ST. CHARLES MESA DRAINAGE BASINS

OUTFALL SYSTEMS PLANNING STUDY

PRELIMINARY DESIGN REPORT AND IMPLEMENTATION PLAN

August, 1994

Prepared for:

Pueblo County Department of Public Works
33601 United Avenue
Pueblo County, Colorado 81001-4896

Prepared by:

Kiowa Engineering Corporation
1011 North Weber #200
Colorado Springs, Colorado 80903

ST. CHARLES MESA DRAINAGE BASINS

OUTFALL SYSTEMS PLANNING STUDY

PRELIMINARY DESIGN REPORT AND IMPLEMENTATION PLAN

Prepared for:

Pueblo County Department of Public Works
33601 United Avenue
Pueblo, Colorado 81001-4896

Prepared by:

Kiowa Engineering Corporation
1011 N. Weber, Suite 200
Colorado Springs, Colorado 80903-2492

KIOWA Project No. 94.01.01
D25/R272

March, 1994
Revised May, 1994
Revised July, 1994

EXECUTIVE SUMMARY

Authorization, Purpose and Scope

The St. Charles Mesa Drainage Basins Outfall Systems Planning Study was authorized by the Pueblo County Department of Public Works. The specific tasks were performed in accordance with the terms of agreement between Pueblo County and Kiowa Engineering, dated December 27, 1993.

The purpose of the study was to analyze the existing and future drainage conditions for the drainage basins on the St. Charles Mesa, to develop alternative outfall planning concepts, to prepare a preliminary design of the preferred outfall alternatives, and to prepare a plan for implementation of the improvements identified when conducting this study. The planning for drainage facilities within the St. Charles Mesa drainage basins was initiated in November, 1992. The preparation of topographic mapping, hydrology, drainage facility inventory and development of outfall alternatives within the study area initially started under a contract between the County and Abel Engineering Professionals, Inc., dated October 3, 1991. The information prepared under the initial contract has been incorporated into this report to the greatest extent practical. The **St. Charles Mesa Outfall Systems Implementation Plan, Alternative Design Report** and **St. Charles Mesa Final Report Drainage Implementation Plan,** was delivered to the County in September of 1993.

Basin Description

The St. Charles Mesa Drainage Basin is a rural area in unincorporated Pueblo County and is located near the confluence of the Arkansas and St. Charles Rivers. The basin contributes runoff to both the Arkansas and St. Charles Rivers. The basin is largely developed with large lot, single family and agricultural uses. The basin is bisected by the business route of US Highway 50 which runs in an east-west direction. The County anticipates that the basin will continue to be developed with increasing land use densities in the future. The existing drainage system(s) which are inadequate for the majority of the basin will be overtopped on a more frequent basis as the basin develops.

The St. Charles basin covers a total of 16 square miles in unincorporated Pueblo County, Colorado. The basin drains generally to the north, towards the Arkansas River. A portion of the study area flows directly to the St. Charles River, or lies within the St. Charles River floodplain. The Bessemer Ditch traverses the basin from west to east. The Ditch enters the basin in the vicinity of County Farm Road and Aspen Road, and exits the basin at the siphon under the St. Charles River. This Ditch has the capability of diverting all of the existing runoff which originates in the southern most areas of the St. Charles Mesa drainage basin.

Development in the basin consists of agricultural and open space, rural residential, low to medium density single family residential, institutional, industrial and commercial uses. The predominant existing uses are agricultural and rural residential which make up over 80 percent of the drainage basin. The existing single family areas have developed in a random manner and have provided little or no storm drainage infrastructure. In some areas, the single-family developments have blocked historic flow paths. Because the basin was historically used for agricultural purposes, there are numerous locations where existing (or remnants of) irrigated fields are very flat and cause excess runoff to pond. Urbanization has increased this tendency to the point where habitable structures are impacted by shallow flooding, mud and debris damages.

This area of Pueblo County can be described, in general as high plains, with total precipitation amounts typical of a semi-arid region. Winters are generally cool and dry. Precipitation ranges from 10 to 12 inches per year, with the majority of this precipitation occurring in spring and summer in the form of rainfall.

Soils within the St. Charles basin vary between soil types A through D, as identified by the U. S. Department of Agriculture, Soil Conservation Service. The predominant soil groupings are in Hydrologic Soils Group B, which cover approximately 90 percent of the basin. These soils are highly permeable and generally result in low rates of excess runoff until they become saturated. The soils have high to moderate infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists.

Land use information for the existing and future conditions was reviewed as part of the planning effort. The existing land use information was compiled through field review and examination of the topographic maps prepared for this study. The future land use information was developed using planning maps, zoning information and through consultation with the Pueblo County Planning and Development Department. This information is used in the hydrologic analysis to predict runoff rates and volumes for the purposes of facility evaluation.

Hydrology

A hydrologic analysis was conducted in order to determine peak discharges and runoff volumes for various storm types, and basin development conditions. This data was used in the evaluation of existing flood problems, and in the evaluation of alternative outfall plans. Discharges for the 2-, 5-, 10- and 100-year frequencies were analyzed for the existing and future development conditions.

The runoff model used to determine the peak flows and volumes within the study area was the Colorado Urban Hydrograph Procedure (CUHP), in combination with the Stormwater Management Model (SWMM). The sub-basin hydrographs were routed through the major flow paths using the UDSWM2-PC computer model.

The study area subject to the hydrologic evaluation is the St. Charles Mesa Drainage Basin. The basin was divided into four regional basins. The St. Charles and Arkansas River basins are direct flow areas to these rivers. Many of the direct flow basins lie within the floodplains of the these Rivers, or are relatively small sub-basins which lie at the northern and eastern edges of the Mesa. The Bessemer Ditch regional sub-basin represents those areas which lie south of the Ditch as it traverses the St. Charles Mesa basin. The existing flow which originates in these basins has been assumed to be intercepted by the Ditch. The Santa Fe Avenue regional sub-basins collect runoff originating north of the Bessemer Ditch and south of Santa Fe Avenue.

For the most part, the sub-basins lying on the St. Charles Mesa are bounded by roadways. The sub-basins are linked together by roadside ditches and culverts. At many of the intersections ponding is possible because the roadways are physically higher than the adjacent ground. Driveway culverts which cross over the roadside ditches also cause runoff to pond in low spots, away from the main flow path.

The amount of impervious area within each sub-basin was estimated for two conditions, namely; (1) Existing development, and (2) future development. Existing development within the St. Charles Mesa basin is predominantly open space, agricultural and rural residential (lots exceeding 1 acre in size). The future condition development will consist mainly of single family residential with lots greater than 1 acre in size. Commercial uses now and in the future occur along Santa Fe Avenue. The projected land use data was obtained using zoning and comprehensive planning information provided by the Pueblo County Planning and Development Department.

Presented on Tables 3-5 and 3-6 in Section III are the peak discharges for the sub-basins defined for the St. Charles Mesa drainage basin. Complete CUHP output for the 100-year existing and future development conditions are contained within he Technical Addendum to this report. The Hydrologic Sub-basin Map which illustrates the basin boundary, channel routing elements, design points and sub-basin locations is contained within the map pocket at the rear of the report (Exhibit 1). A summary of flow rates for key design points is presented on Tables 3-7 and 3-8.

The results show several impacts upon the hydrology for the Mesa because of urbanization. Firstly, there are significant increases in peak discharge and volume for the individual sub-basins which will develop from agricultural use and open space into single-family residential. The impact upon the peak flows along the receiving drainage paths (i.e., the Santa Fe Drive flow path and along the north south roadways), is not as significant in the developed scenario. This is because the channels as modeled assumed the existing cross-section. At many locations along the north-south roadways and at intersections, the adjacent land uses lie below the roadway crown and/or the top of channel bank. A significant amount of floodplain storage results which attenuate the peak discharges from tributary sub-basins as they move through the system.

Secondly, the impact of the Bessemer Ditch relative to interception and diversion of runoff away from the Mesa is not great. During the hydrology analysis, two cases were investigated. These were, (1) interception of all runoff from sub-basin south of the Bessemer Ditch and no connection to the downstream flow paths, and (2) no diversion, or a pass through of the runoff over the Bessemer Ditch and into the downstream flow paths. Increases in peak flow, usually less than 10 percent were noted between cases 1 and 2, with case 2 producing the higher flows for all frequencies.

Hydraulic Analysis and Flood History

A hydraulic structure inventory was conducted and the subsequent information was presented on 1-inch to 200-foot scale aerial mapping and entered in an index created to catalogue the information. For the most part, culverts exist under major roadways although at some intersections only a concrete pan has been installed. The inventory data has also been tabulated in a spreadsheet format. Size, type, condition and capacity is summarized in the database. The spreadsheets and mapping have been turned over to the Pueblo County Department of Public Works.

In the areas where a large number of reported drainage problems occur there is a high incidence of urban development upstream. Frequently, a local storm sewer system has been installed to handle a minor storm; but, the outfall is inadequate or is non-existent. Urban development tends to channelize runoff and concentrate it at a single location. This along with increased imperviousness results in the type of flooding noted on the Mesa.

Another typical drainage problem on the Mesa stems from stormwater ditches overtopping due to restrictions (undersized driveway culverts, blockage in the ditches, etc.) whereby the runoff does not return to the roadside ditch. Instead, the runoff follows the existing low point which may be across a roadway or down a driveway into private property and away from the pubic road right-of-way.

Much of the flooding of residences occurs because several subdivisions have been constructed along the historic low points and have finish floor elevations below the grade of the adjacent roadways and ditch banks. The residential structures are mostly at or near flow line elevations of the adjacent streets. Reconstruction of curb cuts and berming on the upstream side of structures to prevent shallow flooding is being used extensively in many areas of the Mesa.

Research into the existence of any documented floodplains on the St. Charles Mesa established that none are defined. The primary resource for this research was the "Flood Insurance Studies for Pueblo County, Colorado", prepared by the Federal Emergency Management Agency (FEMA), revised 1986. A portion of the basin studied does lie within the St. Charles River 100-year floodplain and the Arkansas River 100-year floodplain. There are no regulated floodplain areas along the major flow paths which drain the Mesa. Areas of overflow flooding have been presented on the Preliminary Design drawings. These floodplains represent areas where runoff which exceeds the design capacity of the proposed system(s) would move out of the road right-of-way and into low lying areas adjacent to the roadways. The overflow floodplains have been presented for information purposes only and are not intended to establish regulatory floodplains subject to more stringent floodplain development standards.

Alternative Development

Alternative outfall plans have been examined that address the existing and future stormwater management needs of the basin. Quantitative and qualitative comparisons are presented in both narrative and tabular format, and a recommendation made as to which plan is most feasible to advance to preliminary design and eventual implementation.

During the alternative analysis it became evident that the basin had one general characteristic which influenced the existing drainageways form and function. The Mesa was originally settled as an irrigated agricultural area. Roads were developed between fields, along irrigation headwater, and along tailwater ditches. Consistent with an agricultural use the slopes across the Mesa are typically less than a half percent. Development which has occurred has in most cases blocked the natural or historic outfall path. Roadways are both gravel and paved, neither of which have much capacity to convey runoff before overtopping the adjacent roadside ditches and curb and gutter. At roadway intersections, flow splits can occur whereby a low runoff event would pass through the existing roadside ditch and/or culverts, while larger volume flow events would be split, or diverted, to low lying areas or a different direction down the intersecting street away from the existing systems.

General planning goals followed during the alternative plan development phase were:

(1) Identify storm water facilities which will reduce existing flooding problems within urbanized area(s);

(2) Provide stormwater management within developing areas of the basin in order to reduce the detrimental effects of runoff from urbanized areas;

(3) Provide stormwater facilities which preserve and/or enhance the existing drainageways and areas adjacent to the drainageways which provide an environmental resource in the area;

(4) Provide for separation of stormwater runoff from existing or abandoned irrigation laterals;

(5) Identify facilities which will minimize future operation and maintenance costs;

(6) Provide stormwater management facilities which will at least maintain and/or enhance the water quality characteristics of the basin;

(7) Provide for a system which has cost feasibility;

(8) Provide for a system which is within the capability of being installed by County forces; and,

(9) Provide for a system which will be adequate to serve future development.

The alternative planning process began with the evaluation of general outfall planning alternatives. Alternatives which are generally available in the majority of urban drainage basins include:

(1) Do nothing, and/or floodplain regulation,

(2) Channelization,

(3) Piped systems,

(4) Detention, on-site or off-site,

(5) Combinations of the above.

These concepts were evaluated for each major outfall path and regional sub-basin on the Mesa. Each of the above alternatives was evaluated for different recurrence intervals. At this time, there are no 100-year capacity facilities within the Mesa, except for the Bessemer Ditch which has the capacity to convey the 100-year discharge from areas upstream of the Ditch, **assuming that the Ditch is only carrying the adjudicated flow at the time of a runoff event.**

The handling of stormwater can be accomplished by the use of pipes, channels, detention basins, bridges, culverts and various other physical improvements. The use of any one or a combination of the above improvements is dependent upon the level of flow, topography, right-of-way and the character of the areas adjacent to the outfall paths. A qualitative discussion of the feasibility of the general drainage alternatives is summarized below:

Curb and Gutter: In some cases use of a standard street section including 6" vertical curb will provide adequate capacity and channelization to prevent localized flooding during the 5-year storm event or reduce required storm sewer sizes when used in combination.

Storm Sewers: Use of storm sewers is feasible within all proposed outfall systems as independent structures or in combination with curb and gutter or existing ditches. This conveyance alternative is somewhat limited by areas of extremely mild slopes (less than .3 percent), which causes the sizes of storm sewers to become very large, and in turn cost prohibitive. In general, storm sewers greater than 60-inches in diameter do not have a high degree of feasibility due to their cost and their impact upon utility relocations and street repaving.

Channels: Channels, including roadside ditches are the predominant existing drainage facility on the Mesa along all flow paths. Enlarging the existing roadside ditch sections to convey future development condition runoff will usually require enlarging numerous private drives. In some areas of the Mesa, undeveloped land still exists to construct a lined channel, however right-of-way acquisition can become a major deciding factor when implementing a channel system on the Mesa. Riprap lined and grasslined ditch sections are most commonly used, however concrete lining does have feasibility wherever the need to keep the acquisition of right-of-way to a minimum is desirable.

Detention: The type of detention basin will be dependent upon the volume and rate of flow; however, right-of-way and the characteristics of the area adjacent to a proposed detention basin plays a large role in this alternative's feasibility. Water quality is an important concern in light of the storm water discharge regulations, and a detention scheme has distinct advantages in this regard. There are three existing onsite detention basins on the Mesa.

Combined Systems: Combining storm sewers with roadside ditches and improved street sections is usually a feasible alternative in basins where development has blocked the historic outfall paths. For the St. Charles Mesa, storm sewers with a five year capacity in combination with the existing roadside ditch or street capacity can bring the total capacity to at least a 10-year level, and in some cases a 100-year level.

The conceptual alternatives developed were each modeled hydrologically to assess the impact on peak flow rates. In general, the historic peak flow condition at Santa Fe Drive (U.S. Highway 50, Business Route), was a primary factor in the alternative planning. Various detention and diversion schemes were evaluated in order to optimize the flow to downstream drainageways. As a starting point the 5-year existing condition flows were used in the alternative evaluation. A 5-year system is a typical design standard for minor or local storm drainage system design within urban areas. The 5-year system is capable of conveying, without surcharging, over 90 percent of all runoff events.

Coordination meetings were held throughout the study to address overall goals and specific concerns of those agencies and individuals asked to participate in the study. A public input meeting was held and specific concerns of the residents were discussed. Complaint forms were collected.

It has been determined that a system of outfall storm sewers is the most practical conveyance alternative for those major flow paths where existing development has already occurred. A piped system will require the least amount of new right-of-way acquisition and minimize disturbances to existing driveways and road intersections. This system will require that existing roadside ditches be connected to the storm sewer outfalls by means of intercepting inlets mostly sited at roadway intersections. The existing ditches serve to collect local flows generated within private property and from the County roadway right-of-way. Where existing structures lie below street grade, there is no option but to leave the existing roadside ditch in service.

Selected Outfall Systems Design

As a result of the alternative planning process, a selected outfall plan was determined for each of the major outfall paths within the St. Charles Mesa drainage basin. The outfall plan for each flow path has been presented on the preliminary design drawings contained at the rear of this report. The selected outfall plan for the St. Charles Mesa Basin includes the following general features:

1. A combined system of storm sewers and roadside ditches capable of conveying the 5-year capacity flow.
2. Curb and gutter along existing streets where the street section is below the adjacent driveway.
3. Inlets of at least 5-year capacity to intercept street flows and flows within roadside ditches at key design points.
4. Upgrading outfalls to the Bessemer Ditch in order to intercept the 100-year existing condition discharge from areas tributary to the Ditch. A spill structure located at Salt Creek is recommended in order to clear the Ditch of runoff from south Pueblo prior to entering the St. Charles Mesa basin. A spill structure at the headgate of the Bessemer Ditch siphon is recommended in order to separate runoff from ditch irrigation flows. This spill structure would outfall to the St. Charles River.

Presented on Table 6-1 is the summary of peak discharges at all design points for the selected outfall plan condition. Sub-basin discharges are the same as shown on Table 3-5 presented in Section III of this report. Diversion of the 5-year flow across Santa Fe Avenue has been accounted for in the selected outfall plan hydrology model. A flow split has been modeled at 21st Lane, 23rd Lane, 25th Lane, 27th Lane and 29th Lane. The five-year flow has been routed north for these outfall paths, and the flow greater than the 5-year flow has been routed along Santa Fe Avenue.

The use of onsite or regional detention must be implemented wherever future development is proposed. Due to the low feasibility of systems with capacity greater than the existing 5-year storm, future developments must maintain existing condition discharges for the 5- and 100-year frequencies. The existing detention basins in the Lakeside Estates subdivision should remain. The main purpose of the detention facilities is to reduce the peak discharges from developed land to historic, or existing conditions. Secondary benefits for regional and onsite basins come in the form of enhanced water quality, and open space benefits.

Costs to implement the preliminary design were estimated using the unit costs presented on Table 6-2. Utility costs have not been incorporated into the cost estimates. Land acquisition for channels or storm sewers have not been estimated. In general, most of the facilities proposed for the Mesa can be kept within existing easements or right-of-ways. In general, the land required for the storm sewer or channel improvements can be obtained for undeveloped areas via the development process. Total estimated cost for the recommended plan is $12,566,894.

Implementation

The selected outfall plan has been presented on the preliminary design plans contained within the rear of this report. The planning and the design of these improvements is a key first step in implementing a comprehensive program for stormwater management for the basin on the St. Charles Mesa. The implementation of this plan will depend upon various factors, however the planning goals associated with the development of this plan should be reviewed whenever a portion of the system is proposed for construction. The primary goals are as follows:

Reduce local flooding problems;

Provide outfall drainage facilities to serve future developments and property owners;

Provide outfall drainage facilities which will convey runoff in a safe and efficient manner through existing developed areas of the Mesa;

Minimize the acquisition of additional public right-of-way associated with stormwater conveyance; and,

Minimize the cost of stormwater conveyance facilities funded solely by Pueblo County.

The review of the above goals will be needed in order to best prioritize the improvements and to better direct the limited amount of capital improvement funds which will be available for stormwater facilities on the Mesa.

The construction and implementation of the selected outfall systems should be driven by the following parameters;

Existing facility inadequacy within a given outfall basin;

Level of flooding problems;

Development pressure within outfall basin;

Availability of funding; and,

Number of potential funding sources.

The selected outfall systems presented on the preliminary design plans should not be considered as final in their form. Each system should be reviewed in terms of system capacity, hydrologic response, right-of-way availability and routing options at the time the system(s) are proposed for final design and construction. Future development should be required to convey the five-year existing condition runoff to the dedicated outfall system by means of local streets and storm sewers.

The following steps are suggested prior to further design and construction of the systems identified in this plan.

1. **Adoption of Drainage Criteria Manual:** The City/County Drainage Criteria Manual referenced in this study should be reviewed, revised, and updated as necessary to allow for the eventual adoption by the County. This criteria is needed in order to help in the review and approval of future drainage plans to be prepared for future developments. The adoption of the drainage criteria will lead to more consistent design and construction of local stormwater systems.
2. **Detention Basin Criteria Development:** A criteria for the planning and design of onsite detention basins should be developed. There are several simplified methods which could be adopted and inserted into the Drainage Criteria Manual.
3. **Adoption of Erosion Control Criteria**: The future level of maintenance for the selected outfall systems will be heavily dependent upon the amount of sediment available to be washed into the stormwater systems. Currently, there are extensive amounts of agricultural ground which lies uncultivated. These areas need to prevent the erosion of unprotected soils into the streets, roadside ditch sections and storm sewer sytems. New development can also cause significant land disturbance which can result in soil erosion.
4. **Agreements with Ditch Company:** The dependence upon the availability flow capacity within the Bessemer Ditch affects each of the selected outfall systems. Discussions with the Bessemer Ditch Company should be considered by the County prior to extensive amounts of new development proceeding within the Bessemer Ditch Basin. An initial project which needs to be considered jointly is the stormwater separation structure for the Bessemer Ditch at Salt Creek. Construction of this structure will ensure that the Ditch will only be carrying irrigation flows into the St. Charles Mesa.

The prioritization of improvements has been accomplished by reviewing the planning goals for each flow path. In general, the outfall storm sewers have the highest priority since they are needed now to address local drainage problems and will be needed upon development of land on the Mesa. In some instances development pressure may change the priority of an outfall storm sewer. The priority of systems has been categorized into three levels; (1) Immediate need; (2) Needed upon development of land within the basin; and (3) as required by correlated projects. Examples of these categories is presented in Section VII.

ST. CHARLES MESA DRAINAGE BASINS
OUTFALL SYSTEMS PLANNING STUDY
PRELIMINARY DESIGN REPORT AND IMPLEMENTATION PLAN

TABLE OF CONTENTS

Table of Contents (Continued)

ST. CHARLES MESA DRAINAGE BASINS
OUTFALL SYSTEMS PLANNING STUDY
PRELIMINARY DESIGN REPORT AND IMPLEMENTATION PLAN

LIST OF TABLES

ST. CHARLES MESA DRAINAGE BASINS
OUTFALL SYSTEMS PLANNING STUDY
PRELIMINARY DESIGN REPORT AND IMPLEMENTATION PLAN

LIST OF FIGURES

ST. CHARLES MESA DRAINAGE BASINS
OUTFALL SYSTEMS PLANNING STUDY
PRELIMINARY DESIGN REPORT AND IMPLEMENTATION PLAN

TABLE OF CONTENTS

I. INTRODUCTION

Authorization, Purpose and Scope

The St. Charles Mesa Drainage Basins Outfall Systems Planning Study was authorized by the Pueblo County Department of Public Works. The specific tasks were performed in accordance with the terms of agreement between Pueblo County and Kiowa Engineering, dated December 27, 1993.

