMP storm sewer	Improve transition structure	100,000		1214		Minor excavations for transition structure	Residential	N/A	N/A	No wetlands or habitats affected	New transition structure between existing 120" CMP storm sewer and 144" CMP storm sewer
		$1,742,000									

APPENDIX B

REVISION	DATE	BY

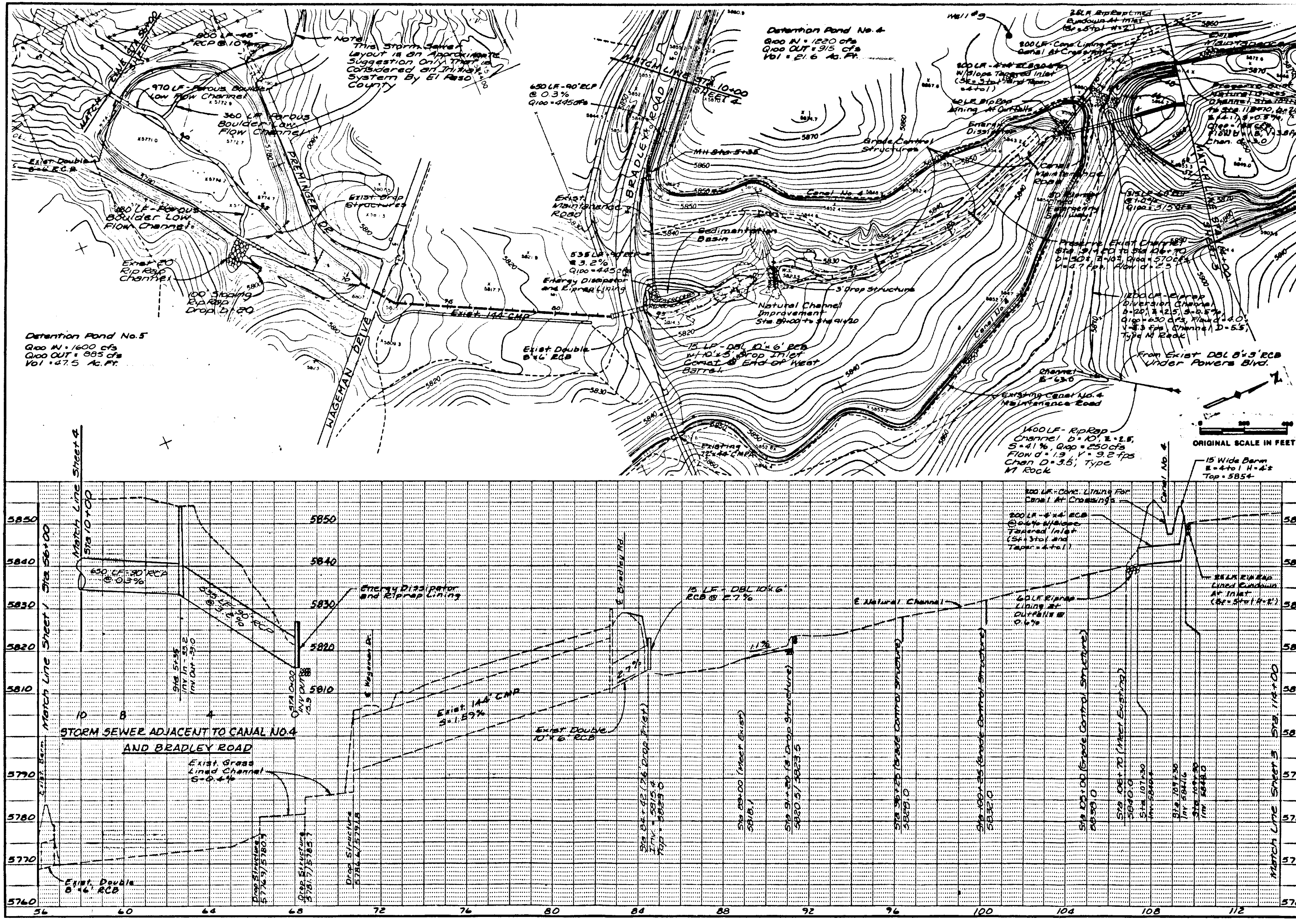
WILSON & COMPANY

WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN
PLAN/PROFILE SHEET
STA 0+00 TO STA 56+00