The purpose of the study was to analyze the existing and future drainage conditions for the drainage basins on the St. Charles Mesa, to develop alternative outfall planning concepts, to prepare a preliminary design of the preferred outfall alternatives, and to prepare a plan for implementation of the improvements identified when conducting this study. The planning for drainage facilities within the St. Charles Mesa drainage basins was initiated in November, 1992. The preparation of topographic mapping, hydrology, drainage facility inventory and development of outfall alternatives within the study area initially started under a contract between the County and Abel Engineering Professionals, Inc., dated October 3, 1991. The information prepared under the initial contract has been incorporated into this report to the greatest extent practical. The **St. Charles Mesa Outfall Systems Implementation Plan, Alternative Design Report** and **St. Charles Mesa Final Report Drainage Implementation Plan,** was delivered to the County in September of 1993. Upon review of the final report, the County found that additional effort was needed to further identify and develop the most feasible preliminary outfall designs and to develop the final implementation plan.

The scope of the entire study, inclusive of the scope authorized by the County with Kiowa Engineering contained the following tasks:

Alternative Outfall Planning Phase:

1. Meet periodically with the sponsors to obtain information, present study findings, and discuss results of the planning tasks.
2. Contact agencies and/or individuals who have knowledge or specific interest in the study area.
3. Prepare hydrologic analysis for the existing and future development basin conditions without any proposed facilities in place (i.e. base line condition hydrology).
4. Prepare topographic mapping for using in the development of alternative outfall systems.
5. Conduct hydraulic analysis along the major outfalls within the study area to ascertain capacities of existing structures, review available floodplain information and floodplain studies, determine location of flooding problems, and analyze hydraulic impacts of future peak discharges.
6. Inventory the size, type, condition and location of existing facilities lying within the public right-of-way and along identifiable outfall paths.
7. Develop outfall system alternatives which address future development impacts.
8. Evaluate alternatives based upon cost, constructability, right-of-way, and maintenance constraints and issues.
9. Prepare a written outfall systems alternative evaluation report.

Preliminary Design Phase:

1. Meet with the County sponsors to select and refine the outfall system alternatives for further evaluation.
2. Prepare preliminary design base mapping for outfall system alignment(s).
3. Refine hydrology and hydraulic analysis for selected alternative outfall plan(s).
4. Prepare preliminary design of selected outfall facilities.
5. Prepare construction cost estimates.
6. Prepare conceptual implementation plan identifying the priority of contacting the preliminary outfall systems.
7. Prepare written report with accompanying drawings showing the preliminary design of the selected plan and discussing the items examined in the study.

Goals and Objectives

1. Reduce the potential for flooding of private properties, roadways and other structures which lie adjacent to the major outfall paths within the St. Charles Mesa drainage basins, for both the existing and future development conditions.

2. Determine the required storm sewers and roadside channel sections for the major outfall paths which will remain adequate to convey runoff in a safe and stable manner as the volume, rate and duration of stormwater runoff changes as the development of the study area proceeds.

3. Develop cost effective outfall systems that can be phased into construction as the existing drainage situation warrants and as the study area develops.

4. Develop outfall system improvements compatible with the existing public right-of-ways and easements within the study area so as to minimize the disturbance of streets, utilities and private property along the existing outfall paths.

Mapping

The U. S. Geological Survey (USGS) 7-1/2-minute quadrangle maps, utilized in combination with aerial topographic mapping dated 1992, were used in development of the technical aspects presented in this report. The topographic mapping was prepared from aerial photography. The topographic mapping was compiled at a scale of 1-inch to 200-feet horizontal scale, with a contour interval of two-feet.

The location of drainageways, storm sewers and culverts were field verified when the existing drainage facilities were inventoried. The existing facilities were noted on the topographic mapping. Field reviews of existing and proposed facilities were conducted. Photographs along key outfall paths.

Acknowledgements

Kiowa Engineering wishes to acknowledge the various individuals who assisted in the preparation of the study. Representative of from the Department of Public Work and the Department of Planning and Development provided information used in the preparation of the alternative and preliminary design reports. A listing of those individuals coordinated with has been presented below.

Name	Representing
John Simmer	Pueblo County Department of Public Works
Alfred Randall	Pueblo County Department of Public Works
Charles Finley	Pueblo County Planning and Development Department
Kim Headley	Pueblo County Planning and Development Department
William Mullen	Bessemer Ditch Company
Lee Simpson	St. Charles Mesa Water District
Abel Tapia	Abel Engineering Professionals, Inc.

The following members of the project team contributed to the preparation of this report.

Mr. Richard N. Wray, P.E.	Project Manager
Ms. Cheryl A. Bean, P.E	Project Engineer
Ms. Elizabeth A. Klein	Technician/Drafting
Ms. Rusty Shukle	Administrative/Word Processing

Bibliography

The following reports were referenced during the course of preparing this report:

(1) Soil survey for Pueblo County, Colorado, dated June 1979.

(2) Preliminary City of Pueblo Drainage Criteria Manual, prepared by the City of Pueblo and WRC, Inc., dated may 1986.

(3) Flood Insurance Study for Pueblo County, Colorado, prepared by the Federal Emergency Management Agency, dated 1979.

(4) St. Charles Mesa Master Drainage Plan prepared by Southern Colorado Engineering, Inc., dated June, 1979.

(5) Wastewater Facility Plan, prepared by GMS, Inc., dated July, 1990.

(6) St. Charles Mesa Outfall Systems Alternative Development Report, prepared by Abel Engineering, Inc., dated June, 1992 and revised July, 1992.

(7) St. Charles Mesa Final Report Drainage Implementation Plan, Volume #2, Chapter 6, Working Implementation Plan, prepared by Abel Engineering, Inc., dated revised September, 1993.

II. STUDY AREA DESCRIPTION

The St. Charles Mesa Drainage Basin is a rural area in unincorporated Pueblo County and is located near the confluence of the Arkansas and St. Charles rivers. The basin contributes runoff to both the Arkansas and St. Charles rivers. The basin is largely developed with large lot, single family and agricultural uses. The basin is bisected by the business route of US Highway 50 which runs in an east-west direction. The County anticipates that the basin will continue to be developed with increasing land use densities in the future. The existing drainage system(s) which are inadequate for the majority of the basin will be overtopped on a more frequent basis as the basin develops. Figure 2-1 shows the location of the St. Charles Mesa basin.

Basin Description

The St. Charles basin covers a total of 16 square miles in unincorporated Pueblo County, Colorado. The basin drains generally to the north, towards the Arkansas River. A portion of the study area flows directly to the St. Charles River, or lies within the St. Charles River floodplain. The Bessemer Ditch traverses the basin from west to east. The Ditch enters the basin in the vicinity of County Farm Road and Aspen Road, and exits the basin at the siphon under the St. Charles River. This Ditch has the capability of diverting a portion of, or all of the existing runoff which originates in the southern most areas of the St. Charles Mesa drainage basin. In fact, the Bessemer Ditch imports urban runoff from the southern portions of the City of Pueblo.

Slopes on the mesa range from moderately steep to steep south of the Bessemer Ditch, and mild to flat slopes within basins lying north of the Ditch. The predominant drainage facilities are a system of roadside swales and ditches ranging in depth from 1-foot to 4-feet. Prior to current development the ditches were, or still are, irrigation laterals. The ditches are usually filled with vegetation. In areas where the agricultural need for the laterals has ended, the ditches have been modified to carry storm drainage. The roadside ditches are crossed at numerous driveways and roadways. In some locations residential structures abutting the roadways lie below the roadway crown and cause the swales to spill towards the structures and pond in low lying fields or yards. Several cross culverts under Santa Fe Avenue (US 50), can carry runoff north along the various roadways, however flow splits may occur sending runoff east on Santa Fe Avenue as well. Near the north edge of the basin, the Mesa outfalls to the floodplain of the Arkansas River via natural drainage swales. The swales which drain the Mesa to the Arkansas River floodplain are highly susceptible to erosion because of their steepness (greater than 10 percent), and lack of vegetation to hold the natural banks in place.

Development in the basin consists of agricultural and open space, rural residential, low to medium density single family residential, institutional, industrial and commercial uses. The predominant existing use is agricultural and rural residential which makes up over 80 percent of the drainage basin. The existing single family areas have developed in a random manner and have provided little or no storm drainage infrastructure. In some areas, the single-family developments have blocked historic flow paths. Because the basin was historically used for agricultural purposes, there are numerous locations where existing (or remnants of) irrigated fields are very flat and cause excess runoff to pond. Urbanization has increased this tendency to the point where habitable structures are impacted by shallow flooding, mud and debris damages.

The maximum basin elevation is approximately 4830 feet above mean sea level, and falls to approximately elevation 4650 at the edge of the Mesa. The basin where it is undeveloped is covered by native vegetation typical of arid areas of Southern Colorado. Vegetation typical of agricultural and single-family uses are found mainly north of the Bessemer Ditch. Vegetative cover ranges from poor-to-fair in the undeveloped areas to fair-to-good in the developed areas of the basin.

Climate

This area of Pueblo County can be described, in general as high plains, with total precipitation amounts typical of a semi-arid region. Winters are generally cool and dry. Precipitation ranges from 10 to 12 inches per year, with the majority of this precipitation occurring in spring and summer in the form of rainfall. Thunderstorms are common during the summer months, and are typified by quick-moving low pressure cells which draw moisture from the Gulf of Mexico into the region. Average temperatures range from about 30 F in the winter to 80 F in the summer. Thunderstorms are the most frequently occurring runoff producing event. These storms can be of short duration but of extremely high-intensity.

Soils and Geology

Soils within the St. Charles basin vary between soil types A through D, as identified by the U. S. Department of Agriculture, Soil Conservation Service. The predominant soil groupings are in Hydrologic Soils Group B, which cover approximately 90 percent of the basin. These soils are highly permeable and generally result in low rates of excess runoff until they become saturated. The soils consist of deep, well drained soils that formed in alluvium and residium, derived from sedimentary rock. The soils have high to moderate infiltration rates, and are extremely susceptible to wind and water erosion where poor vegetation cover exists. In undeveloped areas, the predominance of Type B soils give this basin a lower runoff per unit area as compared to basins with soil dominated by Types C and D. Presented on Figure 2-2 is the Hydrologic Soil distribution map for the St. Charles Mesa Basin basin.

Property Ownership and Impervious Land Densities

Property ownership within the St. Charles Mesa basin are mostly private. South of the Bessemer Ditch the basin is almost totally undeveloped, and has limited agriculture activity. North of the Ditch, rural residential and agricultural uses predominate. Along US Highway 50 in what is known as the Blende area, commercial and single-family uses exist. Where single-family development has occurred, densities range from three to five units per acre. The basin is gridded by local streets of either a north/south or east/west orientation. The grid street pattern is responsible for the generally rectangular shape of the sub-basins in the drainage area. With the exception of flow which enters public roadways there are no drainageway easements or right-of-ways along any of the major flow paths identified in this study. Roadway and utility easements abutting or crossing the major drainageways occur most frequently in the portion of the basin lying north of the Bessemer Ditch.

Land use information for the existing and future conditions were reviewed as part of the planning effort. The existing land use information was compiled through field review and examination of the topographic maps prepared for this study. The future land use information was compiled using planning maps, zoning information and through consultation with Pueblo County. This information is used in the hydrologic analysis to predict runoff rates and volumes for the purposes of facility evaluation. The identification of land uses abutting the flow paths and roadways is also useful in the identification of feasible outfall plans for the Mesa. Presented on Figure 2-3 is the existing land use map for the St. Charles Mesa basin. Presented on Figure 2-4 is the proposed land use map used in the evaluation of impervious land densities discussed in the hydrologic section of this report. Figure 2-4 is not intended to reflect the future zoning for land use policies of Pueblo County.

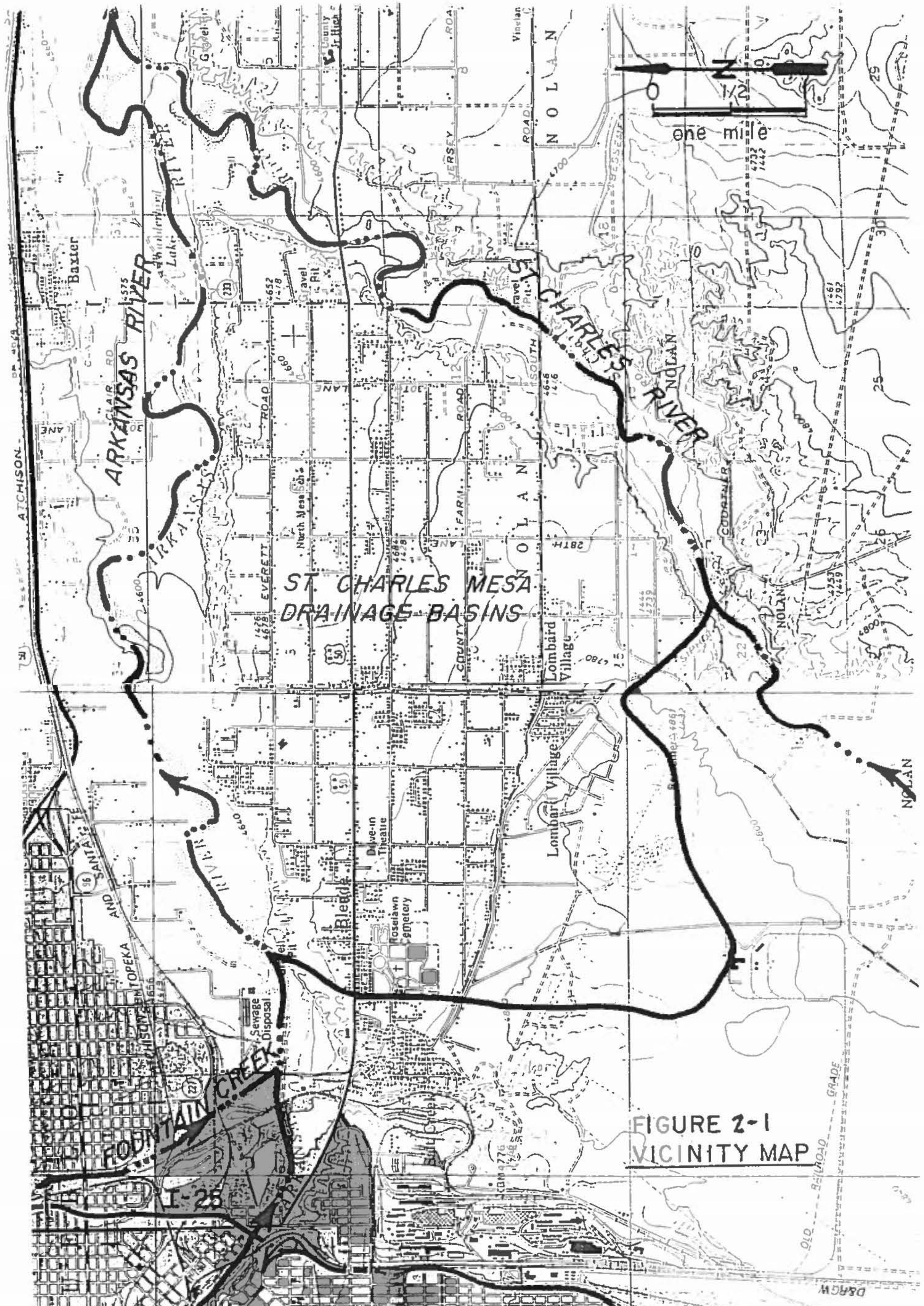


FIGURE 2-1
VICINITY MAP

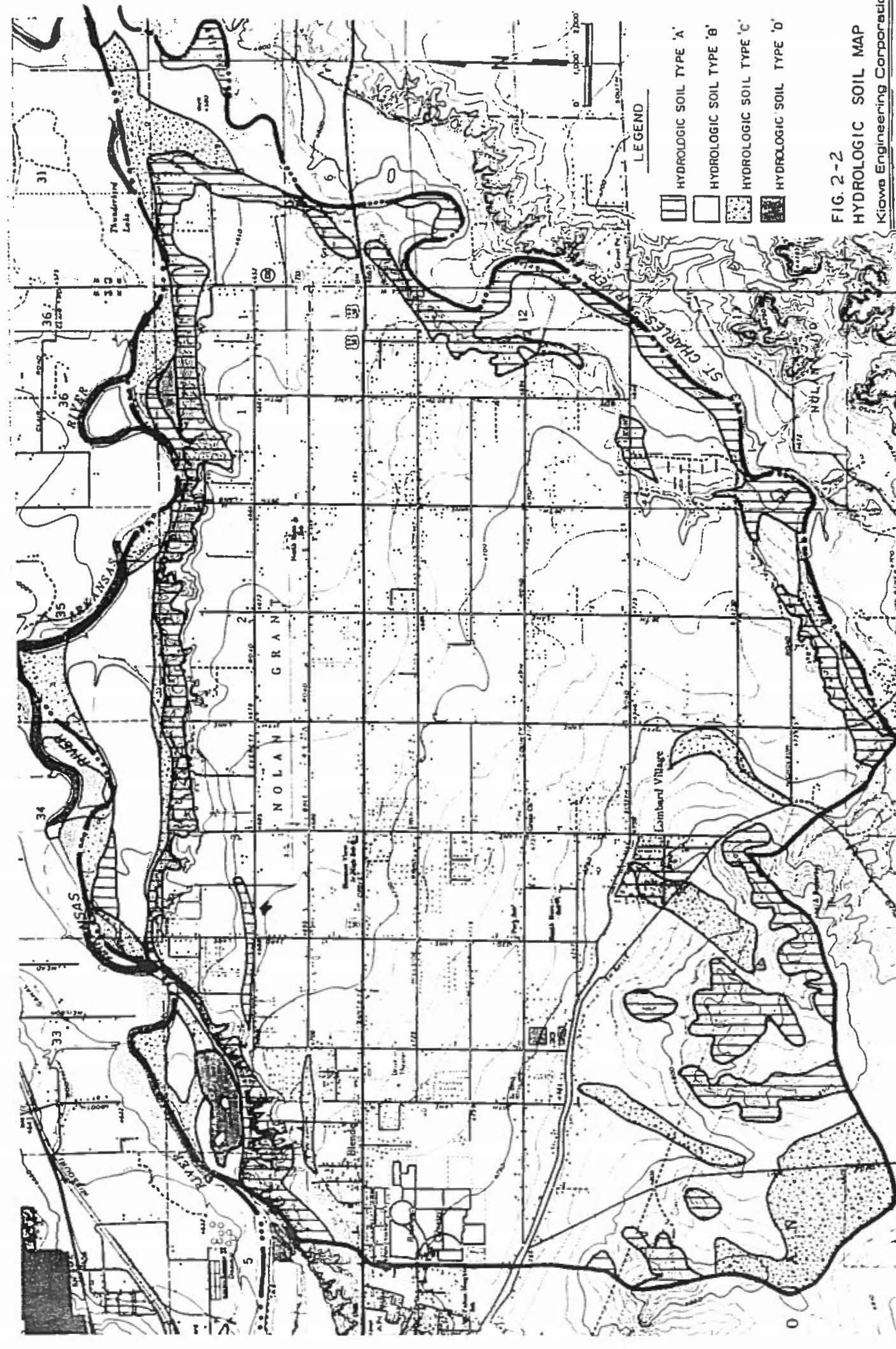
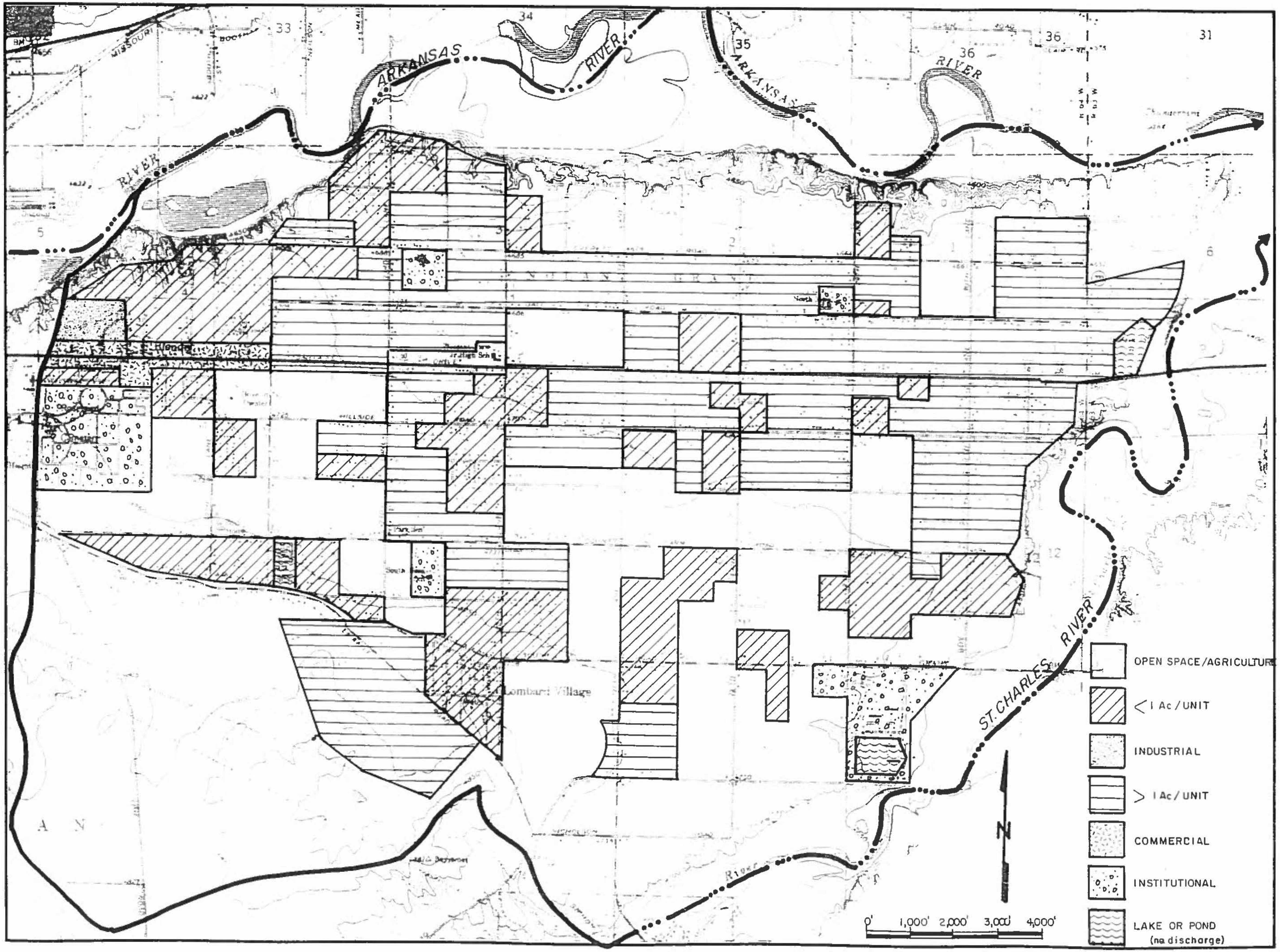


FIG. 2-2
HYDROLOGIC SOIL MAP
Kiowa Engineering Corporation



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

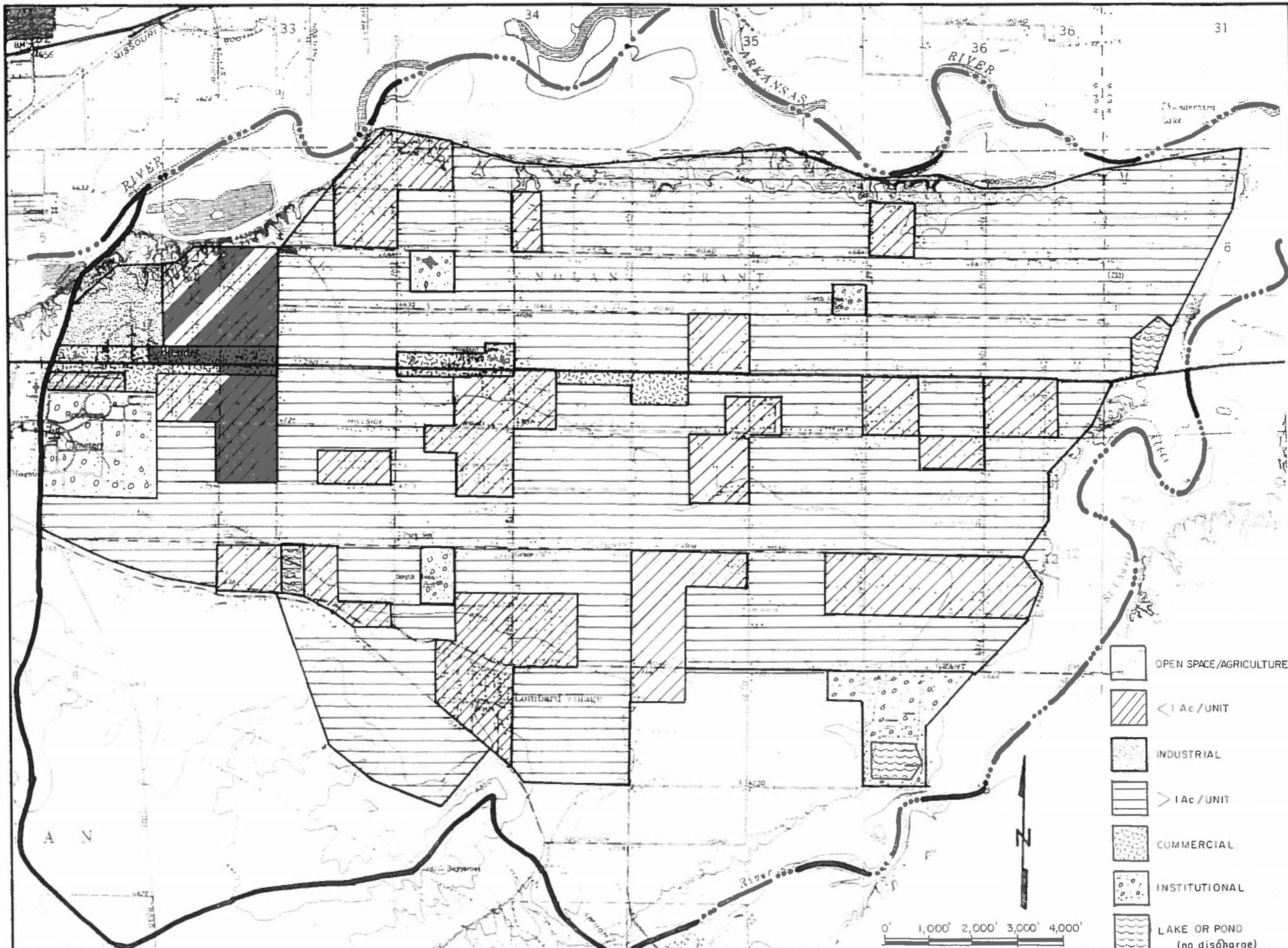
ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

EXISTING PERCENT IMPERVIOUSNESS

Project No.	94 01 01
Date:	1/94
Design:	
Drawn:	
Check:	
Revisions:	

FIGURE 23

6



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

FUTURE PERCENT IMPERVIOUSNESS

Project No. 94.01.01
Date: 1/94
Design:
Drawn:
Check:
Revisions:

FIGURE 2.4

7

III. HYDROLOGIC ANALYSIS

Introduction

A hydrologic analysis was conducted in order to determine peak discharges and runoff volumes for various storm types, and basin development conditions. This data was used in the evaluation of existing flood problems, and in the evaluation of alternative outfall plans. A technical addendum has been prepared which contains the detailed computer output for the various frequencies.

The hydrology data and results in this section represent the baseline hydrologic conditions. The means that the existing and future development hydrology has been determined by routing the sub-basins through the existing flow paths and that no improvements to the drainage facilities have been assumed in the modelling. No diversions or flow splits are assumed in the baseline hydrologic condition.

Colorado Urban Hydrograph Procedure

The runoff model used to determine the peak flows and volumes within the study area was the Colorado Urban Hydrograph Procedure (CUHP), in combination with the Stormwater Management Model (SWMM). Peak flows were predicted for 114 sub-basins and runoff hydrographs were developed for the 2-, 5-, 10-, and 100-year recurrence intervals using the CUHP-PC computer model. The sub-basin hydrographs were routed through the major flow paths using the UDSWM2-PC computer model.

Basin Characteristics

The study area subject to the hydrologic evaluation is the St. Charles Mesa Drainage Basin. The basin is generally divided into four regional basins. The regional basins are shown of Figure 3-1. The St. Charles and Arkansas River basins are direct flow areas to these rivers. Many of the direct flow basins lie within the floodplains of the these Rivers, or are relatively small sub-basins which lie at the northern and eastern edges of the Mesa. The Bessemer Ditch regional sub-basin represents those areas which lie south of the Ditch as it traverses the St. Charles Mesa basin. The existing flow which originates in these basins has been assumed to be intercepted by the Ditch. However, in a flooding event, the Ditch could be full and lacking adequate capacity to intercept the sub-basin flows and divert them to the St. Charles River at the Ditch siphon. In this case runoff could flow directly over the Ditch and enter the Santa Fe Avenue regional sub-basins. The Santa Fe Avenue regional sub-basins collect runoff originating north of the Bessemer Ditch and south of Santa Fe Avenue. For the purposes of modelling the baseline hydrologic conditions for the basin, that runoff reaching Santa Fe Avenue would be conveyed north to the Arkansas basins via the roadway, channels and storm sewers which exist.

For the most part, the sub-basins lying on the St. Charles Mesa are bounded by roadways. The sub-basins are linked together by roadside ditches and culverts. At many of the intersections ponding is possible because the roadways are physically higher than the adjacent ground. Driveway culverts which cross over the roadside ditches also cause runoff to pond in low spots, away from the main flow path. Because of this, runoff which may be concentrated at a point will be attenuated by channel and overbank storage as it is conveyed through the downstream sub-basins.

Colorado Urban Hydrograph Procedure

The input data for CUHP include rainfall, imperviousness, basin area, basin length, shape factor, soil infiltration, and surface storage. The input data were prepared using the guidelines and values recommended in the Urban Storm Drainage Criteria Manual (USDCM), the Preliminary City of Pueblo Storm Drainage Criteria Manual, and the users manual for the CUHP-PC computer program. The basin area, length, length to centroid, amount of impervious area, proportion of soil types and weighted basin slopes were measured and input files prepared using Computer Aided Design and Drafting (CADD) with an input data preparation program (CUHP-CAD). Discussions of specific input parameters follow.

1. Design Rainfall

The design rainfall for the study was determined using the procedures outlined in the City of Pueblo Storm Drainage Criteria Manual. One hour point rainfall values for each basin were determined. The 1-hour point rainfall depths were then distributed over a 2-hour interval. The 1-hour point rainfall data is shown on Table 3-1. The point rainfall data is generally used for sub-basin less than 6 square miles. Most of the basins modeled were smaller than 100 acres. Even though sub-basin peak discharges were developed using the point rainfall and the 2-hour storm distributions, it is recommended that the point rainfall results be used in the hydraulic analysis and outfall system(s) planning.

2. Impervious Land Density

The amount of impervious area within each sub-basin was estimated for two conditions, namely; (1) Existing development, and (2) future development. Existing development within the St. Charles Mesa basin is predominantly open space, agricultural and rural residential (lots exceeding 1 acre in size). The future condition development will consist mainly of single family residential with lots greater than 1 acre in size. Commercial uses now and in the future occur along Santa Fe Avenue. The projected land use data was obtained using zoning and comprehensive planning information provided by the Pueblo County Planning and Development Department. The future imperviousness for each of the sub-basins was estimated by reviewing the available land use data and assigning values of impervious area to each land use type. Presented on Table 3-2 are the percent impervious values input to the computer model. The land uses for existing and future development conditions were presented previously on Figures 2-3 and 2-4 contained in Section II of this report.

3. Basin Characteristics

Sub-basins were delineated on the 1-inch to 200-foot scale topographic mapping prepared for this study. The sub-basin boundaries were then superimposed on a 1-inch to 1000-foot scale USGS map. The sub-basin boundaries were established based upon physical drainage boundaries such as high points or roadways.

Sub-basin areas were measured using the CUHP-CAD computer input program. The measurement process utilizes a digitizer and an IBM-PC compatible computer. Sub-basin length, and length to centroid were also measured using the CAD and CUHP-CAD system. The sub-basin delineations are presented on Exhibit 1 contained within the map pocket at the rear of this report.

Sub-basin impervious areas were obtained by overlaying the land use information of the sub-basin delineation map and proportioning the impervious percentages. Contained within the Hydrology Appendix are the weighted percent impervious calculations for the existing and future basin development conditions.

The CUHP model requires adjusting the slope of the basin to account for slope variations along the flow path. The procedure is described in the CUHP-PC manual. Work sheets for the weighted slope calculations used in the CUHP model are contained in the technical addendum.

Impervious area surface storage and pervious area surface storage were estimated to be 0.1 inch and 0.5 inches, respectively. These values are consistent with the recommendations found in the Pueblo County Drainage Criteria Manual.

Infiltration rates were determined by overlaying the soils map (Figure 2-2), on the sub-basin map (Exhibit 1), and proportioning the amounts of soil type and infiltration rates. An initial infiltration rate of 4.77 inches per hour with a decay rate of .0018 was applied in the CUHP modeling of the sub-basins.

Presented on Tables 3-3 and 3-4 are the CUHP sub-basin data input for the CUHP computer model for the baseline hydrologic conditions.

Channel Routing

Individual sub-basin hydrographs were routed down the drainage flow paths using the UDSWM2-PC computer model. The drainage system was modeled using a system of channels and direct flow elements. The channel input includes length, slope, cross-section and roughness coefficients. This information was obtained during the Drainage structure inventory process and by using the 2-foot contour interval topographic mapping. Direct flow elements do not route upstream elements but instead directly add upstream hydrographs to give a direct translation of incoming flows. The SWMM channel system is presented on Exhibit 1.

For the baseline hydrology conditions, no improved channels were assumed in the SWMM model for either the existing or future development conditions. The alternative outfall systems did however incorporate improved channel sections, which will be discussed in a later section of the report. Lengths were measured from the detailed topography. Typical cross-sections of the channels were measured in the field. Overbank channels were developed using the topographic mapping and field inspection. Roughness coefficients were estimated based upon equation 2 in the UDSWM2-PC manual.

Presented on Figures 3-2 through 3-5 are the flow path diagrams for each of the regional sub-basins. These figures show schematically what was input to the UDSWM2-PC computer program. Contained within Appendix A is the input data for the baseline hydrologic condition SWMM model.

Results of the Hydrologic Analysis

Presented on Tables 3-5 and 3-6 are the peak discharges for the sub-basins defined for the St. Charles Mesa drainage basin. Complete CUHP output for the 100-year existing and future development conditions are contained within Technical Addendum to this report. The Hydrologic Sub-basin Map which illustrates the basin boundary, channel routing elements, design points and sub-basin locations is contained within the map pocket at the rear of the report (Exhibit 1). A summary of flow rates for key design points is presented on Tables 3-7 and 3-8.

The results show several impacts upon the hydrology for the Mesa because of urbanization. Firstly, there are significant increases in peak discharge and volume for the individual sub-basins which will develop from agricultural use and open space into single-family residential. The impact upon the peak flows along the receiving drainage paths (i.e., the Santa Fe Drive flow path and along the north south roadways), is not as significant in the developed scenario. This is because the channels as modeled assumed the existing cross-section. At many locations along the north-south roadways and at intersections, the adjacent land uses lie below the roadway crown and/or the top of channel bank. A significant amount of floodplain storage results which attenuate the peak discharges from tributary sub-basins as they move through the system. Therefore, as the model predicts and as the storm drainage problems along the major flow paths have shown, a relatively constant peak discharge is estimated. The duration of the runoff along the flow paths and roadways is extended by the floodplain storage and could last two to three hours after the peak discharge passes.

Secondly, the impact of the Bessemer Ditch relative to interception and diversion of runoff away from the Mesa is not great. During the hydrology analysis, two cases were investigated. These were, (1) interception of all runoff from sub-basin south of the Bessemer Ditch and no connection to the downstream flow paths, and (2) no diversion, or a pass through of the runoff over the Bessemer Ditch and into the downstream flow paths. Increases in peak flow, usually less than 10 percent were noted between cases 1 and 2, with case 2 producing the higher flows for all frequencies. Flow attenuation and the lagging of peaks through the flow paths are the primary reasons for this. Tables 3-7 and 3-8 reflect interception of runoff by the Bessemer Ditch (case 1). The practicality of utilizing the Ditch for the conveyance of urban runoff is discussed in later sections of this report. No importation of flow from urbanized areas in the City of Pueblo via the Ditch was assumed in the modeling.

Comparison to Previous Studies

Comparison to the 1979 St. Charles Mesa Drainage Plan with regards to hydrology is difficult. The 1979 study used a different hydrology model, a different rainfall pattern and storm duration, and no channel routing was performed. Consequently, there are few, if any common design points between this study and the 1979 study to compare peak discharges. Peak discharges for the 5-year and 10-year event were estimated in the 1979 study. As with this study, the 1979 study found that urbanization of the Mesa would increase peak discharges and volumes along the major drainageways and flow paths.

There are no other known studies which have been completed for the flood hydrology of the St. Charles Mesa Drainage Basin.

Table 3-1 One-hour Point Rainfall

Frequency	Rainfall Depth (in.)
2-year	1.13
5-year	1.50
10-year	1.73
100-year	2.67

Table 3-2: Uniform Percent Impervious Values

Land Use Category	Uniform % Imperviousness
Single-Family Residential	25-30
Large lot Residential/Agricultural	5-15
Commercial	90-95
Industrial	95
Institutional	50
Dedicated Open Space/Park	5-10

TABLE 3-3:
SUB-BASIN DATA FOR CUHP INPUT
ST. CHARLES MESA DRAINAGE BASINS, EXISTING CONDITIONS

SUB-BASIN #	AREA (sm)	LENGTH (mi)	LENGTH TO CENTROID (mi)	EXISTING % IMP.	SLOPE (ft/ft)	INITIAL INFIL. RATE (in.)	DECAY RATE	FINAL INFIL. RATE (in.)
1	0.198	0.57	0.30	5.0	0.003	4.77	.0018	0.81
2	0.317	0.74	0.36	5.0	0.007	4.18	.0018	0.67
3	0.268	0.80	0.48	5.0	0.008	4.21	.0018	0.60
4	0.143	0.72	0.41	5.0	0.017	4.54	.0018	0.69
5	0.148	0.81	0.44	5.0	0.027	4.59	.0018	0.68
6	0.193	0.50	0.20	5.0	0.014	4.50	.0018	0.60
7	0.021	0.16	0.06	5.0	0.025	4.50	.0018	0.60
8	0.300	0.70	0.33	5.0	0.022	4.60	.0018	0.77
9	0.099	0.31	0.16	10.0	0.014	4.08	.0018	0.62
10	0.216	0.54	0.37	10.0	0.034	4.58	.0018	0.66
11	0.266	0.93	0.48	6.7	0.020	4.62	.0018	0.70
12	0.027	0.28	0.14	10.0	0.021	3.21	.0018	0.51
13	0.079	0.29	0.14	30.0	0.011	3.97	.0018	0.56
14	0.068	0.38	0.18	21.5	0.018	4.50	.0018	0.60
15	0.066	0.42	0.11	15.0	0.007	4.50	.0018	0.60
16	0.101	0.40	0.20	22.6	0.014	4.50	.0018	0.60
17	0.134	0.56	0.23	21.5	0.009	4.50	.0018	0.60
18	0.122	0.67	0.35	18.0	0.006	4.50	.0018	0.60
19	0.273	0.82	0.49	6.7	0.005	4.50	.0018	0.60
20	0.254	0.79	0.36	12.0	0.007	4.50	.0018	0.60
21	0.127	0.63	0.35	9.0	0.007	4.50	.0018	0.60
22	0.126	0.53	0.30	5.0	0.008	4.50	.0018	0.60
23	0.062	0.36	0.19	5.0	0.006	4.50	.0018	0.60
24	0.095	0.45	0.30	42.4	0.005	4.50	.0018	0.60
25	0.082	0.42	0.25	15.0	0.007	4.50	.0018	0.60
26	0.092	0.65	0.34	24.0	0.006	4.50	.0018	0.60
27	0.198	0.54	0.33	26.6	0.007	4.50	.0018	0.60
28	0.068	0.53	0.19	54.5	0.030	4.69	.0018	0.75
29	0.022	0.30	0.15	21.4	0.052	4.75	.0018	0.80
30	0.050	0.60	0.36	20.0	0.052	4.87	.0007	0.89
31	0.060	0.54	0.33	48.3	0.039	4.45	.0018	0.65
32	0.041	0.45	0.17	24.6	0.034	4.55	.0018	0.72
33	0.053	0.54	0.25	40.8	0.022	4.47	.0018	0.64
34	0.044	0.48	0.21	15.0	0.013	4.53	.0018	0.63
35	0.126	0.64	0.35	15.0	0.010	4.50	.0018	0.60
36	0.016	0.15	0.06	5.0	0.051	5.00	.0007	1.00
37	0.030	0.12	0.07	19.4	0.057	4.82	.0007	0.86
38	0.056	0.32	0.16	27.0	0.011	4.58	.0018	0.66
39	0.100	0.45	0.26	15.0	0.003	4.50	.0018	0.60

TABLE 3-3:
SUB-BASIN DATA FOR CUHP INPUT
ST. CHARLES MESA DRAINAGE BASINS, EXISTING CONDITIONS

SUB-BASIN #	AREA (sm)	LENGTH (mi)	LENGTH TO CENTROID (mi)	EXISTING % IMP.	SLOPE (ft/ft)	INITIAL INFIL. RATE (in.)	DECAY RATE	FINAL INFIL. RATE (in.)
40	0.126	0.64	0.35	39.3	0.002	4.50	.0018	0.60
41	0.082	0.50	0.26	30.0	0.016	4.54	.0018	0.63
42	0.082	0.73	0.43	23.0	0.008	4.53	.0018	0.62
43	0.085	0.55	0.21	15.0	0.018	4.58	.0018	0.67
44	0.074	0.49	0.22	5.0	0.016	4.66	.0018	0.73
45	0.084	0.70	0.30	5.0	0.010	4.47	.0018	0.64
46	0.143	0.66	0.26	5.0	0.005	4.41	.0018	0.64
47	0.089	0.30	0.10	5.0	0.021	4.27	.0018	0.58
48	0.184	0.44	0.18	5.0	0.017	4.24	.0018	0.61
49	0.214	0.47	0.16	5.0	0.045	4.53	.0018	0.72
50	0.304	1.10	0.61	8.4	0.002	4.41	.0018	0.59
51	0.261	0.97	0.61	16.3	0.015	4.52	.0018	0.62
52	0.221	1.14	0.55	21.6	0.013	4.52	.0018	0.62
53	0.144	0.74	0.33	16.0	0.008	4.44	.0018	0.60
54	0.052	0.40	0.18	15.0	0.007	4.50	.0018	0.60
55	0.136	0.63	0.36	8.8	0.011	4.50	.0018	0.60
56	0.207	0.83	0.43	23.8	0.008	4.50	.0018	0.60
57	0.181	0.70	0.25	11.3	0.007	4.50	.0018	0.60
58	0.064	0.97	0.56	20.0	0.011	4.56	.0018	0.65
59	0.033	0.33	0.15	5.0	0.024	4.50	.0018	0.60
60	0.099	0.49	0.25	10.9	0.023	4.53	.0018	0.62
61	0.059	0.51	0.23	26.3	0.003	4.50	.0018	0.60
62	0.188	0.54	0.21	7.0	0.028	4.73	.0018	0.78
63	0.037	0.28	0.15	15.0	0.017	4.58	.0018	0.67
64	0.250	0.75	0.35	10.0	0.005	4.50	.0018	0.60
65	0.072	0.48	0.24	11.6	0.013	4.68	.0018	0.74
66	0.053	0.37	0.19	11.6	0.010	4.56	.0018	0.65
67	0.089	0.48	0.20	15.0	0.002	4.50	.0018	0.60
68	0.380	0.93	0.41	17.3	0.008	4.50	.0018	0.60
69	0.230	0.85	0.32	12.0	0.005	4.50	.0018	0.60
70	0.302	1.21	0.59	9.5	0.004	4.50	.0018	0.60
71	0.127	0.63	0.35	14.1	0.008	4.50	.0018	0.60
72	0.257	1.16	0.51	19.5	0.004	4.50	.0018	0.60
73	0.126	0.59	0.34	5.0	0.002	4.50	.0018	0.60
74	0.126	0.52	0.27	22.5	0.003	4.50	.0018	0.60
75	0.124	0.66	0.42	15.0	0.002	4.50	.0018	0.60
76	0.166	0.55	0.27	14.0	0.003	4.50	.0018	0.60
77	0.115	0.61	0.23	19.5	0.003	4.50	.0018	0.60
78	0.130	0.63	0.39	13.5	0.004	4.50	.0018	0.60