DESIGN	MAB
DRAWN	RLC
DATE	FEB. 1992
FILE NO.	89-820
SHEET NO.	1

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



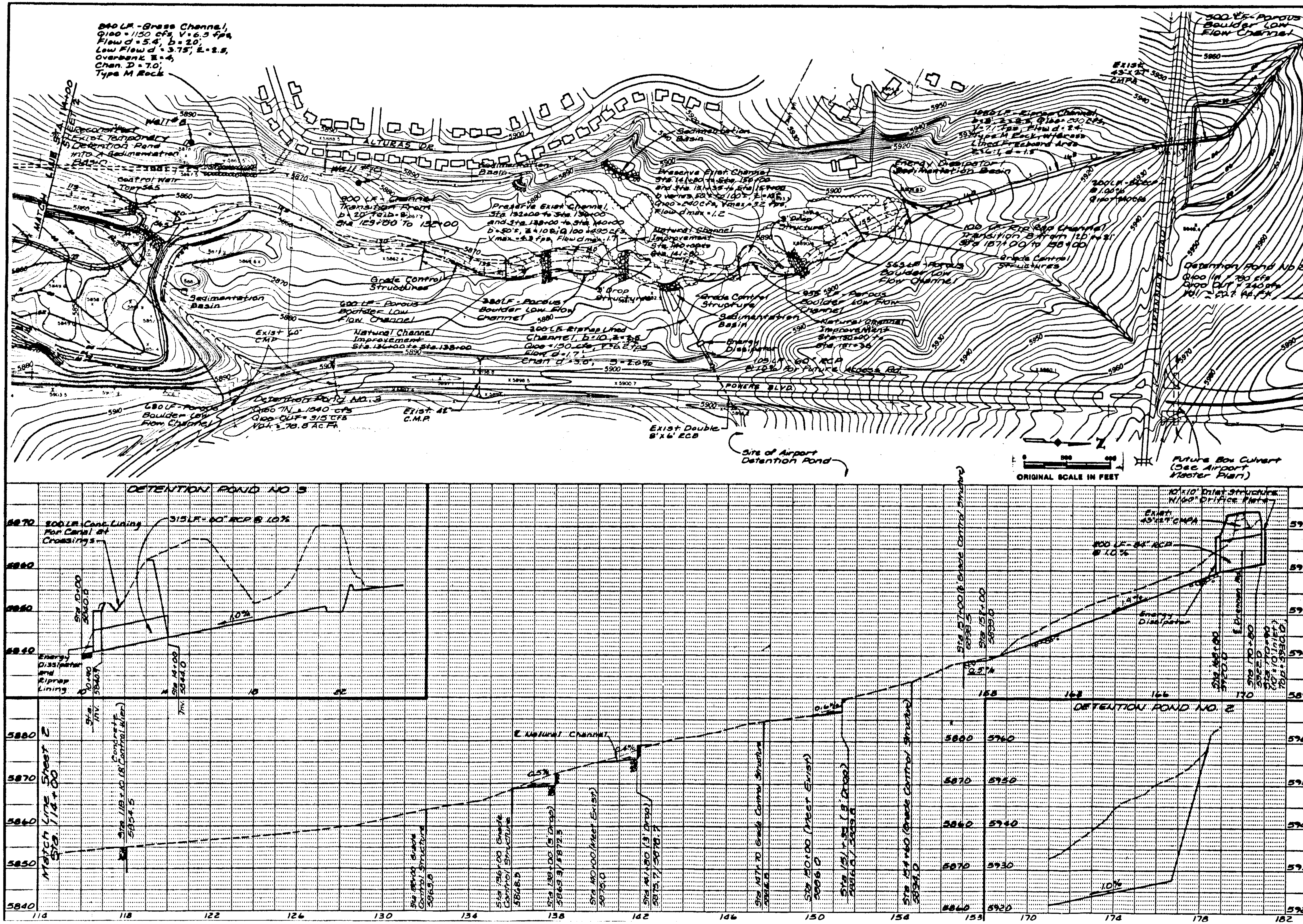
WILSON & COMPANY

WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN
PLAN/PROFILE SHEET
STA. 56+00 TO STA. 114+00

DESIGN	MAB
DRAWN	RLC
DATE	FEB, 1992
FILE NO.	89-820
SHEET NO.	2

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



WILSON & COMPANY

WINDMILL GULCH DRAINAGE BASIN PLANNING STUDY

PRELIMINARY DESIGN PLAN/PROFILE SHEET STA. 114+00 TO STA. 182+00

REVISION	
DATE	
BY	

DESIGN: MAB

DRAWN: RLC

DATE: FEB. 1992

FILE NO.: 89-820

SHEET NO.: 3

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

Note:
Dashed Roadway Alignments And Contours Provided By El Paso County Per The Little Johnson / Security Creek D.B.P.S.