TABLE 3-3:
SUB-BASIN DATA FOR CUHP INPUT
ST. CHARLES MESA DRAINAGE BASINS, EXISTING CONDITIONS

SUB-BASIN #	AREA (sm)	LENGTH (mi)	LENGTH TO CENTROID (mi)	EXISTING % IMP.	SLOPE (ft/ft)	INITIAL INFIL. RATE (in.)	DECAY RATE	FINAL INFIL. RATE (in.)
79	0.077	0.62	0.32	5.0	0.006	4.54	.0018	0.63
80	0.089	0.42	0.19	15.0	0.027	4.65	.0018	0.72
81	0.017	0.14	0.08	5.0	0.057	4.81	.0007	0.84
82	0.110	0.65	0.33	9.0	0.012	4.56	.0018	0.65
83	0.062	0.44	0.21	5.0	0.012	4.54	.0018	0.63
84	0.092	0.59	0.31	5.0	0.052	4.81	.0007	0.85
85	0.074	0.44	0.16	5.0	0.013	4.70	.0018	0.76
86	0.065	0.45	0.24	8.8	0.011	4.57	.0018	0.66
87	0.100	0.62	0.28	15.0	0.001	4.50	.0018	0.60
88	0.017	0.17	0.07	6.9	0.043	4.84	.0007	0.87
89	0.093	0.47	0.25	10.5	0.007	4.60	.0018	0.68
90	0.126	0.44	0.25	15.0	0.002	4.50	.0018	0.60
91	0.025	0.27	0.12	5.0	0.012	4.55	.0018	0.64
92	0.080	0.48	0.19	9.5	0.004	4.52	.0018	0.62
93	0.067	0.52	0.21	10.0	0.012	4.62	.0018	0.70
94	0.062	0.50	0.22	12.0	0.015	4.61	.0018	0.69
95	0.119	0.85	0.51	10.0	0.004	4.48	.0018	0.63
96	0.090	0.41	0.22	5.0	0.006	4.63	.0018	0.71
97	0.126	0.55	0.25	15.0	0.002	4.50	.0018	0.60
98	0.072	0.44	0.25	15.0	0.005	4.50	.0018	0.60
99	0.066	0.29	0.12	10.7	0.007	4.66	.0018	0.73
100	0.069	0.61	0.31	9.2	0.018	4.55	.0018	0.64
101	0.060	0.40	0.20	30.0	0.006	4.50	.0018	0.60
102	0.042	0.42	0.25	5.0	0.011	4.56	.0018	0.65
103	0.059	0.33	0.21	30.0	0.008	4.50	.0018	0.60
104	0.059	0.29	0.14	30.0	0.010	4.50	.0018	0.60
105	0.038	0.30	0.11	5.0	0.006	4.50	.0018	0.60
106	0.093	0.42	0.32	30.0	0.004	4.50	.0018	0.60
107	0.044	0.34	0.11	88.5	0.015	4.61	.0018	0.69
108	0.091	0.68	0.38	40.3	0.008	4.37	.0018	0.59
109	0.085	0.43	0.10	5.0	0.004	4.75	.0018	0.80
110	0.045	0.41	0.17	5.0	0.002	4.74	.0018	0.79
111	0.099	0.50	0.25	27.5	0.015	4.51	.0018	0.61
112	0.026	0.23	0.10	5.8	0.037	4.63	.0018	0.71
113	0.024	0.15	0.05	6.4	0.042	4.85	.0007	0.88
114	0.128	0.71	0.35	15.0	0.006	4.85	.0007	0.88

TABLE 3-4
SUB-BASIN DATA FOR CUHP INPUT
ST. CHARLES MESA DRAINAGE BASINS, FUTURE CONDITIONS

SUB-BASIN #	AREA (sm)	LENGTH (mi)	LENGTH TO CENTROID (mi)	FUTURE % IMP.	SLOPE (ft/ft)	INITIAL INFIL. RATE (in.)	DECAY RATE	FINAL INFIL. RATE (in.)
1	0.198	0.57	0.30	5.0	0.003	4.77	.0018	0.81
2	0.317	0.74	0.36	5.0	0.007	4.18	.0018	0.67
3	0.268	0.80	0.48	5.0	0.008	4.21	.0018	0.60
4	0.143	0.72	0.41	5.0	0.017	4.54	.0018	0.69
5	0.148	0.81	0.44	5.0	0.027	4.59	.0018	0.68
6	0.193	0.50	0.20	5.0	0.014	4.50	.0018	0.60
7	0.021	0.16	0.06	5.0	0.025	4.50	.0018	0.60
8	0.300	0.70	0.33	5.0	0.022	4.60	.0018	0.77
9	0.099	0.31	0.16	10.0	0.014	4.08	.0018	0.62
10	0.216	0.54	0.37	10.0	0.034	4.58	.0018	0.66
11	0.266	0.93	0.48	6.7	0.020	4.62	.0018	0.70
12	0.027	0.28	0.14	10.0	0.021	[illegible]	.0018	0.51
13	0.079	0.29	0.14	30.0	0.011	[illegible]	.0018	0.56
14	0.068	0.38	0.18	23.2	0.018	4.50	.0018	0.60
15	0.066	0.42	0.11	15.0	[illegible]	4.50	.0018	0.60
16	0.101	0.40	0.20	25.7	[illegible]	4.50	.0018	0.60
17	0.134	0.56	0.23	22.5	0.009	4.50	.0018	0.60
18	0.122	0.67	0.35	18.0	0.006	4.50	.0018	0.60
19	0.273	0.82	0.49	15.0	0.005	4.50	.0018	0.60
20	0.254	0.79	0.36	14.0	0.007	4.50	.0018	0.60
21	0.127	0.63	0.35	18.8	0.007	4.50	.0018	0.60
22	0.126	0.53	0.30	15.0	0.008	4.50	.0018	0.60
23	0.062	0.36	0.19	30.0	0.006	4.50	.0018	0.60
24	0.095	0.45	0.30	42.5	0.005	4.50	.0018	0.60
25	0.082	0.42	0.25	15.0	0.007	4.50	.0018	0.60
26	0.092	0.65	0.34	24.0	0.006	4.50	.0018	0.60
27	0.198	0.54	0.33	26.6	0.007	4.50	.0018	0.60
28	0.068	0.53	0.19	77.0	0.030	4.69	.0018	0.75
29	0.022	0.30	0.15	67.2	0.052	4.75	.0018	0.80
30	0.050	0.60	0.36	67.0	0.052	4.87	.0007	0.89
31	0.060	0.54	0.33	48.3	0.039	4.45	.0018	0.65
32	0.041	0.45	0.17	24.6	0.034	4.55	.0018	0.72
33	0.053	0.54	0.25	43.8	0.022	4.47	.0018	0.64
34	0.044	0.48	0.21	15.0	0.013	4.53	.0018	0.63
35	0.126	0.64	0.35	15.0	0.010	4.50	.0018	0.60
36	0.016	0.15	0.06	5.0	0.051	5.00	.0007	1.00
37	0.030	0.12	0.07	19.4	0.057	4.82	.0007	0.86
38	0.056	0.32	0.16	27.0	0.011	4.58	.0018	0.66
39	0.100	0.45	0.26	15.0	0.003	4.50	.0018	0.60
40	0.126	0.64	0.35	39.3	0.002	4.50	.0018	0.60
41	0.082	0.50	0.26	30.0	0.016	4.54	.0018	0.63
42	0.082	0.73	0.43	36.5	0.008	4.53	.0018	0.62
43	0.085	0.55	0.21	30.0	0.018	4.58	.0018	0.67
44	0.074	0.49	0.22	5.0	0.016	4.66	.0018	0.73
45	0.084	0.70	0.30	5.0	0.010	4.47	.0018	0.64
46	0.143	0.66	0.26	8.6	0.005	4.41	.0018	0.64
47	0.089	0.30	0.10	15.0	0.021	4.27	.0018	0.58
48	0.184	0.44	0.18	5.0	0.017	4.24	.0018	0.61
49	0.214	0.47	0.16	5.0	0.045	4.53	.0018	0.72
50	0.304	1.10	0.61	31.3	0.002	4.41	.0018	0.59
51	0.261	0.97	0.61	16.3	0.015	4.52	.0018	0.62
52	0.221	1.14	0.55	21.6	0.013	4.52	.0018	0.62
53	0.144	0.74	0.33	20.0	0.008	4.44	.0018	0.60
54	0.052	0.40	0.18	15.0	0.007	4.50	.0018	0.60
55	0.136	0.63	0.36	20.0	0.011	4.50	.0018	0.60
56	0.207	0.83	0.43	26.3	0.008	4.50	.0018	0.60
57	0.181	0.70	0.25	18.8	0.007	4.50	.0018	0.60
58	0.064	0.97	0.56	20.0	0.011	4.56	.0018	0.65
59	0.033	0.33	0.15	15.0	0.024	4.50	.0018	0.60
60	0.099	0.49	0.25	10.9	0.023	4.53	.0018	0.62
61	0.059	0.51	0.23	30.0	0.003	4.50	.0018	0.60
62	0.188	0.54	0.21	7.0	0.028	4.73	.0018	0.78
63	0.037	0.28	0.15	15.0	0.017	4.58	.0018	0.67
64	0.250	0.75	0.35	17.3	0.005	4.50	.0018	0.60
65	0.072	0.48	0.24	11.6	0.013	4.68	.0018	0.74
66	0.053	0.37	0.19	14.9	0.010	4.56	.0018	0.65
67	0.089	0.48	0.20	15.0	0.002	4.50	.0018	0.60
68	0.380	0.93	0.41	17.3	0.008	4.50	.0018	0.60
69	0.230	0.85	0.32	20.0	0.005	4.50	.0018	0.60
70	0.302	1.21	0.59	15.0	0.004	4.50	.0018	0.60
71	0.127	0.63	0.35	18.0	0.008	4.50	.0018	0.60
72	0.257	1.16	0.51	25.5	0.004	4.50	.0018	0.60
73	0.126	0.59	0.34	15.0	0.002	4.50	.0018	0.60
74	0.126	0.52	0.27	22.5	0.003	4.50	.0018	0.60
75	0.124	0.66	0.42	15.0	0.002	4.50	.0018	0.60
76	0.166	0.55	0.27	15.0	0.003	4.50	.0018	0.60
77	0.115	0.61	0.23	22.5	0.003	4.50	.0018	0.60
78	0.130	0.63	0.39	15.0	0.004	4.50	.0018	0.60

TABLE 3-4
SUB-BASIN DATA FOR CUHP INPUT
ST. CHARLES MESA DRAINAGE BASINS, FUTURE CONDITIONS

TABLE 3-4
SUB-BASIN DATA FOR CUHP INPUT
ST. CHARLES MESA DRAINAGE BASINS, FUTURE CONDITIONS

SUB-BASIN #	AREA (sm)	LENGTH (mi)	LENGTH TO CENTROID (mi)	FUTURE % IMP.	SLOPE (ft/ft)	INITIAL INFIL. RATE (in.)	DECAY RATE	FINAL INFIL. RATE (in.)
79	0.077	0.62	0.32	15.0	0.006	4.54	.0018	0.63
80	0.089	0.42	0.19	21.0	0.027	4.65	.0018	0.72
81	0.017	0.14	0.08	15.0	0.057	4.81	.0007	0.84
82	0.110	0.65	0.33	15.0	0.012	4.56	.0018	0.65
83	0.062	0.44	0.21	15.0	0.012	4.54	.0018	0.63
84	0.092	0.59	0.31	15.0	0.052	4.81	.0007	0.85
85	0.074	0.44	0.16	15.0	0.013	4.70	.0018	0.76
86	0.065	0.45	0.24	17.3	0.011	4.57	.0018	0.66
87	0.100	0.62	0.28	15.0	0.001	4.50	.0018	0.60
88	0.017	0.17	0.07	6.9	0.043	4.84	.0007	0.87
89	0.093	0.47	0.25	15.0	0.007	4.60	.0018	0.68
90	0.126	0.44	0.25	15.0	0.002	4.50	.0018	0.60
91	0.025	0.27	0.12	15.0	0.012	4.55	.0018	0.64
92	0.080	0.48	0.19	15.0	0.004	4.52	.0018	0.62
93	0.067	0.52	0.21	15.0	0.012	4.62	.0018	0.70
94	0.062	0.50	0.22	13.5	0.015	4.61	.0018	0.69
95	0.119	0.85	0.51	15.0	0.004	4.48	.0018	0.63
96	0.090	0.41	0.22	5.0	0.006	4.63	.0018	0.71
97	0.126	0.55	0.25	15.0	0.002	4.50	.0018	0.60
98	0.072	0.44	0.25	15.0	0.005	4.50	.0018	0.60
99	0.066	0.29	0.12	10.7	0.007	4.66	.0018	0.73
100	0.069	0.61	0.31	15.5	0.018	4.55	.0018	0.64
101	0.060	0.40	0.20	30.0	0.006	4.50	.0018	0.60
102	0.042	0.42	0.25	7.0	0.011	4.56	.0018	0.65
103	0.059	0.33	0.21	30.0	0.008	4.50	.0018	0.60
104	0.059	0.29	0.14	30.0	0.010	4.50	.0018	0.60
105	0.038	0.30	0.11	15.0	0.006	4.50	.0018	0.60
106	0.093	0.42	0.32	30.0	0.004	4.50	.0018	0.60
107	0.044	0.34	0.11	88.5	0.015	4.61	.0018	0.69
108	0.091	0.68	0.38	40.3	0.008	4.37	.0018	0.59
109	0.085	0.43	0.10	5.0	0.004	4.75	.0018	0.80
110	0.045	0.41	0.17	15.0	0.002	4.74	.0018	0.79
111	0.099	0.50	0.25	27.5	0.015	4.51	.0018	0.61
112	0.026	0.23	0.10	5.8	0.037	4.63	.0018	0.71
113	0.024	0.15	0.05	6.4	0.042	4.85	.0007	0.88
114	0.128	0.71	0.35	20.0	0.006	4.85	.0007	0.88

TABLE 3-5:
SUB-BASIN DISCHARGES
EXISTING DEVELOPMENT CONDITIONS

SUB-BASIN #	DISCHARGE/FREQUENCY (CFS) 2YR	5YR	10YR	100YR
1	4.	7.	20.	119.
2	7.	24.	50.	219.
3	5	21	40	166
4	3.	9.	20	97
5	5	10	22	102
6	7.	26.	50.	205.
7	1.	6.	13.	45.
8	9.	18.	49.	253.
9	15	43	81	244
10	14.	31.	56.	222.
11	8.	18.	38.	178.
12	4	17	23	64
13	41	67	94	247
14	24.	39.	65.	186.
15	15	30	56	166
16	37	60	99	276
17	36	64	103	293
18	28	54	91	268
19	7.	20.	38	154
20	14.	31.	52.	186.
21	14	38	75	258
22	8	30	68	252
23	5	19	44	144
24	79.	105	136	350
25	20.	38.	71.	211.
26	37	57	94	268
27	39	64	90	254
28	78.	103.	119.	276.
29	8.	11.	17.	51.
30	16	21	24	81
31	54	75	90	224
32	16.	21.	37.	105.
33	39.	52.	70.	176.
34	10.	18.	35.	104.
35	23	48	84	263
36	0.	1.	2.	17.
37	9	12	13	47
38	25.	34.	56.	155.
39	23	46	85	250
40	62	91	121	295
41	43	51	91	248
42	31	48	81	232
43	20.	34.	69.	214.
44	6.	13.	45.	166.
45	7.	24.	60.	198.
46	3.	11.	22.	97.
47	7.	33.	69.	216.
48	7.	28.	56.	216.
49	10.	27.	66.	293.
50	6.	18.	31.	125.
51	18	35	55	189
52	22.	38.	56.	176.
53	11.	23.	35.	116.
54	12	24	43	127
55	14	37	73	260
56	27.	47.	67.	198.
57	10.	25.	41.	148.
58	5.	8.	12.	40.
59	2	10	22	73
60	16	37	75	232
61	26.	39.	61.	167.
62	10	17	43	202
63	8.	14.	28.	86.
64	11.	26.	45.	170.
65	13.	19.	49.	164.
66	9	18	39	121
67	21.	42.	78.	232.
68	63	62	96	315
69	12	27	44	159
70	8	20	35	139
71	21	45	79	254
72	18	34	50	162
73	7	30	65	244
74	35	62	97	275
75	23	47	83	258
76	27	55	76	319
77	30	55	91	261
78	21	45	80	259
79	6	22	54	180
80	21.	31.	69.	221.
81	0.	2.	2.	20.
82	13	31	67	231
83	5.	17.	42.	142.
84	7.	10.	11.	128.
85	6.	11.	42.	165.
86	9	20	46	148
87	22	45	81	237
88	2.	2.	2.	21.
89	15	29	68	220
90	23	48	84	263
91	2.	6.	15.	53.
92	12.	29.	60.	189.
93	10	19	46	152
94	11.	20.	45.	142.
95	15	36	73	247
96	7	18	58	207
97	22	46	81	255
98	17	33	62	183
99	11	17	44	148
100	10.	23.	50.	160.
101	30.	44.	66.	176.
102	3	10	27	93
103	30.	43.	65.	173.
104	30.	43.	65.	173.
105	3.	11.	25.	85.
106	49	69	106	288
107	103	137	157	264
108	71.	94.	127.	326.
109	7.	9.	46.	189.
110	3.	5.	23.	96.
111	45	66	104	280
112	2.	5.	15.	54.
113	2.	3.	3.	30.
114	23	31	36	162

TABLE 3-6:
SUB-BASIN DISCHARGES
FUTURE DEVELOPMENT CONDITIONS

SUB-BASIN #	DISCHARGE/FREQUENCY (CFS) 2YR	5YR	10YR	100YR
1	4.	7.	20.	119.
2	7.	24.	50.	219.
3	5	21	40	166
4	3.	9.	20	97
5	3	10	22	102
6	7.	26.	50.	205.
7	1.	6.	13.	45.
8	9.	18.	49.	253.
9	15	43	81	224
10	14.	31.	56.	222.
11	8.	18.	38.	178.
12	4	17	23	64
13	41	67	94	247
14	26	41	67	189
15	15	30	56	166
16	43	65	104	283
17	37	66	104	294
18	28	54	91	268
19	16	33	53	181
20	17	35	56	195
21	31	57	96	281
22	31	61	113	340
23	31	45	69	183
24	79.	105	136	350
25	20.	38.	71.	211.
26	37	57	94	268
27	39	64	90	254
28	137	182	209	385
29	31	42	48	95
30	78	103	118	200
31	57	75	90	224
32	16.	21.	37.	105.
33	43	58	74	184
34	10.	18.	35.	104.
35	23	48	84	263
36	0.	1.	2.	17.
37	9	12	13	47
38	25.	34.	56.	155.
39	23	46	85	250

SUB-BASIN #	DISCHARGE/FREQUENCY (CFS) 2YR	5YR	10YR	100YR
40	62	91	121	295
41	43	58	91	248
42	55	73	103	270
43	44	59	92	255
44	6.	13.	45.	166.
45	7.	24.	60.	198.
46	6	14	26	100
47	21	46	800	235
48	7.	28.	56.	216.
49	10.	27.	66.	293.
50	42	68	92	251
51	18	35	55	189
52	22.	38.	56.	176.
53	15	29	43	132
54	12	24	43	127
55	33	60	98	287
56	32	54	76	216
57	20	38	58	181
58	5.	8.	12.	40.
59	7	15	27	77
60	16	37	75	232
61	30	43	65	173
62	10	17	43	202
63	8.	14.	28.	86.
64	21	41	62	204
65	13.	19.	49.	164.
66	12	21	42	127
67	21.	42.	78.	232.
68	32	62	96	315
69	23	43	63	199
70	14	28	45	159
71	27	52	87	263
72	28	48	67	200
73	23	48	84	263
74	35	62	97	275
75	23	47	83	258
76	29	58	101	322
77	35	60	96	266
78	23	48	83	263

SUB-BASIN #	DISCHARGE/FREQUENCY (CFS) 2YR	5YR	10YR	100YR
79	18	34	65	195
80	31	41	78	239
81	4	5	5	24
82	23	41	78	242
83	14	27	51	153
84	22	29	34	146
85	17	23	53	177
86	18	29	55	165
87	22	45	81	237
88	2.	2.	2.	21.
89	22	36	76	235
90	23	48	84	263
91	5	10	19	57
92	19	36	68	204
93	16	24	52	162
94	13	21	47	146
95	24	46	84	259
96	7	18	58	207
97	22	46	81	255
98	17	33	62	183
99	11	17	44	148
100	17	30	57	173
101	30	44	66	176
102	4	12	28	93
103	30.	43.	65.	173.
104	30.	43.	65.	173.
105	9	17	31	90
106	49	69	106	288
107	103	137	157	264
108	71.	94.	127.	326.
109	7.	9.	46.	189.
110	10	14	30	101
111	45	66	104	280
112	2.	5.	15.	54.
113	2.	3.	3.	30.
114	32	43	49	176

TABLE 3-7:
DESIGN POINT DISCHARGES, EXISTING CONDITIONS
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
1	4.	7.	20.	119.
2	7.	24.	50.	219.
3	9.	25.	45.	176.
4	3.	9.	20.	97.
5	6	17.	39.	156.
6	7.	26.	50.	205.
7	1.	6.	13.	45.
8	9.	18.	49.	253.
9	16.	46.	85.	249.
10	14.	31.	56.	222.
11	8	18.	38.	178.
12	20.	63.	108.	313.
13	47.	91.	141.	432.
14	24.	39.	65.	186.
15	51.	73.	102.	223.
16	37.	60.	99.	276.
17	36.	64.	103.	293.
18	40.	68.	107.	299.
19	7.	20.	38.	154.
20	14.	31.	52.	186.
21	49.	100.	160.	416.
22	96.	175.	272.	558.
23	82.	131.	172.	332.,
24	79.	106.	138.	352.
25	20.	38.	71.	211.
26	46.	75.	112.	286.
27	118	179.	231.	502.
28	181.	240.	276.	539.
29	8.	11.	17.	51.
30	16.	21.	24.	81.
31	73	96.	113.	290.
32	16.	21.	37.	105.
33	39.	52.	70.	176.
34	10	18.	35.	104.
35	23.	48.	84.	263.
36	0.	1.	2.	17.
37	19.	25.	31.	91.
38	25	34.	56.	155.
39	41.	85.	146.	498.
40	62.	91.	121.	295.
41	51.	90.	140.	311.
42	32.	50.	84.	234.
43	20.	34.	69.	214.
44	6.	13.	45.	166.
45	7.	24.	60.	198.
46	3.	11.	22.	97.
47	7.	33.	69.	216.
48	7.	28.	56.	216.
49	10.	27.	66.	293.
50	6.	18.	31.	125.
51	23.	41.	61.	196.
52	22.	38.	56.	176.
53	11.	23.	35.	116.
54	16.	28.	48.	133.
55	25.	64.	103.	353.
56	27.	47.	67.	198.
57	10.	25.	41.	148.
58	5.	8.	12.	40.
59	12.	20.	33.	87.
60	16.	37.	75.	232.
61	26.	39.	61.	167.
62	14.	22.	48.	208.
63	8.	14.	28.	86.
64	11.	26.	45.	170.
65	13.	19.	49.	164.
66	89.	158.	229.	483.
67	21.	42.	78.	232.
68	158.	268.	354.	784.
69	24.	41.	59.	184.
70	179.	249.	311.	604.
71	40.	66.	102.	287.
72	167.	221.	270.	513.
73	7.	30.	65.	244.
74	45.	77.	120.	361.
75	49.	97.	146.	354.
76	27.	55	98.	319.
77	178.	240.	299.	585.
78	21.	45.	80.	259.
79	29.	65.	111.	436.
80	21.	31.	69.	221.
81	0.	2.	2.	20.
82	13.	31.	67.	231.
83	5.	17.	42.	142.
84	7.	10.	11.	128.
85	6.	11.	42.	165.
86	66.	140.	226.	695.
87	22.	45.	81.	237.
88	2.	2.	2.	21.
89	28.	46.	87.	245.
90	37.	82.	138.	493.
91	2.	6.	15.	53.
92	12.	29.	60.	189.
93	19.	44	80.	214.
94	11.	20.	45.	142.
95	15.	36.	73.	247.
96	11.	23.	63.	215.
97	64.	132.	210.	595.
98	144.	221.	284.	570.
99	21.	42.	79.	300.
100	10.	23.	50.	160.
101	30.	44.	66.	176.
102	6.	14.	31.	98.
103	30.	43.	65.	173.
104	30.	43.	65.	173.
105	3.	11.	25.	85.
106	49.	69.	106.	288.
107	103.	137.	157.	264.
108	71.	94.	127.	326.
109	7.	9.	46.	189.
110	3.	5.	23.	96.
111	45.	66.	104.	280.
112	2	5	15.	54.
113	2	3.	3.	30.
114	30.	52.	88.	353.
115	178.	239.	297.	583.
116	155.	215	270.	551.
117	7.	8.	8.	12.
118	5.	14.	32.	89.
119	7.	27.	53.	236.
120	12.	42.	86.	400.