CANTRELL DRIVE

Sta. 56+00 MH

400 LF - 48" RCP @ 2.1% Q100 = 155 cfs

Proposed 54" RCP (As Proposed in El Paso County Hancock Expressway Widening Project)

BRADLEY ROAD

Sta 52+00 - MH

Sta 48+50 MH

600 LF - 60" RCP @ 0.7% Q100 = 205 cfs

ACTURAS DRIVE

Sta 48+50 MH

350 LF - 48" RCP @ 1.3% Q100 = 135 cfs

350 LF - 48" RCP @ 1.3% Q100 = 135 cfs

CANAL NO. 4

Sta 39+00 - MH

CABLE LANE

600 LF - 60" RCP @ 0.7% Q100 = 205 cfs

Existing Double 8'x 4' RCB

Sta. 33+00 MH

BRADLEY CIRCLE

Exist. 42" RCP

Sta. 29+75 MH

375 LF - 90" RCP @ 0.3% Q100 = 445 cfs

375 LF - 90" RCP @ 0.3% Q100 = 445 cfs

325 LF - 90" RCP @ 0.3% Q100 = 445 cfs

Sta. 26+00 MH

BRADLEY ROAD

Well #12

390 LF - 90" RCP @ 0.3% Q100 = 445 cfs

Sta. 18+85 MH

700 LF - 90" RCP @ 0.3% Q100 = 445 cfs

CANAL NO. 4

Exist. 10'x6' RCB

Sta 11+85 MH

650 LF - 90" RCP @ 0.3% Q100 = 445 cfs

MATCH LINE STA. 10+00 SHEET 2

MAEABOU WAY

Existing 58"x 36" CMPA (Future 10'x 3' RCB By El Paso County)

HANCOCK EXPRESSWAY

Note:
Storm Sewer Layout Upstream of Sta. 33+00 is an Approximate Suggestion Only That is Considered an Initial System By EL Paso County and is Not Included in the Cost Analysis of This Study.