TABLE 3-7:
DESIGN POINT DISCHARGES, EXISTING CONDITIONS
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
121	18.	55.	114.	546.
122	21.	63.	133.	614.
123	47.	93.	148.	582.
124	47.	102.	161.	573.
125	29.	78.	148.	555.
126	30.	75.	155.	570.
127	28.	74.	153.	559.
128	11.	31.	70.	338.
129	6.	16.	36.	89.
130	23.	41.	51.	101.
200	14.	31.	52.	186.
202	6.	16.	36.	89.
203	3.	8.	18.	65.
204	5.	14.	32.	89.
205	15.	22.	27.	71.
206	4.	9.	16.	51.
207	27.	60.	67.	97.
208	7.	8.	8.	12.
209	7.	29.	62.	198.
210	18.	23.	29.	69.
211	33.	61.	81.	133.
212	47.	95.	142.	340.
213	14.	32.	53.	76.
214	19.	43.	73.	272.
215	63.	130.	200.	587.
216	5.	6.	7.	14.
217	13.	28.	50.	156.
218	89.	158.	229.	483.
219	144.	221.	284.	570.
220	178.	239.	297.	583.
221	167.	227.	281.	545.
222	150.	200.	247.	483.
223	9.	13.	18.	48.
224	23.	41.	51.	101.
225	15.	22.	30.	66.
226	10.	15.	20.	47.
227	150.	207.	258.	517.
228	109.	158.	192.	377.
229	3.	4.	4.	8.
230	5.	12.	16.	31.

DESIGN POINT #	2YR	5YR	10YR	100YR
231	39.	61.	66.	92.
232	19.	22.	25.	39.
233	20.	22.	23.	32.
234	19.	50.	84.	186.
235	2.	8.	17.	74.
236	11.	20.	22.	30.
237	5.	5.	6.	10.
238	49.	62.	76.	151.
239	43.	52.	60.	104.
240	4.	7.	11.	40.
242	36.	63.	80.	135.
243	49.	97.	161.	277.
244	20.	24.	28.	51.
245	14.	18.	22.	51.
246	58.	84.	110.	280.
247	20.	42.	71.	213.
248	38.	64.	97.	189.
249	5.	5.	6.	8.
250	10.	11.	12.	18.
251	4.	5.	6.	8.
252	6.	7.	8.	15.
257	6.	8.	8.	12.
258	4.	12.	29.	88.
259	5.	19.	47.	225.
260	12.	40.	85.	381.
261	16.	50.	109.	491.
262	20.	57.	124.	533.
263	34.	79.	146.	563.
264	29.	72.	147.	555.
265	28.	71.	145.	539.
266	28.	74.	153.	559.
267	4.	5.	7.	22.
268	13.	40.	71.	219.
269	5.	6.	8.	23.
270	12.	23.	36.	129.
271	20.	24.	28.	50.
275	26.	48.	77.	284.

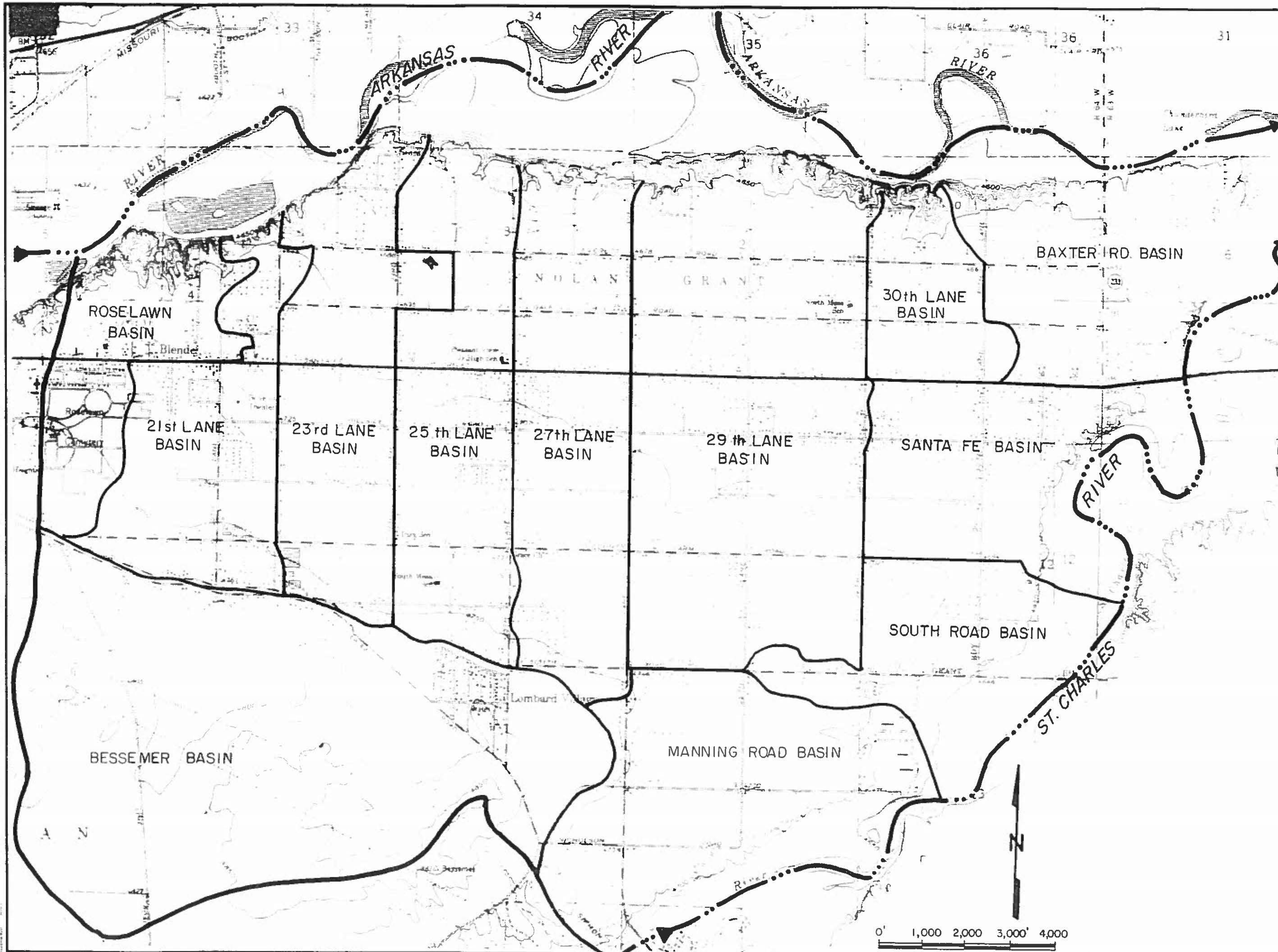
TABLE 3-8:
DESIGN POINT DISCHARGES, FUTURE CONDITIONS
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	DISCHARGE/FREQUENCY (CFS) 2YR	5YR	10YR	100YR
1	4.	7.	20.	119.
2	7.	24.	50.	219.
3	9.	25.	45.	176.
4	3.	9.	20.	97.
5	6.	17.	39.	156.
6	7.	26.	50.	205.
7	1.	6.	13.	45.
8	9.	18.	49.	253.
9	16.	46.	85.	249.
10	14.	31.	56.	222.
11	8.	18.	38.	178.
12	20.	63.	108.	313.
13	47.	91.	141.	432.
14	26.	41.	67.	190.
15	52.	74.	103.	224.
16	43.	65.	104.	283.
17	37.	66.	104.	294.
18	40.	68.	107.	299.
19	16.	33.	53.	181.
20	17.	35.	56.	195.
21	72.	120.	183.	442.
22	130.	218.	312.	633.
23	102.	146.	197.	359.
24	81.	107.	139.	353.
25	20.	38.	71.	211.
26	46.	75.	112.	286.
27	128.	192.	245.	516.
28	240.	318.	366.	649.
29	31.	42.	48.	95.
30	78.	103.	118.	200.
31	134.	178.	208.	424.
32	16.	21.	37.	105.
33	43.	58.	74.	183.
34	10.	18.	35.	104.
35	23.	48.	84.	263.
36	0.	1.	2.	17.
37	19.	25.	31.	91.
38	25.	34.	56.	155.
39	41.	85.	146.	498.
40	62.	91.	121.	295.
41	51.	90.	140.	311.
42	55.	73.	106.	272.
43	44.	59.	92.	255.
44	6.	13.	45.	166.
45	7.	24.	60.	198.
46	6.	14.	26.	100.
47	21.	46.	80.	235.
48	7.	28.	56.	216.
49	10.	27.	66.	293.
50	42.	68.	92.	251.
51	24.	41.	62.	197.
52	22.	38.	56.	176.
53	15.	29.	43.	132.
54	16.	28.	48.	133.
55	48.	86.	135.	389.
56	32.	54.	76.	216.
57	20.	38.	58.	181.
58	5.	8.	12.	40.
59	16.	25.	37.	91.
60	16.	37.	75.	232.
61	30.	43.	65.	173.
62	15.	22.	48.	208.
63	8.	14.	28.	86.
64	21.	41.	62.	204.
65	13.	19.	49.	164.
66	114.	187.	253.	502.
67	21.	42.	78.	232.
68	184.	293.	376.	796.
69	34.	55.	78.	220.
70	208.	275.	333.	627.
71	47.	74.	110.	296.
72	185.	238.	285.	519.
73	23.	48.	84.	263.
74	45.	77.	120.	361.
75	49.	97.	146.	354.
76	29.	58.	101.	322.
77	208.	266.	320.	599.
78	23.	48.	83.	263.
79	59.	101.	151.	453.
80	31.	41.	78.	239.
81	4.	5.	5.	24.
82	23.	41.	78.	242.
83	14.	27.	51.	153.
84	22.	29.	34.	146.
85	17.	23.	53.	177.
86	70.	143.	230.	697.
87	22.	45.	81.	237.
88	2.	2.	2.	21.
89	33.	53.	94.	256.
90	39.	84.	140.	497.
91	5.	10.	19.	57.
92	19.	36.	68.	204.
93	25.	49.	85.	220.
94	13.	21.	47.	146.
95	24.	46.	84.	259.
96	11.	23.	63.	215.
97	64.	132.	210.	595.
98	179.	248.	306.	584.
99	21.	42.	79.	300.
100	17.	30.	57.	173.
101	30.	44.	66.	176.
102	8.	15.	32.	98.
103	30.	43.	65.	173.
104	30.	43.	65.	173.
105	9.	17.	31.	90.
106	49.	69.	106.	288.
107	103.	137.	157.	264.
108	71.	94.	127.	326.
109	7.	9.	46.	189.
110	10.	14.	30.	101.
111	45.	66.	104.	280.
112	2.	5.	15.	54.
113	2.	3.	3.	30.
114	54.	80.	112.	372.
115	206.	265.	319.	596.
116	171.	230.	285.	568.
117	7.	8.	8.	12.
118	5.	14.	32.	89.
119	7.	27.	53.	236.
120	12.	42.	86.	400.

TABLE 3-8:
DESIGN POINT DISCHARGES, FUTURE CONDITIONS
ST. CHARLES MESA DRAINAGE BASINS

DESIGN	DISCHARGE/FREQUENCY (CFS)			
POINT #	2YR	5YR	10YR	100YR
121	18.	55.	114.	546.
122	21.	63.	133.	614.
123	47.	93	148.	582.
124	49.	103.	163.	573.
125	33.	82.	151.	558.
126	33.	80.	160.	574.
127	33.	79.	158.	563.
128	11.	31.	70.	338.
129	6.	16.	36.	89.
130	27.	46.	53.	105.
200	17.	35.	57.	196.
202	6.	16.	36.	89.
203	3.	8.	18.	65.
204	5.	14.	32.	89.
205	15.	22.	27.	71.
206	4.	9.	16.	51.
207	27.	60.	67.	97.
208	7.	8.	8.	12.
209	23.	46.	78.	204.
210	18.	24.	30.	70.
211	33.	61.	81.	133.
212	47.	95.	142.	340.
213	15.	34.	53.	76.
214	20.	46.	75.	275.
215	63.	130.	200.	587.
216	5.	6.	7.	14.
217	13.	28.	50.	156.
218	114.	187.	253.	502.
219	179.	248.	306.	584.
220	206.	265	319.	596.
221	191.	249.	299.	555.
222	164.	214.	260.	497.
223	11.	15.	20.	50.
224	27.	46.	53.	105.
225	16.	24.	32.	68.
226	13.	18.	23.	52.
227	165.	220.	270.	529.
228	121.	166.	201.	387.
229	3.	4.	4.	8.
230	9.	16.	18.	33.

DESIGN	DISCHARGE/FREQUENCY (CFS)			
POINT #	2YR	5YR	10YR	100YR
231	39.	61.	66.	92.
232	19.	22.	25.	39.
233	20.	22.	23.	32.
234	37.	72.	108.	192.
235	6.	13.	23.	78.
236	11.	20.	22.	30.
237	5.	5.	6.	10.
238	53.	68.	81.	158.
239	43.	53.	61.	104.
240	6.	10.	14.	45.
242	36.	63.	80.	135.
243	69.	121.	186.	283.
244	21.	25.	28.	51.
245	14.	18.	22.	51.
246	70.	97.	123.	292.
247	20.	42.	71.	213.
248	44.	71.	104.	192.
249	5.	5.	6.	8.
250	10.	11.	12.	18.
251	4.	5.	6.	8.
252	8.	9.	11.	17.
257	6.	8.	8.	12.
258	4.	12.	29.	88.
259	5.	19.	47.	225.
260	12.	40.	85.	381.
261	16.	50.	109.	491.
262	20.	57.	124.	533.
263	34.	79.	146.	563.
264	30.	73.	147.	555.
265	30.	73.	148.	541.
266	33.	79.	158.	563.
267	4.	5.	7.	22.
268	13.	40.	71.	219.
269	5.	6.	8.	23.
270	12.	23.	36.	129.
271	21.	25.	29.	51.
275	48.	76.	108.	294.



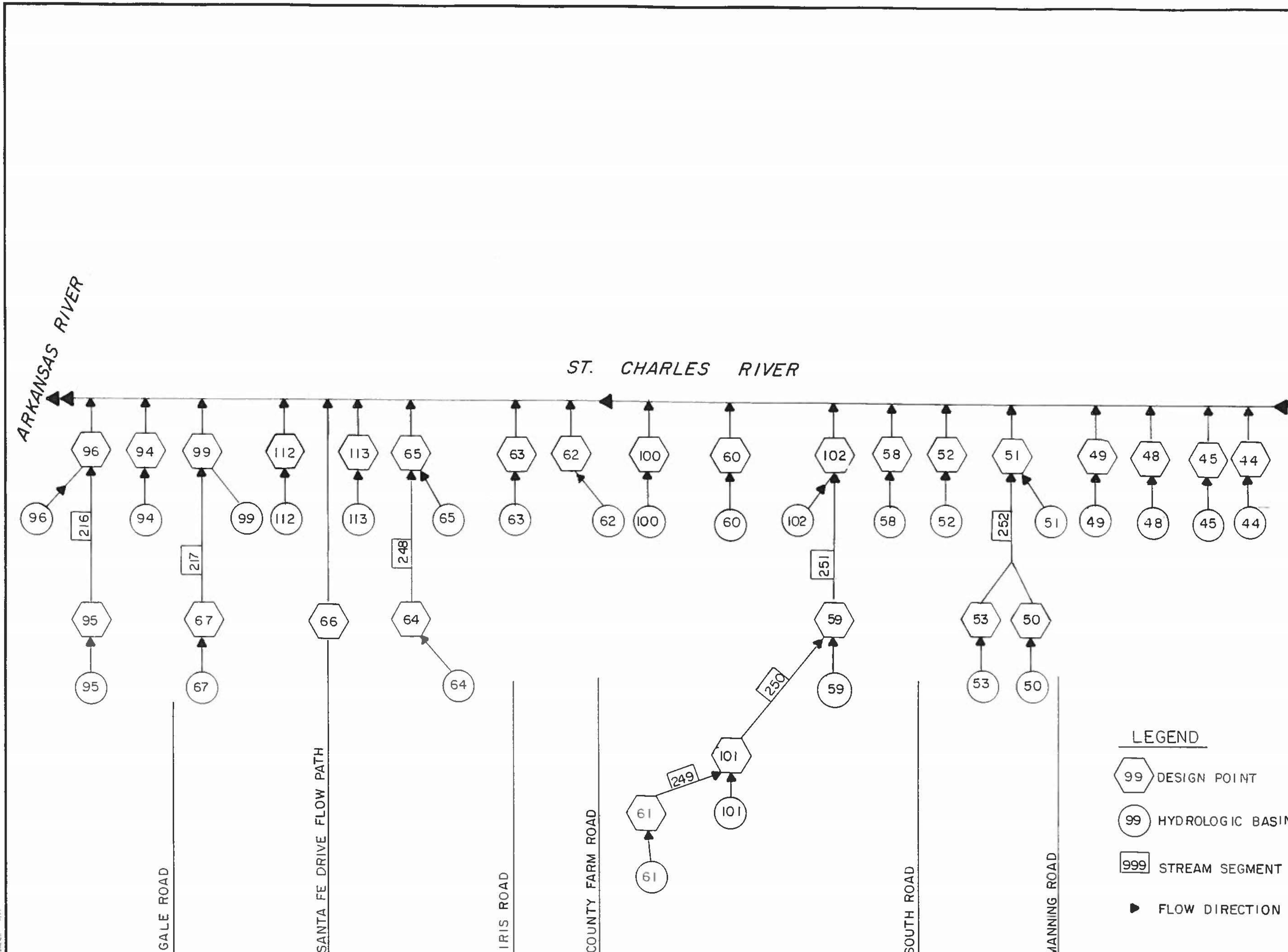
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

REGIONAL SUB-BASIN MAP

Project No.	94-01-01
Date:	3/94
Design:	CAB
Drawn:	
Check:	
Revisions:	

FIGURE 3-1



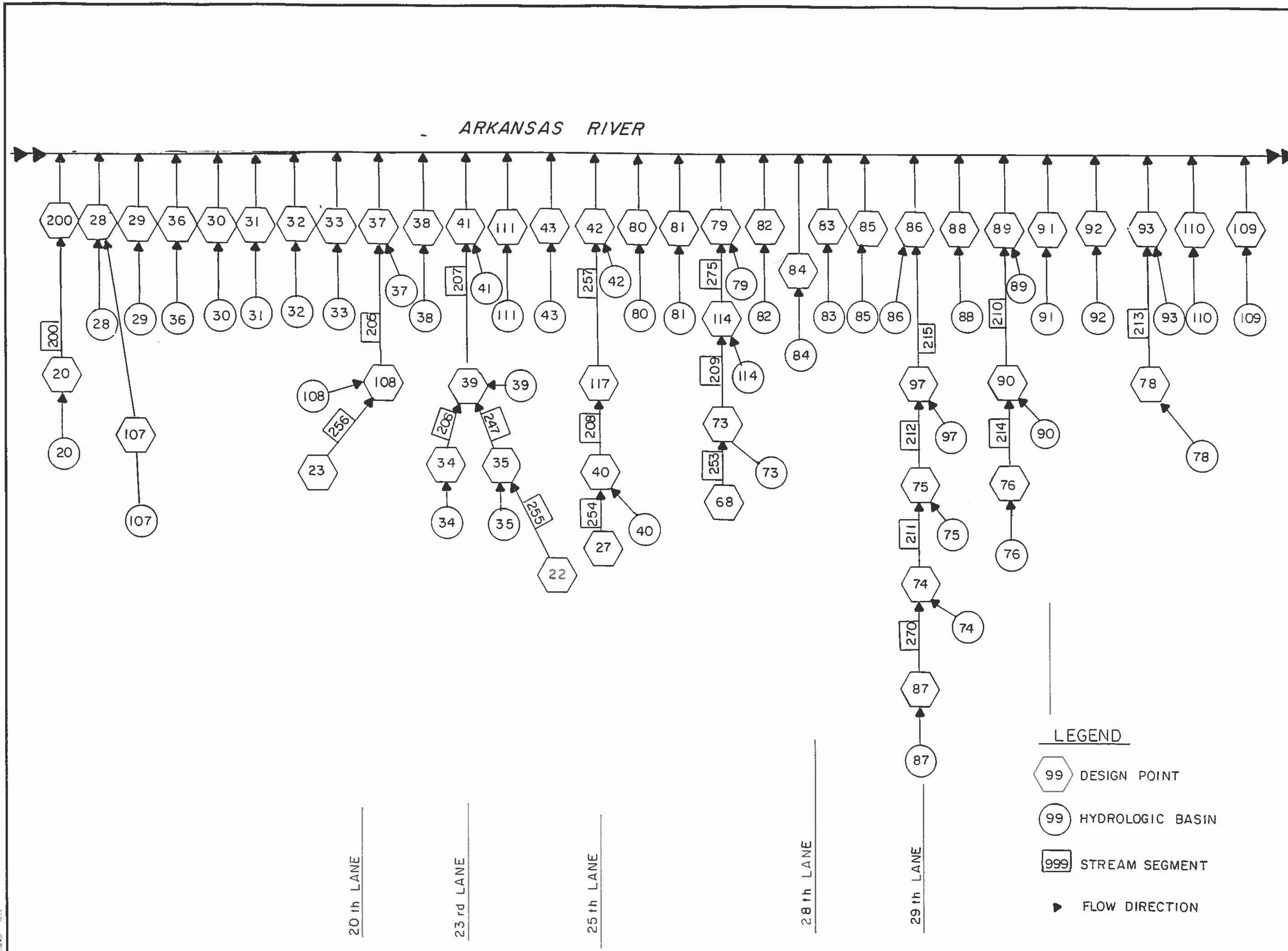
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

FLOW SCHEMATICS

Project No. 94-01-01
Date: 1/94
Design:
Drawn: EAK
Check:
Revisions:

FIGURE 3-2



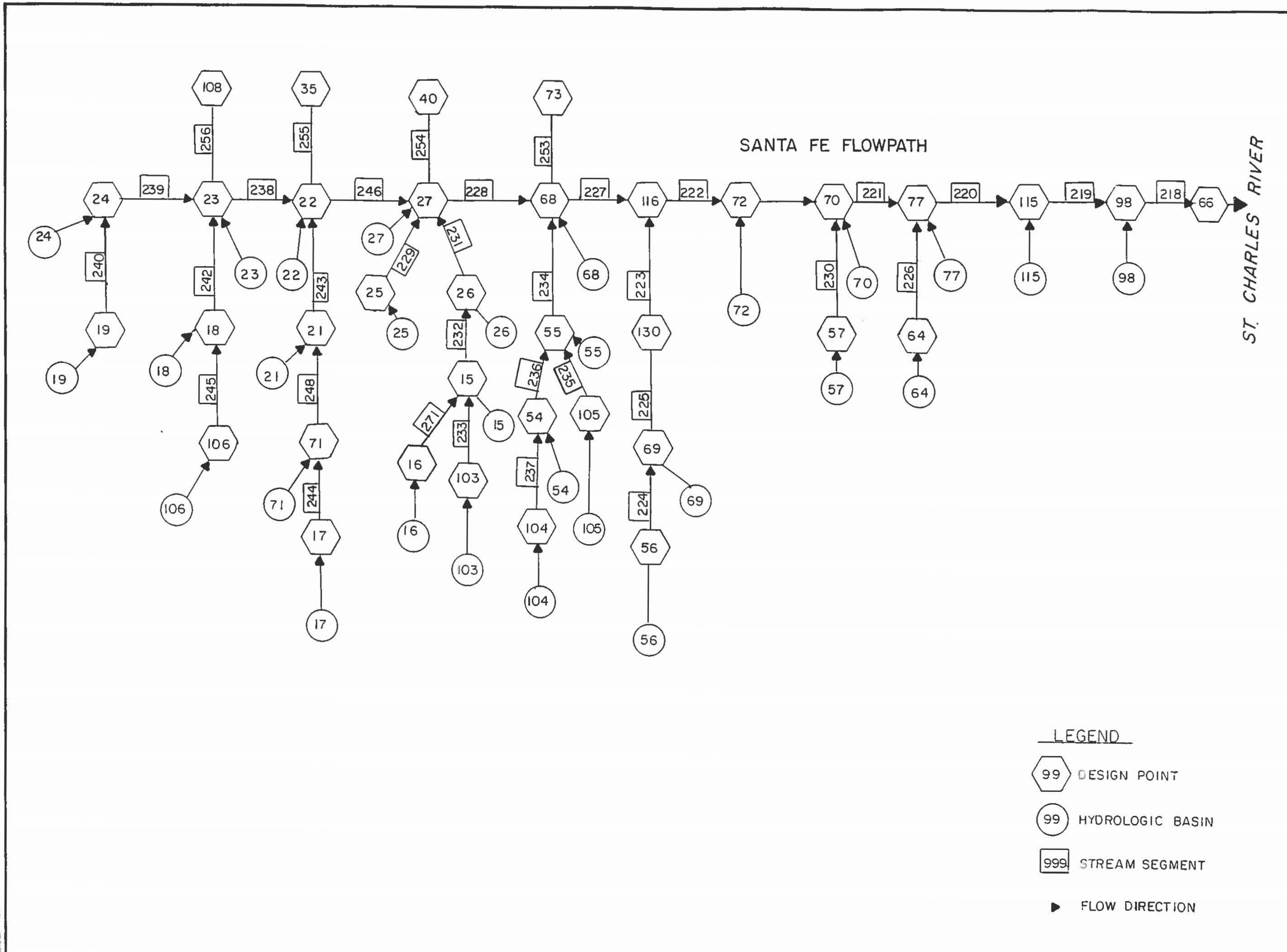
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

FLOW SCHEMATICS

Project No.	94-01-01
Date:	1/94
Design:	
Drawn:	EAK
Check:	
Revisions:	

Figure 3-3



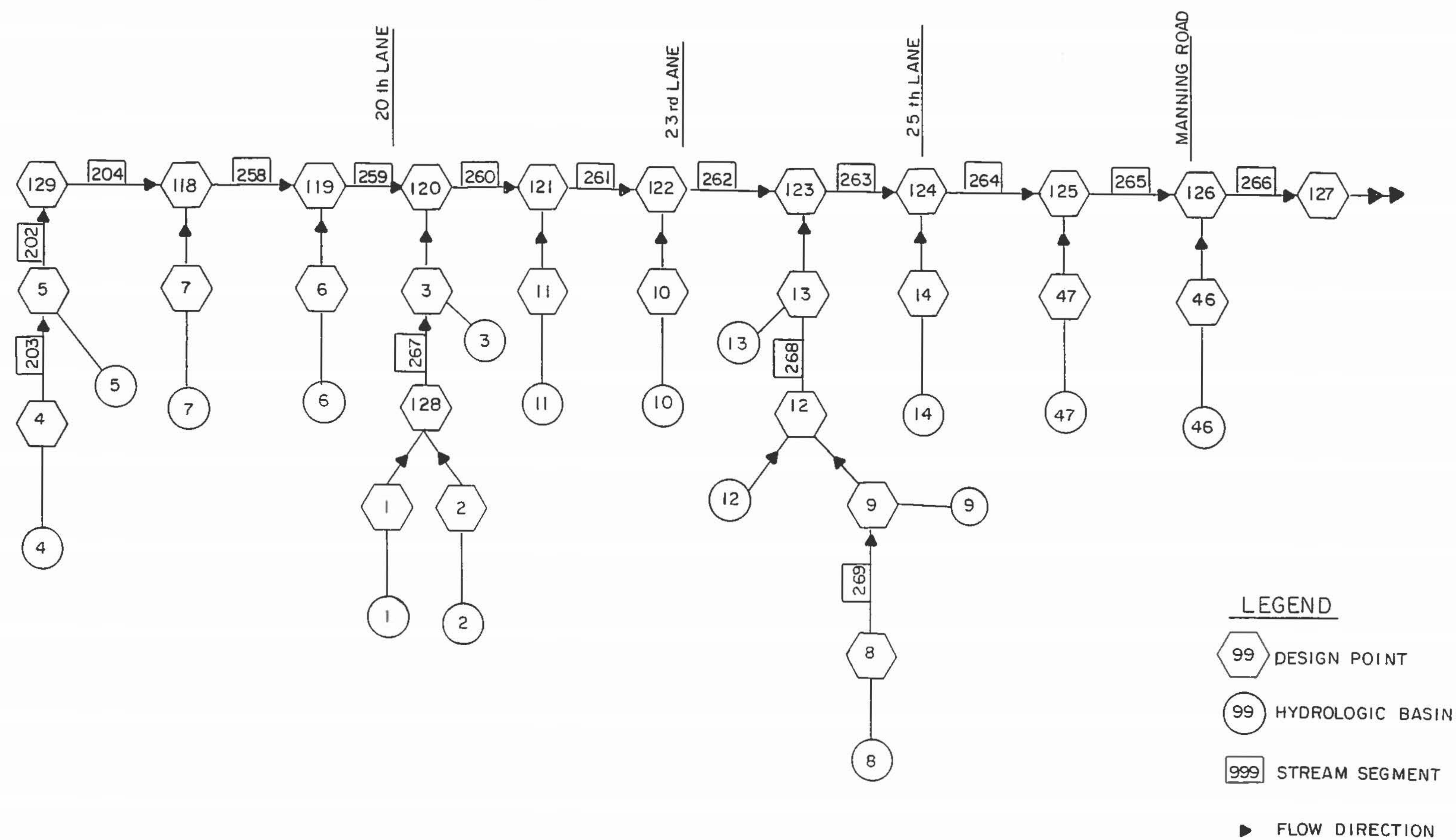
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

FLOW SCHEMATICS

Project No. 94 01 01
Date: 1/94
Design:
Drawn: EAK
Check:
Revisions:

FIGURE 3-4



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

FLOW SCHEMATICS

Project No 94-01-01
Date: 1/94
Design:
Drawn: EAK
Check:
Revisions:

FIGURE 3-5

IV. HYDRAULIC ANALYSIS AND STORM DRAINAGE SYSTEM DESCRIPTION

Hydraulic Structure Inventory

A hydraulic structure inventory was conducted and the subsequent information was presented on 1-inch to 200-foot scale aerial mapping and entered in an index created to catalogue the information. Few major hydraulic structures exist on the St. Charles Mesa. The bulk of the inventory consists of driveway culverts installed to permit access across the existing storm/irrigation tailwater ditches. For the most part, culverts exist under major roadways although at some intersections only a concrete pan has been installed.

The inventory data has also been tabulated in a spreadsheet format. Size, type, condition and capacity is summarized in the database. The spreadsheets and mapping has been turned over to the Pueblo County Department of Public Works.

Review of the inventory data against the hydrology results show that many of the existing culvert and storm sewer facilities have less than a 5-year existing development condition flow capacity. Many of the existing roadside ditches are blocked by driveway culverts and debris. The are no natural drainageways on the Mesa. There are three detention basins on the Mesa. Two are onsite basins serving small subdivisions and they discharge to roadside ditches. Runoff entering these detention basins has to be pumped out because of the adjacent roadside ditch elevations. The third detention basin is more of a regional facility, and serves the Lakeside Estates subdivision. This detention basin outfalls to the roadside ditch system along LaSalle Street.

The Bessemer Ditch, though a dedicated irrigation structure owned and operated by the Bessemer Ditch company has adequate capacity to intercept and convey the tributary 100-year runoff out of the basin. At several locations, roadway and footbridges cross the ditch. These crossings restrict the flow capacity compared to the typical section of the Ditch.

Flood History

In the areas where a large number of reported drainage problems occur there is a high incidence of urban development upstream. Frequently, a local storm sewer system has been installed to handle a minor storm; but, the outfall is inadequate or is non-existent. Urban development tends to channelize runoff and concentrate it at a single location. This along with increased imperviousness results in the type of flooding noted on the Mesa.

Another typical drainage problem on the Mesa stems from stormwater ditches overtopping due to restrictions (undersized driveway culverts, blockage in the ditches, etc.) whereby the runoff does not return to the roadside ditch. Instead, the runoff follows the existing low point which may be across a roadway or down a driveway into private property and away from the pubic road right-of-way. In some cases, this is an easily correctable problem by removing the restrictions or upsizing the culverts. However, in the case of an insufficient ditch section or a roadway sloping away from the ditch, major road cross-section modification would be required.

Much of the flooding of residences occurs because several subdivisions have been constructed along the historic low points and have finish floor elevations below the grade of the adjacent roadways and ditch banks. The residential structures are mostly at or near flow line elevations of the adjacent streets. Reconstruction of curb cuts and berming on the upstream side of structures to prevent shallow flooding is being used extensively in many areas of the Mesa.

In many cases of localized flooding, the once existing drainage ditches have been filled either intentionally or as a result of the development process. Reconstructing the minor swales or ditches could eliminate some localized flooding.

Another potential source of flooding may be the Bessemer Ditch. During the development of the basin hydrology, it was assumed that the Bessemer Ditch was only conveying dedicated ditch flows as it enters the St. Charles Mesa basin (near Aspen Street). This assumption allows for the routing of existing runoff into the ditch, and eventually through the basin without allowing flows from the Bessemer basins upstream to pass to the downstream areas of the Mesa. It has been reported that runoff from urban areas of south Pueblo can reach the St. Charles Mesa via the Bessemer Ditch. According to information provided by the Bessemer Ditch company, ditch overflows have been recorded in the past, mostly at existing roadway and pedestrian bridges which cross over the Ditch. Remedies for this situation will be discussed in later sections of this report.

Floodplains

Research into the existence of any documented floodplains on the St. Charles Mesa established that none are defined. The primary resource for this research was the "Flood Insurance Studies for Pueblo County, Colorado", prepared by the Federal Emergency Management Agency (FEMA), revised 1986. A portion of the basin studied does lie within the

St. Charles River 100-year floodplain and the Arkansas River 100-year floodplain. There are no regulated floodplain area along the major flow paths which drain the Mesa.

Basis of Analysis and Design

In general, the City/County unadopted Drainage Criteria Manual, January 1987, was used as a technical guide to the evaluation, and design of existing and future drainage facilities. A consistent application of this criteria was used for comparing the feasible alternative drainageway plans, and during the selected preliminary designs. This criteria was supplemented as necessary by the Urban Storm Drainage Criteria manual (USDCM), prepared by the Urban Drainage and Flood Control District.

V. DEVELOPMENT OF ALTERNATIVE PLANS

Introduction

Alternative outfall plans have been examined that address the existing and future stormwater management needs of the basin. Quantitative and qualitative comparisons are presented in both narrative and tabular format, and a recommendation made as to which plan is most feasible to advance to preliminary design and eventual implementation.

General Considerations

During the alternative analysis it became evident that the basin had one general characteristic which influenced the existing drainageways form and function. The Mesa was originally settled as an irrigated agricultural area. Roads were developed between fields, along irrigation headwater, and tailwater ditches. Consistent with an agricultural use the slopes across the Mesa are less than a half percent. Development which has occurred has in most cases blocked the natural or historic outfall path. Roadways are both gravel and paved, neither of which have much capacity to convey runoff before overtopping the adjacent roadside ditches and curb and gutter. At roadway intersections, flow splits can occur whereby a low runoff event would pass through the existing roadside ditch and/or culverts, while larger volume flow events would be split, or diverted, to low lying areas or a different direction down the intersecting street away from the existing systems.

General planning goals followed during the alternative plan development phase were:

(1) Identify storm water facilities which will reduce existing flooding problems within urbanized area(s);
(2) Provide stormwater management within developing areas of the basin in order to reduce the detrimental effects of runoff from urbanized areas;
(3) Provide stormwater facilities which preserve and/or enhance the existing drainageways and areas adjacent to the drainageways which provide an environmental resource in the area;
(4) Provide for separation of stormwater runoff from existing or abandoned irrigation laterals;
(5) Identify facilities which will minimize future operation and maintenance costs;
(6) Provide stormwater management facilities which will at least maintain and/or enhance the water quality characteristics of the basin;
(7) Provide for a system which has cost feasibility;
(8) Provide for a system which is within the capability of being installed by County forces; and,
(9) Provide for a system which will be adequate to serve future development.

The preliminary City/County Drainage Criteria Manual was used to estimate rates of runoff and size facilities. Other planning goals were developed through a coordination process, utilizing common or mutual goals of the interested agencies identified prior to the initiation of the alternative development phase.

Preliminary Matrix of Alternatives

The alternative planning process began with the evaluation of general outfall planning alternatives. Alternatives which are generally available in the majority of urban drainage basins include:

(1) Do nothing, and/or floodplain regulation,
(2) Channelization,
(3) Piped systems,
(4) Detention, on-site or off-site,
(5) Combinations of the above.

These concepts were evaluated for each major outfall path and regional sub-basin on the Mesa. Each of the above alternatives was evaluated for different recurrence intervals. At this time, there are no 100-year capacity facilities within the Mesa, except for the Bessemer Ditch which has the capacity to convey the 100-year discharge from areas upstream of the Ditch, **assuming that the Ditch is only carrying the adjudicated flow at the time of a runoff event.**

Outfall paths have been defined within the basin using the inventory information as well as the topographic mapping prepared for this study. In general, the regional sub-basins north of the Bessemer Ditch flow to the north. Santa Fe Drive acts as a diversion point for some of these regional outfall basins. Flow reaching Santa Fe Avenue is split for lower frequencies (i.e., greater than the 10-year flow). Flows in excess of the 5-year existing development condition discharge are forced to the east along Santa Fe via the street section and a concrete roadside ditch along the south flowline of Santa Fe. A brief description of each flow path follows:

Roselawn/Aspen Street Outfall: This outfall path drains the Roselawn Cemetery area. At Santa Fe Avenue and Aspen Street, an existing storm drainage system conveys low flows across Santa Fe, into a roadside ditch system along Aspen Court. The Aspen Street ditch system is steep and eroded. This path outfalls to the Arkansas River via a natural drainage ravine. The Aspen Street basin north of Santa Fe is developed mostly into as industrial areas.

21st Lane Outfall: This outfall path serves mostly residential areas, and a small amount of commercial in the vicinity of Santa Fe Drive. The primary flow path north of Santa Fe is the street itself, along with roadside ditches. At many locations, private driveway culverts block the roadside ditches and in turn this has the potential of sending flow in the ditch into private property away from the public right-of-way. The 21st Street basin outfalls to a natural ravine and then into the Arkansas River floodplain. There are no storm sewer facilities along the 21st Lane outfall path.

23rd Lane Outfall: This outfall path drains mostly residential areas ranging from single-family to low density (large lot) residential areas. At Santa Fe, the runoff from upstream areas of this basin is conveyed to the Santa Fe right-of-way via roadside ditches. North of Santa Fe, a roadside ditch along the west side of 23rd conveys flow to the north and eventually to a natural ravine which outfalls to the Arkansas River floodplain. There are no storm sewer systems along this outfall path.

25th Lane Outfall: Similar to the 23rd Street basin, the 25th Street basin conveys flow from residential areas. At Santa Fe Drive, a cross culvert conveys low flows across the Santa Fe Drive right-of-way. From this point, the runoff follows roadside ditches which are blocked by driveway culverts. Flows in excess of the cross culvert will move east along Santa Fe. The 25th Lane outfall enters the Arkansas River floodplain via a natural ravine. There are areas within this basin which will be subject to future development into single-family subdivisions.

27th Lane Outfall: This basin drains both agricultural and medium density residential areas. Within the residential areas, curb and gutter and paved streets have been constructed. The runoff is conveyed to Santa Fe via roadside ditches. North of Santa Fe Drive roadside ditches convey flow along the 27th Lane right-of-way. The flow from the ditches outfall to a natural ravine and into the Arkansas River floodplain. There is a development potential within this basin in the future.

29th Lane Outfall: This basin drains primarily single-family and low density residential areas. There is a good potential for continued development within this basin. Along 29th Lane, power poles are aligned within the existing ditch section which make widening this ditch to accommodate future flow impractical.

30th Lane Outfall: This basin drains single-family and low density residential areas. There is currently ongoing subdivision construction in this basin, and more could occur in the future. The existing system is mostly roadside ditches along paved and unpaved roadways.

Santa Fe Drive Outfall: This outfall drains low density residential and single-family residential areas lying east of 29th lane and south of Santa Fe Drive. The primary outfall route is a concrete channel along the south flowline of Santa Fe. This channel is blocked at several locations by driveway culverts. The concrete channel outfalls to the St. Charles River via a concrete and grasslined rundown just south of the Santa Fe Drive bridge over the St. Charles River.

Manning Road Outfall: This outfall drains mostly undeveloped agricultural areas and low density residential properties. The existing drainage system consists of roadside ditches and culverts under driveways and roadways. There is little additional development which is anticipated within this portion of the St. Charles Mesa.

South Road Outfall: This basin drains single-family and low density residential areas. There is the potential for future urbanization of this basin. South Road is paved and has curb and gutter. At intersections, the flowlines are discharged to roadside ditches which then flow to culverts under South Road. The basin outfalls to the St. Charles River via a shallow cross-country swale.

Baxter Road Outfall: This basin drains single-family residential areas. Roadside ditches carry the flow along Baxter Road to its eventual outfall point at the Arkansas River. There is the potential for continued residential development within this basin.

Bessemer Ditch Outfall: The outfall for the Bessemer Ditch basin is the irrigation canal itself. The Ditch traverses the basin in generally an eastward direction. Near Nicholson Road, a siphon carries the irrigation water under the St. Charles River. The area draining to the ditch is mostly undeveloped agricultural and low density residential areas. Some additional single-family development is anticipated within the Lakeside Estates subdivision, which at this time is not fully built out. This subdivision drains to an existing detention basin. The detention basin outfalls to the roadside ditch system along La Salle Road, and eventually to the Ditch.

Drainage System Alternatives

The handling of stormwater can be accomplished by the use of pipes, channels, detention basins, bridges, culverts and various other physical improvements. The use of any one or a combination of the above improvements is dependent upon the level of flow, topography, right-of-way and the character of the areas adjacent to the outfall paths. A qualitative discussion of the feasibility of the general drainage alternatives is summarized below:

Curb and Gutter: In some cases use of a standard street section including 6" vertical curb will provide adequate capacity and channelization to prevent localized flooding during the 5-year storm event or significantly reduce required storm sewer sizes when used in combination.

Storm Sewers: Use of storm sewers is feasible within all proposed outfall systems as independent structures or in combination with curb and gutter or existing ditches. This conveyance alternative is somewhat limited by areas of extremely mild slopes (less than .3 percent), which causes the sizes of storm sewers to become very large, and in turn cost prohibitive. Utilities can also play a major role in determining the feasibility of storm sewer systems. In general, storm sewers greater than 60-inches in diameter do not have a high degree of feasibility due to their cost and their impact upon utility relocations and street repaving.