0 200 400
ORIGINAL SCALE IN FEET

BRADLEY ROAD

400 LF - 48" RCP @ 2.1%

Sta 56+00 - MH
Inv. Out = 72.5

350 LF - 48" RCP @ 1.3%

Sta 52+00 - MH
Inv. In = 64.1
Inv. Out = 63.5

350 LF - 48" RCP @ 1.3%

Sta 48+50 - MH
Inv. In = 59.5
Inv. Out = 59.1

ACTURAS DRIVE

600 LF - 60" RCP @ 0.7%

Sta 43+00 - MH
Inv. In = 54.5
Inv. Out = 53.5

600 LF - 60" RCP @ 0.7%

Sta 39+00 - MH
Inv. In = 49.3
Inv. Out = 49.1

525 LF - 72" RCP @ 0.3%

Sta 35+00 - MH
Inv. In = 44.9
Inv. Out = 43.5

BRADLEY ROAD

375 LF - 90" RCP @ 0.3%

Sta 29+75 MH
Inv. In = 41.4
Inv. Out = 40.3

325 LF - 90" RCP @ 0.3%

Sta 26+00 - MH
Inv. In = 40.2
Inv. Out = 40.1

CANAL NO. 4

390 LF - 90" RCP @ 0.3%

Sta 22+75 MH
Inv. In = 39.1
Inv. Out = 38.9

700 LF - 90" RCP @ 0.3%

Sta 18+85 MH
Inv. In = 37.2
Inv. Out = 37.5

650 LF - 90" RCP @ 0.3%

Sta 11+85 MH
Inv. In = 35.4
Inv. Out = 35.2

Match Line Sheet 2
Sta 10+00

5880 5870 5860 5850 5840 5830

56 52 48 44 40 36 32 28 24 20 16 12 10

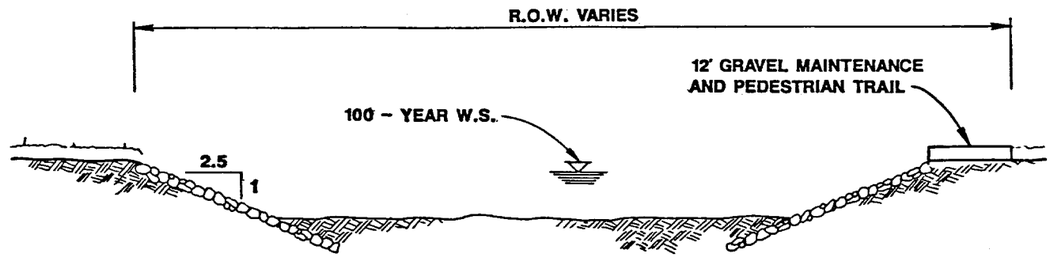
REVISION	DATE	BY

WILSON & COMPANY

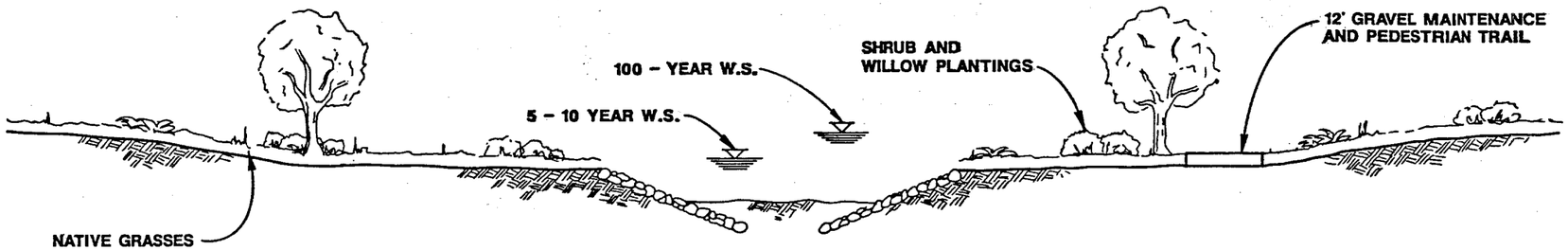
WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY
PRELIMINARY DESIGN
PLAN/PROFILE SHEET
STORM SEWER ADJACENT TO CANAL NO. 4 AND BRADLEY ROAD
STA. 10+00 TO STA. 45+75

DESIGN	MAB
DRAWN	WEC
DATE	FEB, 1992
FILE NO.	89-820
SHEET NO.	4

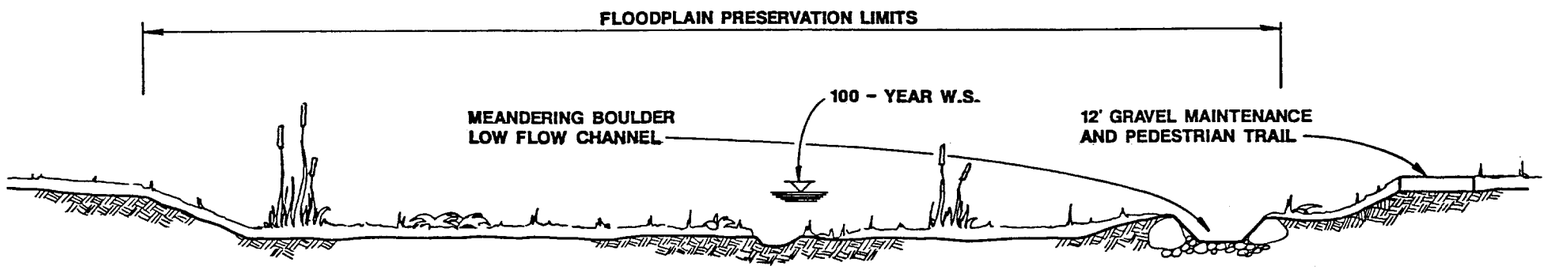
WILSON & COMPANY
COLORADO SPRINGS, COLORADO



RIPRAP LINED CHANNEL



GRASS CHANNEL



NATURAL CHANNEL
WITH LOW FLOW CHANNEL

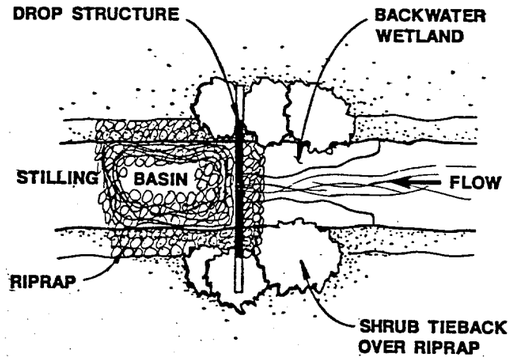
WILSON & COMPANY

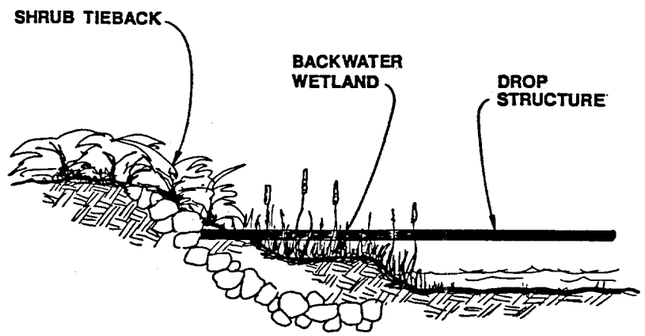
WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY

TYPICAL CHANNEL SECTIONS

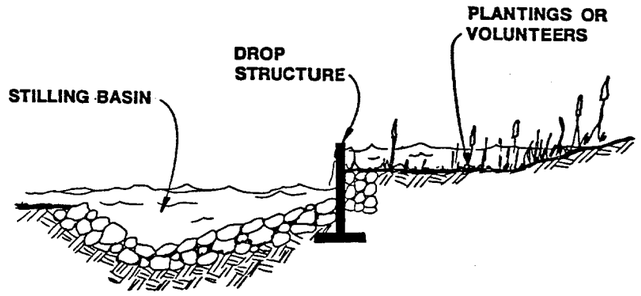
DESIGN
DRAWN
DATE
FILE NO.
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



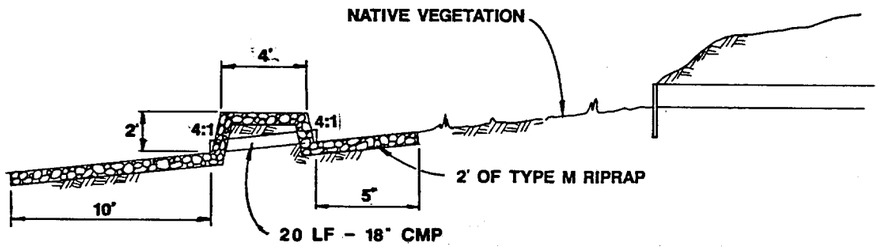


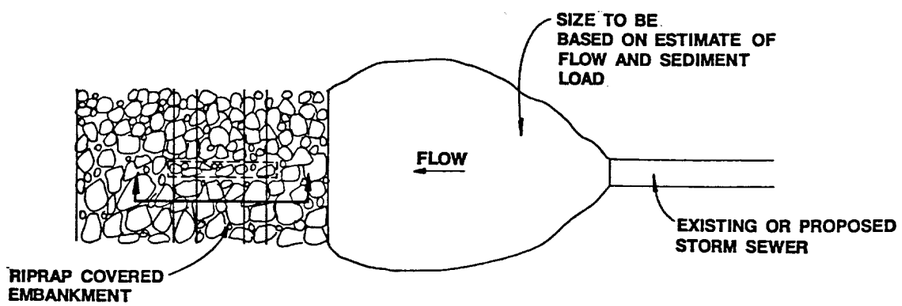
SHRUB TIEBACK



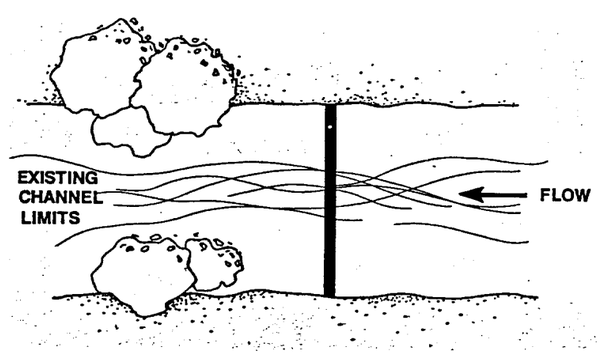
BACKWATER WETLAND

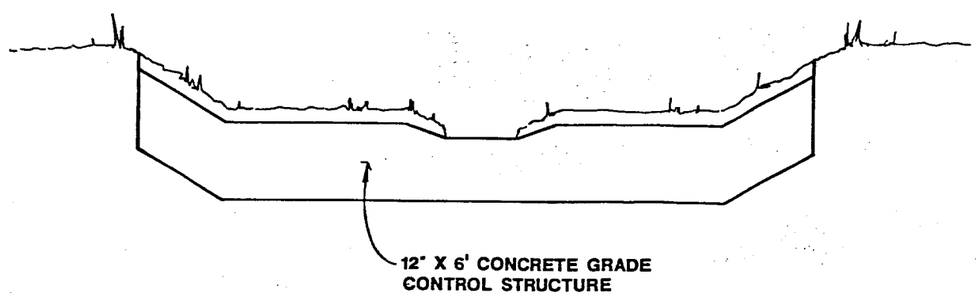
DROP STRUCTURES





SEDIMENTATION BASIN





GRADE CONTROL STRUCTURES

WILSON & COMPANY

DATE

REVISION

WINDMILL GULCH
DRAINAGE BASIN PLANNING STUDY
MISCELLANEOUS DETAILS

DESIGN

DRAWN

DATE

FILE NO.

SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

APPENDIX C