Channels: Channels, including roadside ditches are the predominant existing drainage facility on the Mesa along all flow paths. Enlarging the existing roadside ditch sections to convey future development condition runoff will usually require enlarging numerous private drives. In some areas of the Mesa, undeveloped land still exists to construct a lined channel, however right-of-way acquisition can become a major deciding factor when implementing a channel system on the Mesa. Riprap lined and grasslined ditch sections are most commonly used, however concrete lining does have feasibility wherever the need to keep the acquisition of right-of-way to a minimum is desirable.

Detention: The type of detention basin will be dependent upon the volume and rate of flow; however, right-of-way and the characteristics of the area adjacent to a proposed detention basin plays a large role in this alternative's feasibility. Water quality is an important concern in a light of the storm water discharge regulations, and a detention scheme has distinct advantages in this regard. Finally, operation and maintenance is a mandatory requirement of a storm water detention basin if the overall system is to function properly. Water quality is an important aspect of urban storm water management. If the basin develops a more urban density, this will be an important consideration. Detention facilities as well as increasing the efficiency of pollutant removal, may have a side benefit of enhancing the vegetative habitat. There are three onsite detention basins within the Mesa.

Combined Systems: Combining storm sewers with roadside ditches and improved street sections is usually a feasible alternative in basins where development has blocked the historic outfall paths. For the St. Charles Mesa, storm sewers with a five year capacity in combination with the existing roadside ditch or street capacity can bring the total capacity to at least a 10-year level, and in some cases a 100-year level. A storm sewer system can also be useful in handling nuisance flows resulting from lawn watering or everyday rainfalls which in the present situation tend to pond and stagnate along the roadside ditch system or within low points adjacent to the roadways.

Alternative Analysis

The conceptual alternatives developed were each modeled hydrologically to assess the impact on peak flow rates. In general, the historic peak flow condition at Santa Fe Drive (U.S. Highway 50, Business Route), was a primary factor in the alternative planning. Various detention and diversion schemes were evaluated in order to optimize the flow to downstream drainageways. As a starting point the 5-year existing condition flows were used in the alternative evaluation. A 5-year system is a typical design standard for minor or local storm drainage system design within urban areas. The 5-year system is capable of conveying, without overtopping, over 90 percent of all runoff events.

Evaluation Parameters

Coordination meetings were held throughout the study to address overall goals and specific concerns of those agencies and individuals asked to participate in the study. A public input meeting was held and specific concerns of the residents were discussed. Complaint forms were collected. Additional complaints were received through the Pueblo County Engineers Office during the course of the study. Existing records for the years 1989 through 1991 were reviewed to determine recurring drainage problems on the Mesa. A list of all complaints was compiled for the County's use. Site visits were made to evaluate existing conditions relative to all complaints. Observations, history and solutions were presented by many of the residents during the site visits and incorporated into the alternate evaluation. Meetings with the Bessemer Irrigation Ditch Company, and St. Charles Mesa Water District, included discussions of historic overtopping and modifications. One result of the coordination efforts was the following list of factors which were considered during the alternate evaluation process.

- Flood Control
- Operation and Maintenance
- Water Quality
- Right-of-way
- Erosion Control
- Constuctability
- Construction Cost
- Implementation

The major outfall systems for the regional basins on the St. Charles Mesa Basin were defined. Discharges along each at critical design points were identified for the 2-, 5-, 10-, and

100-year storm events. Several design alternatives were analyzed hydraulically for each of the design storms. The hydrology data summarized in Section III was used to check the capacity the existing systems along the outfall paths. This capacity varies throughout the basin, but in general the existing outfall systems cannot handle the 5-year storm event.

Presented on Tables 5-1 through 5-4 are qualitative comparisons for each of the general alternatives discussed above. The general feasibility of a concept has been determined for each of the major outfall paths.

Design Parameters and Goals

The hydrology, hydraulic and alternative analyses discussed above have been combined in order to formulate a recommended alternative to each flow path. The recommendations have been based upon the existing system capacity, right-of-way constraints, the level of known flooding, cost and constructability issues.

As a result of the qualitative and quantitative comparisons presented above, design parameters and goals were identified to guide the selection of feasible outfall systems for each of the major flow paths on the St. Charles Mesa. The parameters and goals establish the minimum level of design for each outfall system. A discussion of the key design parameters follows:

1. Frequency: The level of service which each system must be able to achieve was established at the 5-year design frequency. In most case, the types of flooding currently being experienced is very localized. This is due to the relative flatness of the Mesa itself, and the existence of development or roadways which have blocked the natural drainage paths. In some cases residential development and associated roadways have blocked the major outfall path, however in some instances agricultural uses have also diverted runoff from natural drainage paths. The County roads are therefore the only conveyance right-of-way for stormwater runoff to reach the Arkansas or St. Charles rivers.

The five year frequency was considered appropriate for the design of outfall facilities because it will solve most of the existing local drainage problems and will not be as expensive to construct compared to the 10-year or 100-year design frequencies. In most cases, the existing roadside ditches along the major flow paths are of sufficient size to collect local runoff. Connecting the collector ditches into a 5-year capacity storm sewer or roadside channel outfall system will then provide for a safe conveyance of the 5-year flow through downstream basins on the Mesa without negatively impacting existing private property along the major flow paths with regard to flooding and additional right-of-way acquisition.

The baseline storm used in the evaluation of the conceptual design alternates was the 5-year existing storm event. From an analysis of the hydraulic design data it was determined that use of the 100-year existing storm event produced an infrastructure which would not be feasible for the County to attempt to construct or to pay for. Even a 10-year existing system would require the construction of culverts in excess of 60-inches in diameter and greater along segments which are very flat in gradient.

2. Development Condition: Along with frequency, a key design parameter is whether or not runoff can be maintained to existing levels. For the design of the storm sewer systems on the Mesa, the existing development condition hydrology was determined to be appropriate. For the most part, the areas subject to future single-family development lie south of Santa Fe Drive. The runoff generated by such development can not be handled along the major flow paths north of Santa Fe Drive without causing additional localized flooding. Coupled within the high construction cost associated with handling developed runoff within existing downstream County road right-of-ways, it was determined that the existing condition runoff rates should be maintained. This can be achieved through the use of onsite detention to serve future development. The design of detention basins should be such that the developed 5-year and 100-year frequencies are controlled to the levels presented in this report for the existing basin conditions.

3. Conveyance Systems: The type of conveyance system, (i.e., piped or channelized), will depend mostly upon the size of the County right-of-way which currently exists and the capacity of existing facilities. Along the flow paths north of Santa Fe Drive, the existing roadside ditches are of insufficient capacity to convey runoff generated south of Santa Fe to the Arkansas River. The reality is that most of the flow generated south of Santa Fe never reaches the outfall flow paths north of Santa Fe Drive since much of the runoff infiltrates or is stored in localized low points or ditches. In the future, the localized low points will become developed and unavailable for stormwater depression storage. The type of flow conveyance will also depend heavily on the extent of existing development along the major flow paths, and whether or not the existing roadside ditches can be modified without requiring substantial amounts of new right-of-way.

It has been determined that a system of outfall storm sewers is the most practical conveyance alternative for those major flow paths where existing development has already occurred. A piped system will require the least amount of new right-of-way acquisition and minimize disturbances to existing driveways and road intersections. This system will require that existing roadside ditches be connected to the storm sewer outfalls by means of intercepting inlets mostly sited at roadway intersections. The existing ditches serve to collect local flows generated within private property and from the County roadway right-of-way. Where existing structures lie below street grade, there is no option but to leave an existing the roadside ditch in service.

Along flow paths where a limited amount of development has occurred adjacent to the right-of-way, pipes or ditches have been proposed. This concept is primarily confined to the flow paths south of Santa Fe Drive. If possible, roadside ditches should be removed in favor of curbing, gutters and inlets to collect runoff generated from areas within or adjacent to the road right-of-way. For those areas served by gravel streets, paving and curb and guttering has been determined to be practical once development proceeds.

The goals to be achieved by the implementation of a storm sewer outfall system are:

- Limiting the extent of local and nuisance flooding problems along the existing County right-of-ways for both the existing and future development condition
- Providing future development with adequate stormwater outfall conveyance facilities through developed area of the Mesa
- Limit the extent of right-of-way acquisition dedicated for stormwater conveyances
- Provide existing and future development with local roadways which are not degraded by excessive amounts of storm drainage
- Provide for systems which have feasibility with respect to funding and implementation

It is with these constraints and goals in mind that the facilities presented in Section 6 of this report have been designed.

Table 5-1: Evaluation of Conceptual Alternatives

Alternative Concept: Floodplain Regulation (do-nothing)

Parameter / Impact / Flow Path	Localized Flood Control		Erosion Control		Operations and Maintenance		Comparative Cost		Constructability		Right-of-Way		Relative Advantages/Disadvantages of Alternative Concept	
	Reduced Hazard	No change	Reduced	Increased	Reduced effort	Increased effort	Most Costly	Least Costly	Increased Difficulty	Decreased Difficulty	Acquisition Increased	Acquisition Decreased	Relative Advantages	Relative Disadvantages
Roselawn		X	No change	Increase in erosion possible with continued development.	No reduction compared to existing conditions	Localized flooding causes widespread clean up		Least expensive if flood damages are ignored.		X	N/A	N/A	Least costly, minimal ROW acquisition required.	Recurring O & M, with no solution to long-term stormwater management and flood damage reduction.
21st Lane		X	No change	Increase in erosion possible with continued development.	No reduction compared to existing conditions	Localized flooding causes widespread clean up		Least expensive if flood damages are ignored.		X	N/A	N/A	Most flooding confined to existing street sections.	Same as Roselawn
23rd Lane		X	No change	Increase in erosion possible with continued development.	No reduction compared to existing conditions	Localized flooding causes widespread clean up		Least expensive if flood damages are ignored.		X	N/A	N/A	Most flooding confined to existing street sections.	Same as Roselawn
25th Lane		X	No change	Increase in erosion possible with continued development.	No reduction compared to existing conditions	Localized flooding causes widespread clean up		Least expensive if flood damages are ignored.		X	N/A	N/A	Most flooding confined to existing street sections.	Same as Roselawn
27th Lane		X	No change	Agricultural areas susceptible to erosion from developed offsite flows.	No reduction compared to existing conditions	Localized flooding causes widespread clean up		Least expensive if flood damages are ignored.		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Flood prone zones would have to be defined and regulated.
29th Lane		No change. Relatively sparse development at this time	No change	Agricultural areas susceptible to erosion from developed offsite flows.	No reduction compared to existing conditions	Localized flooding causes widespread clean up		Least expensive if flood damages are ignored.		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Flood prone zones would have to be defined and regulated.
Santa Fe Drive		X	No change	Sedimentation of roadside ditches would be common because of mild grades.	No reduction compared to existing conditions	Increased effort if ero-soin is not controlled.		Least expensive if flood damages are ignored.		X	N/A	N/A		Flood prone zones would have to be defined and regulated.
30th Lane		X	No change	Agricultural areas susceptible to erosion from developed offsite flows.	No reduction compared to existing conditions	Increased effort if ero-soin is not controlled.		Least expensive if flood damages are ignored.		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Flood prone zones would have to be defined and regulated.
South Road		X	No change	Increase in erosion possible with continued development.	No reduction compared to existing conditions	Increased effort if ero-soin is not controlled.		Least expensive if flood damages are ignored.		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Flood prone zones would have to be defined and regulated.
Manning Road		X	No change	Increase in erosion possible with continued development.	No reduction compared to existing conditions	Increased effort if erosion is not controlled.		Least expensive if flood damages are ignored.		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Flood prone zones would have to be defined and regulated.
Bessemer Ditch		Developed flows could cause uncontrolled ditch overtopping	No change	Increase in erosion possible with continued development.		Sedimentation of ditch would cause increased effort		Least expensive if impacts to ditch are ignored		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Uncontrolled runoff into and out of ditch could cause increased flooding risks.
Baxter Road		X	No change	Increase in erosion possible with continued development.		Increased effort if erosion is not controlled.		Least expensive if flood damages are ignored.		X	N/A	N/A	Area is relatively undeveloped. Advantage is that flood prone areas can be defined and development restricted.	Flood prone zones would have to be defined and regulated.

Table 5-2: Evaluation of Conceptual Alternatives

Alternative Concept: Channelization

Parameter / Impact / Flow Path	Localized Flood Control: Reduced Hazard	Localized Flood Control: No change	Erosion Control: Reduced	Erosion Control: Increased	Operations and Maintenance: Reduced effort	Operations and Maintenance: Increased effort	Comparative Cost: Most Costly	Comparative Cost: Least Costly	Constructability: Increased Difficulty	Constructability: Decreased Difficulty	Right-of-Way: Acquisition Increased	Right-of-Way: Acquisition Decreased	Relative Advantages/Disadvantages of Alternative Concept: Relative Advantages	Relative Disadvantages
Roselawn	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept is a costly option.		Difficult construction for outfall channels at Mesa.		Few areas outside of the street ROW's where adequate ROW exists.			Little ROW exists in this flow path to site an outfall channel.
21st Lane	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept is a costly option.			Decreased difficulty cross-country conditions are the case.	Few areas outside of the street ROW's where adequate ROW exists.		Some existing roadside ditch sections are adequate for conveyance of runoff.	Same as Roselawn
23rd Lane	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept is a costly option.		Existing subdivisions limit construction access to flow path.		Few areas outside of the street ROW's where adequate ROW exists.			Main flow paths are adjacent to street. Cross-country routes are not along low points.
25th Lane	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept is a costly option.		Existing subdivisions limit construction access to flow path.		Few areas outside of the street ROW's where adequate ROW exists.		Local flooding reduced significantly	ROW acquisition would negatively impact existing subdivisions and residences along 25th Lane.
27th Lane	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept this a costly option.	Where area is undeveloped, cost is lower than piped system.	Access to outfall point at Mesa difficult.		Few areas outside of the street ROW's where adequate ROW exists, north of Santa Fe.	For some cross country routes , ROW could be through development process.	Open areas south of Santa Fe could be used to channelize full 100-year runoff.	ROW acquisition would negatively impact existing subdivisions and residences along 27th Lane, north of Santa Fe.
29th Lane		Areas along ROW's are typically lower than the roadways.		Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept this a costly option.	Where area is undeveloped, cost is lower than piped system.	Access to outfall point at Mesa difficult.		Few areas outside of the street ROW's where adequate ROW exists, north of Santa Fe.	For some cross country routes , ROW could be through development process.		North of Santa Fe, ROW acquistion would be costly and render this option unfeasible. Low areas adjacent to the ROW will not be drained by channel section in this basin.
Santa Fe Drive	Modest expansion of existing roadside ditches could achieve damage reduction for 10-year.		Use of existing concrete channel along Santa Fe would eliminate erosion control needs.	Mild slope of existing concrete channel requires yearly cleaning of trash.		Greater effort compared to piped systems.		If Santa Fe channel can be utilized, this option has favorable cost compared to piped systems.		Use of existing channel would limit need for excavation of existing street sections.			Improving roadside channel in combination with street capacity would limit flooding for most frequencies.	Cleaning of roadside ditch on yearly basis would be required. This work would have to be coordinated through CDoT.
30th Lane	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept this a costly option.			Use of existing channel would limit need for excavtion of existing street sections.	ROW requried through existing residential areas.		Relatively sparse development could allow siting of channel to the Mesa.	Existing roadside ditch sections would require expansion and associated ROW acquisition adjacent private residences.
South Road		No change. No substantial damage currently exists		Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept is a costly option.	In cross-country areas, this option is less costly than piped option.		No change. All areas are accessible and away from residential areas.	Greater ROW requirements in general.		Channel works well in cross country areas of this flow path. 100-year channel could be constructed.	Little existing flood damages justify this option.
Manning Road		No change. No substantial damage currently exists		Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.		In cross-country areas, this option is less costly than piped option.		No change. All areas are accessible and away from residential areas.	Greater ROW requirements in general compared to piped systems.		Channel works well in cross country areas of this flow path. 100-year channel could be constructed.	Little existing flood damages justify this option.
Bessemer Ditch		No change. No substantial damage currently exists		Increase in bank erosion possible with continued development.		Sedimentation of ditch would cause increased effort		Most areas have adequate room for channel without ROW acquisition.		No change. All areas are accessible and away from residential areas.	Shared ROW with Ditch company required		Uses existing ditch and roadside channel sections to control runoff from moving north of Bessemer Ditch.	Dual use of Ditch could potentially restrict County's construction and maintenance of Ditch channel banks.
Baxter Road	Local flooding associated with 5- and 10-year frequencies eliminated.			Increase in erosion possible if bank linings are not maintained		Greater effort compared to piped systems.	If ROW included in this concept is a costly option.		Residences along Baxter Road create access problems.		Few areas outside of the street ROW's where adequate ROW exists.			Existing roadside ditch sections would require expansion and associated ROW acquisition adjacent private residences.

Table 5-3: Evaluation of Conceptual Alternatives

Alternative Concept: Piped Systems

Parameter / Impact / Flow Path	Localized Flood Control: Reduced Hazard	Localized Flood Control: No change	Erosion Control: Reduced	Erosion Control: Increased	Operations and Maintenance: Reduced effort	Operations and Maintenance: Increased effort	Comparative Cost: Most Costly	Comparative Cost: Least Costly	Constructability: Increased Difficulty	Constructability: Decreased Difficulty	Right-of-Way: Acquisition Increased	Right-of-Way: Acquisition Decreased	Relative Advantages/Disadvantages of Alternative Concept: Relative Advantages	Relative Disadvantages
Roselawn	Local flooding associated with 2- and 5-year frequencies eliminated.		Reduction compared to existing channel roadside ditch system	Outfalls to Mesa needs protection against point discharges	Reduced effort for cleanup associated with localized flooding		Diameters over 60" become cost prohibitive.	Reduced cost compared to channel assuming additional ROW is not needed.	Difficult construction at outfall points	Avoids disturbances to private driveways and roadside ditches		Piped system can fit within existing road ROW	Fits within existing street sections. This option can solve most local flooding concerns.	10-year flow or greater runoff is not feasible from the cost standpoint. Utility conflicts a concern.
21st Lane	Local flooding associated with 2- and 5-year frequencies eliminated.		Reduction compared to existing channel roadside ditch system	Outfalls to Mesa needs protection against point discharges	Reduced effort for cleanup associated with localized flooding	Street and inlet cleaning required	Diameters over 60" become cost prohibitive. Utility relocations may be costly.	Reduced cost compared to channel assuming additional ROW is not needed.	Difficult construction at outfall points			Piped system can fit within existing road ROW	Fits within existing street sections. This option can solve most local flooding concerns.	Same as Roselawn
23rd Lane	Local flooding associated with 2- and 5-year frequencies eliminated.		Reduction compared to existing channel roadside ditch system	Outfalls to Mesa needs protection against point discharges	Reduced effort for cleanup associated with localized flooding	Street and inlet cleaning required	Diameters over 60" become cost prohibitive. Utility relocations may be costly.		Difficult construction at outfall points			Piped system can fit within existing road ROW	Fits within existing street sections. This option can solve most local flooding concerns.	Utility relocation and depth of pipe along mild gradients present cost raises costs. Sizes over 60-inch are not as constructable by County forces
25th Lane	Local flooding associated with 2- and 5-year frequencies eliminated.		Reduction compared to existing channel roadside ditch system	Outfalls to Mesa needs protection against point discharges	Reduced effort for cleanup associated with localized flooding	Street and inlet cleaning required	Diameters over 60" become cost prohibitive. Utility relocations may be costly.	In new subdivisions, cost of new systems could be bourne by developer.	Difficult construction access at outfall points			Piped system can fit within existing road ROW	Fits within existing street sections. This option can solve most local flooding concerns.	Milder slopes present cost and construction concerns. Paving and curb and gutter required
27th Lane	Local flooding associated with 2- and 5-year frequencies eliminated.		Reduction compared to existing channel roadside ditch system	Outfalls to Mesa needs protection against point discharges	Reduced effort for cleanup associated with localized flooding	Street and inlet cleaning required	Diameters over 60" become cost prohibitive. Utility relocations may be costly.	In new subdivisions, cost of new systems could be bourne by developer.	Difficult construction access at outfall points			Piped system can fit within existing road ROW	Fits within existing street sections. This option can solve most local flooding concerns.	Milder slopes present cost and construction concerns. New curb and gutter needed at several locations to make system work.
29th Lane	5-year flooding reduced		Reduction compared to existing channel roadside ditch system	Outfalls to Mesa needs protection against point discharges		Street and inlet cleaning required	Diameters over 60" become cost prohibitive. Utility relocations may be costly.	In new subdivisions, cost of new systems could be bourne by developer.	Difficult construction access at outfall points			Piped system can fit within existing ditch line	Fits within existing street sections. This option can solve most local flooding concerns.	Street paving and curb and gutter required at some locations to make piped system work.
Santa Fe Drive	5-year flooding reduced		Relatively unchanged compared to existing concrete channel system		Similar to existing channel system O & M.		Higher cost compared to modification of existing channel system.		Construction would take place within CDoT right-of-way.			Piped system can fit within existing road ROW	Conveys nuisance flows better than existing channel system.	Distance to outfall point at St. Charles River and mild slope renders this option unfeasible.
30th Lane	5-year flooding reduced			Outfall to Mesa needs protection against point discharges		Street and inlet cleaning required		In new subdivisions, cost of new systems could be bourne by developer.	Difficult construction access at outfall points			Piped system can fit within existing road ROW	Existing streets and grades make this option feasible.	Street paving and curb and gutter required at some locations to make piped system work.
South Road	5-year flooding reduced		Reduction compared to existing roadside ditch system to outfall to River.			Street and inlet cleaning required		In new subdivisions, cost of new systems could be bourne by developer.	Pavement replacement required along recently completed roadway project.			Piped system can fit within existing road ROW	Controls local flooding problems	Little existing flood damages justify this option. Existing street section is adequate at most locations
Manning Road		No change. No substantial damage currently exists		Outfall to St. Charles River needs protection.		Street and inlet cleaning required	More compared to upgrading of roadside ditch systems.			No change. All areas are accessible and away from residential areas.		Piped system can fit within existing road ROW		New street and curb and gutter required to implement this option. Rural nature of this does not justify this alternative.
Bessemer Ditch		No change. No substantial damage currently exists		Outfalls to ditch need stabilization		Street and inlet cleaning required	Piped system to convey full 100-year flow from Bessemer basins unfeasible.			No change. All areas are accessible and away from residential areas.	Shared ROW with Ditch company required		Controls local flooding problems.	New street and curb and gutter required to make this option work. Existing subdivision adequately served by roadside sections.
Baxter Road	Local flooding associated with 2- and 5-year frequencies eliminated.			Outfall at Mesa needs protection.		Street and inlet cleaning required	Higher cost compared to modification of existing channel system.		Construction would take place within CDoT right-of-way. Access			Piped system can fit within existing road ROW	Controls local flooding problems.	Street paving and curb and gutter required at some locations to make piped system work.

Table 5-4: Evaluation of Conceptual Alternatives

Alternative Concept: Onsite or Regional Detention

Parameter / Impact / Flow Path	Localized Flood Control: Reduced Hazard	Localized Flood Control: No change	Erosion Control: Reduced	Erosion Control: Increased	Operations and Maintenance: Reduced effort	Operations and Maintenance: Increased effort	Comparative Cost: Most Costly	Comparative Cost: Least Costly	Constructability: Increased Difficulty	Constructability: Decreased Difficulty	Right-of-Way: Acquisition Increased	Right-of-Way: Acquisition Decreased	Relative Advantages/Disadvantages of Alternative Concept: Relative Advantages	Relative Disadvantages
Roselawn		No area exists to site detention basin.				Detention area and outlet structure needs annual cleaning							New development should provide onsite detention sites as well as ROW access for County O & M activities.	Availability of sites for use as detention facilities limited in this basin.
21st Lane		No area exists to site detention basin.				Detention area and outlet structure needs annual cleaning							New development should provide onsite detention sites as well as ROW access for County O & M activities.	
23rd Lane		X	Detained flows to downstream flow paths reduce the erosion potential			Detention area and outlet structure needs annual cleaning		In new subdivisions, cost of new systems could be bourne by developer.		Downstream facilities reduced therefore less construction difficulties	Area of detention basin will need to be acquired		New development should provide onsite detention sites as well as ROW access for County O & M activities.	Maintenance increased over piped system
25th Lane		X	Detained flows to downstream flow paths reduce the erosion potential			Detention area and outlet structure needs annual cleaning		In new subdivisions, cost of new systems could be bourne by developer.		Downstream facilities reduced therefore less construction difficulties	Area of detention basin will need to be acquired		New development should provide onsite detention sites as well as ROW access for County O & M activities.	Maintenance increased over piped system Existing detention basin needs to be maintained by County.
27th Lane		X	Detained flows to downstream flow paths reduce the erosion potential			Detention area and outlet structure needs annual cleaning		In new subdivisions, cost of new systems could be bourne by developer.		Downstream facilities reduced therefore less construction difficulties	Area of detention basin will need to be acquired		New development should provide onsite detention sites as well as ROW access for County O & M activities.	Maintenance increased over piped system Existing detention basin needs to be maintained by County.
29th Lane		X	Detained flows to downstream flow paths reduce the erosion potential			Detention area and outlet structure needs annual cleaning		In new subdivisions, cost of new systems could be bourne by developer.		Downstream facilities reduced therefore less construction difficulties	Area of detention basin will need to be acquired		New development should provide onsite detention sites as well as ROW access for County O & M activities.	Maintenance increased over piped system
Santa Fe Avenue		X	Detained flows to downstream flow paths reduce the erosion potential			Detention area and outlet structure needs annual cleaning		Upstream detention will decrease required sizes of downstream facilities		Downstream facilities reduced therefore less construction difficulties	Area of detention basin will need to be acquired		New development should provide onsite detention sites as well as ROW access for County O & M activities.	Maintenance increased over piped system
30th Lane		Little additional development anticipated to warrant the use of onsite detention.						No impact		No impact	N/A	N/A	Onsite detention not feasible in this basin.	
South Road		Little additional development anticipated to warrant the use of onsite detention.								No impact	N/A	N/A	Onsite detention not feasible in this basin.	
Manning Road		Little additional development anticipated to warrant the use of onsite detention.								No impact	N/A	N/A	Onsite detention not feasible in this basin.	
Bessemer Ditch	Detention in areas upstream of Ditch can reduce total flow in Ditch section		Detained flows to downstream flow paths reduce the erosion potential			Detention area and outlet structure needs annual cleaning		Existing detention basin in Lakeside Estates reduces to flow to downstream flow path and therefore costs.		No impact	County should obtain ROW and access to existing detention basin in Lakeside Estates.		Onsite facility in this basin adequate to maintain flow to historic levels.	
Baxter Road		Little additional development anticipated to warrant the use of onsite								No impact	N/A	N/A	Onsite detention not feasible in this basin.	

VI. SELECTED OUTFALL SYSTEMS PLAN

As a result of the alternative planning process, a selected outfall plan was determined for each of the major outfall paths within the St. Charles Mesa drainage basin. The outfall plan for each flow path has been presented on the preliminary design drawings contained at the rear of this report.

The selected outfall plan for the St. Charles Mesa Basin includes the following general features:

1. A combined system of storm sewers and roadside ditches capable of conveying the 5-year capacity flow.

2. Curb and gutter along existing streets where the street section is below the adjacent driveway.

3. Inlets of at least 5-year capacity to intercept street flows and flows within roadside ditches at key design points.

4. Upgrading outfalls to the Bessemer Ditch in order to intercept the 100-year existing condition discharge from areas tributary to the Ditch. A spill structure located at Salt Creek is recommended in order to clear the Ditch of runoff from south Pueblo prior to entering the St. Charles Mesa basin. A spill structure at the headgate of the Bessemer Ditch siphon is recommended in order to separate runoff from ditch irrigation flows. This spill structure would outfall to the St. Charles River.

Hydrology

Presented on Table 6-1 is the summary of peak discharges at all design points for the selected outfall plan condition. Sub-basin discharges are the same as shown on Table 3-5 presented in Section III of this report. Diversion of the 5-year flow across Santa Fe Avenue has been accounted for in the selected outfall plan hydrology model. A flow split has been modeled at 21st Lane, 23rd Lane, 25th Lane, 27th Lane and 29th Lane. The five-year flow has been routed north for these outfall paths, and the flow greater than the 5-year flow has been routed along Santa Fe Avenue. The hydrology model has been modified from the baseline condition to reflect the proposed roadside channel and storm sewer facilities presented on the drawings. The selected outfall plan basin divides, design points and channel elements are presented on Exhibit 1, contained in the map pocket of this report. A sample SWMM input data file for the selected plan hydrology is presented in Appendix B.

Revegetation

The Urban Drainage & Flood Control District's publication "Guidelines for Development and Maintenance of Natural Vegetation" may be referred to as a guide for revegetation criteria for 100-year grasslined channels. Criteria for "bioengineered" vegetation should be in the form of performance specifications. That is, the vegetation should be designed to withstand specific velocity, depth and roughness criteria. All disturbed areas should be revegetated with plant species recommended in the above referenced guidelines. Areas in the bottoms of wetland channels should be planted with wetland-type vegetation. Detention basin areas should be planted with dryland species except for the permanent pool fringe area where wetland/riparian vegetation could be used. Existing trees and desirable vegetation should be saved wherever possible. Large cottonwoods and/or willow trees should be protected during construction activities.

Maintenance

All storm sewers and roadside channels will require periodic maintenance to ensure operation as designed. Routine mowing, debris pick up, and minor erosion area repair are the commonly needed maintenance measures. Signs and educational materials can help prevent some debris dumping into the roadside ditches. Use of native-type grasses helps reduce mowing requirements. For the purposes of limiting the maintenance of closed conduits, a minimum flow velocity of three feet per second for the one-quarter full flow condition should be used in the design.

Routine inspection of drop structures, riprapped areas, crossing structures, and detention facilities is required to detect deficiencies prior to flood events. All facilities must be designed to meet current Pueblo County drainage criteria as published in the preliminary Storm Drainage Criteria Manual.

Stormwater Detention

The use of onsite or regional detention must be implemented wherever future development is proposed. Due to the low feasibility of systems with capacity greater than the existing 5-year storm, future developments must maintain existing condition discharges for the 5- and 100-year frequencies. The existing detention basins in the Lakeside Estates subdivision should remain. An increase in peak discharges is seen for all frequencies in the developed condition. The main purpose of the detention facilities is to reduce the peak discharges from developed land to historic, or existing conditions. Secondary benefits for regional and onsite basins come in the form of enhanced water quality, and open space benefits. In some cases the detention basins may be incorporated into park or open space, whereby the detention basins can become multi-purpose in their function.

Cost Estimates

Costs to implement the preliminary design were estimated using the unit costs presented on Table 6-2. Utility costs have not been incorporated into the cost estimates. Land acquisition for channels or storm sewers have not been estimated. In general, most of the facilities proposed for the Mesa can be kept within existing easements or right-of-ways. In general, the land required for the storm sewer or channel improvements can be obtained for undeveloped areas via the development process. An allowance for engineering and contingency costs associated with the construction has been estimated using a factor of 20 percent of the total construction cost. A summary of the preliminary design costs are presented on Table 6-3 for each of the major outfall paths. Total estimated cost for the recommended plan is $12,595,814. Costs for the facilities on each sheet of the drawings are presented on the pages facing the preliminary design drawings.

TABLE 6-1:
DESIGN POINT DISCHARGES, SELECTED OUTFALL PLAN
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
1	4	7	20	119
2	7	24	50	219
3	9	25	45	176
4	3	9	20	97
5	6	17	39	156
6	7	26	50	205
7	1	6	13	45
8	9	18	49	253
9	16	46	85	249
10	14	31	56	222
11	8	18	38	178
12	20	63	108	313
13	47	91	141	432
14	24	39	65	186
15	51	73	102	223
16	37	60	99	276
17	36	64	103	293
18	40	68	107	299
19	7	20	38	154
20	14	31	52	186
21	49	100	160	416
22	54	127	223	521
23	82	131	172	332
24	79	106	138	352
25	20	38	71	211
26	46	75	112	286
27	81	128	195	456
28	181	240	276	539
29	8	11	17	51
30	16	21	24	81
31	73	96	113	290
32	16	21	37	105
33	39	52	70	176
34	10	18	35	104
35	66	110	151	330
36	0	1	2	17
37	42	71	88	124
38	25	34	56	155
39	77	119	161	363
40	118	186	222	409

TABLE 6-1:
DESIGN POINT DISCHARGES, SELECTED OUTFALL PLAN
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
41	59	92	125	282
42	122	195	231	397
43	20	34	69	214
44	6	13	45	166
45	7	24	60	198
46	3	11	22	97
47	7	33	69	216
48	7	28	56	216
49	10	27	66	293
50	6	18	31	125
51	23	41	61	196
52	22	38	56	176
53	11	23	35	116
54	16	28	48	133
55	25	64	103	353
56	27	47	67	198
57	10	25	41	148
58	5	8	12	40
59	12	20	33	88
60	16	37	75	232
61	26	39	61	167
62	10	17	43	202
63	8	14	28	86
64	11	26	45	170
65	13	19	49	164
66	9	18	39	121
67	21	42	78	232
68	51	112	212	704
69	32	61	94	249
70	59	100	171	589
71	40	66	102	287
72	47	71	123	467
73	54	123	160	359
74	45	77	120	361
75	77	144	197	415
76	27	55	98	319
77	33	63	101	395
78	21	45	80	259
79	64	139	196	446
80	21	31	69	221

TABLE 6-1:
DESIGN POINT DISCHARGES, SELECTED OUTFALL PLAN
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
81	0	2	2	20
82	13	31	67	231
83	5	17	42	142
84	7	10	11	128
85	6	11	42	165
86	82	145	192	312
87	22	45	81	237
88	2	2	2	21
89	28	46	87	245
90	37	82	138	493
91	2	6	15	53
92	12	29	60	189
93	19	44	80	214
94	11	20	45	142
95	15	36	73	247
96	11	23	63	215
97	82	142	179	383
98	40	81	127	386
99	21	42	79	300
100	10	23	50	160
101	37	63	94	248
102	6	14	31	98
103	30	43	65	173
104	30	43	65	173
105	3	11	25	85
106	49	69	106	288
107	103	137	157	264
108	110	167	214	406
109	7	9	46	189
110	3	5	23	96
111	45	66	104	280
112	38	80	133	392
113	2	3	3	30
114	64	136	179	368
115	33	59	92	392
116	32	44	81	556
117	113	180	208	270
118	5	14	32	89
119	7	27	53	236
120	12	42	86	400

TABLE 6-1:
DESIGN POINT DISCHARGES, SELECTED OUTFALL PLAN
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
121	18	55	114	546
122	21	63	133	614
123	47	93	148	582
124	47	102	161	573
125	29	78	148	555
126	30	75	155	570
127	28	74	153	559
128	11	31	70	338
129	6	16	36	89
130	32	44	54	145
200	14	31	52	186
202	6	16	36	89
203	3	8	18	65
204	5	14	32	89
205	42	69	88	120
206	4	9	16	51
207	34	39	46	77
208	113	180	208	270
209	54	122	159	238
210	18	23	29	69
211	33	61	81	133
212	77	111	139	264
213	14	32	53	76
214	19	43	73	272
215	82	136	163	213
216	5	6	7	14
217	13	28	50	156
218	38	76	122	381
219	31	56	92	386
220	33	59	92	392
221	58	88	97	100
222	30	44	79	398
223	32	44	54	134
224	21	38	53	104
225	32	44	54	145
226	10	15	20	47
227	0	0	34	449
228	0	0	50	244
229	3	4	4	8
230	5	12	16	31

TABLE 6-1:
DESIGN POINT DISCHARGES, SELECTED OUTFALL PLAN
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
231	39	61	66	92
232	19	22	25	39
233	20	22	23	32
234	19	50	84	186
235	2	8	17	74
236	11	20	22	30
237	5	5	6	10
238	0	0	24	85
239	43	52	60	104
240	4	7	11	40
242	36	63	80	135
243	49	97	161	277
244	20	24	28	51
245	14	18	22	51
246	0	0	39	177
247	64	69	72	97
248	38	64	97	189
249	14	24	37	86
250	11	13	15	25
251	5	6	7	10
252	6	7	8	15
253	51	106	136	161
254	75	121	128	128
255	52	68	71	92
256	76	92	92	97
257	111	176	183	184
258	4	12	29	88
259	5	19	47	225
260	12	40	85	381
261	16	50	109	491
262	20	57	124	533
263	34	79	146	563
264	29	72	147	555
265	28	71	145	539
266	28	74	153	559
267	4	5	7	22
268	13	40	71	219
269	5	6	8	23
270	12	23	36	129
271	20	24	28	50

TABLE 6-1:
DESIGN POINT DISCHARGES, SELECTED OUTFALL PLAN
ST. CHARLES MESA DRAINAGE BASINS

DESIGN POINT #	2YR	5YR	10YR	100YR
274	0	0	67	351
275	62	133	175	303

TABLE 6-2:
Unit Construction Costs

Item	Unit	Unit Material Cost	Unit Installation Cost
CHANNEL AND HYDRAULIC STRUCTURES			
Channel earthwork	CY	$2	$6
Filter material	Ton	$13	$12
Concrete flatwork	SF	$4	$4
Seeding and mulch	SF	$0.05	$0.10
Riprap Type H	CY	$26	$6
Riprap Type M	CY	$20	$6
Erosion netting	SY	$0.75	$0.50
CULVERTS RCP/CMP (1)			
15-inch	LF	$18/15	$6
18-inch	LF	$20/17	$6
24-inch	LF	$25/22	$6
22-inch X 36-inch arch	LF	$42/37	$10
30-inch	LF	$38/29	$10
36-inch	LF	$46/35	$10
27-inch X 44-inch arch	LF	$70/55	$12
29-inch X 45-inch arch	LF	$75/59	$12
42-inch	LF	$60/42	$15
31-inch X 51-inch arch	LF	$80/60	$18
48-inch	LF	$68/50	$18
40-inch X 65-inch arch	LF	$75/55	$18
54-inch	LF	$78/60	$24
45-inch X 73-inch arch	LF	$90/65	$24
60-inch	LF	$116/70	$24
JUNCTION STRUCTURES AND INLETS			
5-foot manhole	EA	$2,000	$500
Box base manhole	EA	$4,000	$1,000
2' X 4' grated inlet	EA	$1,500	$500
4' X 4' grated inlet	EA	$1,800	$600
2' X 2' intercepting inlet	EA	$1,200	$500
2' X 3' intercepting inlet	EA	$1,400	$500
2.5' X 3' intercepting inlet	EA	$1,500	$500
3' X 3' intercepting inlet	EA	$1,500	$500
3' X 3.5' intercepting inlet	EA	$1,800	$700
3' X 4' intercepting inlet	EA	$2,000	$700
4' X 4' intercepting inlet	EA	$2,500	$800
5' CO inlet	EA	$2,500	$800

TABLE 6-2:
Unit Construction Costs

Item	Unit	Unit Material Cost	Unit Installation Cost
10' CO inlet	EA	$3,000	$1,000
Storm sewer outfall structure	EA	$25,000	$10,000
Storm sewer outlet structure	EA	$10,000	$3,000
Flap Gate	EA	$700	$400
Concrete headwall	EA	$2,000	$800
ROADWAY IMPROVEMENTS			
Pavement replacement	SY	$15	$5
Street Paving	SY	$4	$4
Vertical curb and gutter	LF	$4	$2
Cross-pan	SF	$8	$2
Driveway culvert headwalls	EA	$400	$400
CHANNEL IMPROVEMENTS			
Grasslined Channel	LF	$5	$15
Concrete lined channel	LF	$25-$60	$25-$60

Table 6-3
Summary of Preliminary Design Costs

Basin and Flow Path	Total Material	Total Installation	Total Construction
Aspen Street/Roselawn	$548,150	$259,190	$807,340
21st Lane	$682,635	$317,990	$1,000,625
23rd Lane	$1,144,845	$490,750	$1,635,595
25th Lane	$642,989	$369,450	$1,012,439
27th Lane	$856,430	$442,410	$1,298,840
29th Lane	$1,416,687	$770,271	$2,186,958
30th Lane	$284,110	$156,550	$440,660
Santa Fe Drive	$270,928	$268,212	$539,140
Manning Road	$30,880	$47,090	$77,970
Bessemer Ditch	$391,130	$432,540	$823,670
South Road	$41,750	$60,850	$102,600
Baxter Road	$308,965	$261,710	$570,675
Total Estimated Construction Cost	$6,619,499	$3,877,013	$10,496,512
Engineering and Contingency (20%)	$1,323,900	$775,403	$2,099,302
Total Estimated Cost	$7,943,399	$4,652,416	$12,595,814

VII. IMPLEMENTATION OF SELECTED OUTFALL SYSTEMS

The selected outfall system has been presented on the preliminary design plans contained within the rear of this report. The planning and the design of these improvements is a key first step in implementing a comprehensive program for stormwater management for the basin on the St. Charles Mesa. The implementation of this plan will depend upon various factors, however the planning goals associated with the development of this plan should be reviewed whenever a portion of the system is proposed for construction. The primary goals are as follows:

Reduce local flooding problems;

Provide outfall drainage facilities to serve future developments and property owners;

Provide outfall drainage facilities which will convey runoff in a safe and efficient manner through existing developed areas of the Mesa;

Minimize the acquisition of additional public right-of-way associated with stormwater conveyance; and,

Minimize the cost of stormwater conveyance facilities funded solely by Pueblo County.

The review of the above goals will be needed in order to best prioritize the improvements and to better direct the limited amount of capital improvement funds which will be available for stormwater facilities on the Mesa.

The construction and implementation of the selected outfall systems should be driven by the following parameters;

Existing facility inadequacy within a given outfall basin;

Level of flooding problems;

Development pressure within outfall basin;

Availability of funding; and,

Number of potential funding sources.

The selected outfall systems presented on the preliminary design plans should not be considered as final in their form. Each system should be reviewed in terms of system capacity, hydrologic response, right-of-way availability and routing options at the time the system(s) are proposed for final design and construction. Future development should be required to convey the five-year existing condition runoff to the dedicated outfall system by means of local streets and storm sewers. Alternatives to the systems presented in this plan should be considered by the County as long as the hydrologic response and impact upon downstream basins is not compromised or changed.

Implementation Tasks

The following steps are suggested prior to further design and construction of the systems identified in this plan.

1. **Adoption of Drainage Criteria Manual:** The City/County Drainage Criteria Manual referenced in this study should be reviewed, revised, and updated as necessary to allow for the eventual adoption by the County. This criteria is needed in order to help in the review and approval of future drainage plans to be prepared for future developments. The adoption of the drainage criteria will lead to more consistent design and construction of local stormwater systems. In revising the criteria, the requirements of individual master drainage plans such as the St. Charles Mesa Outfall Systems Planning Study should be incorporated into the criteria by reference.

2. **Detention Basin Criteria Development:** A criteria for the planning and design of onsite detention basins should be developed. There are several simplified methods which could be adopted. The criteria used by Douglas County contained in Appendix C of this report is an easy and effective way to design onsite detention basins and is based upon the soils types and historic drainage conditions in the area tributary to the detention basin.

3. **Adoption of Erosion Control Criteria:** The future level of maintenance for the selected outfall systems will be heavily dependent upon the amount of sediment available to be washed into the stormwater systems. Currently, there are extensive amounts of agricultural ground which lies uncultivated. These areas need to prevent the erosion of unprotected soils into the streets, roadside ditch sections, and storm sewer systems. New development can also cause significant land disturbance which can result in soil erosion. Erosion control criteria needs to be adopted by the County in an effort to limit the amount of soil loss from disturbed areas. Reducing the amount of soil erosion will directly impact the functioning of the stormwater outfall system(s).

4. **Agreements with Ditch Company:** The dependence upon the available flow capacity within the Bessemer Ditch affects each of the selected outfall systems. Discussions with the Bessemer Ditch Company should be considered by the County prior to extensive amounts of new development proceeding within the Bessemer Ditch Basin. An initial project which needs to be considered jointly is the stormwater separation structure for the Bessemer Ditch at Salt Creek. Construction of this structure will ensure that the Ditch will only be carrying irrigation flows into the St. Charles Mesa, thereby leaving sufficient capacity within the

ditch to convey the existing condition flows generated within the Bessemer Ditch basin through the St. Charles Mesa.

The development and eventual adoption of the above criteria form the initial steps for the development and implementation of any master drainage plan. The development of the above criteria will help to guide the implementation of the improvements in a consistent manner.

Prioritization

The prioritization of improvements has been accomplished by reviewing the planning goals for each flow path. In general, the outfall storm sewers have the highest priority since they are needed now to address local drainage problems and will be needed upon development of land on the Mesa. In some instances development pressure may change the priority of an outfall storm sewer. The priority of systems has been categorized into three levels; (1) Immediate need; (2) Needed upon development of land within the basin; and (3) as required by correlated projects. An example of a system in immediate need is the 23rd Street basin, north of Santa Fe Drive. Known flooding problems exist along this outfall, and extensive development in areas tributary to this system could not proceed since no safe outfall conveyance now exists. An example of a level 2 priority is the 25th Lane Outfall, south of Santa Fe Drive. The existing systems are currently adequate, but new development will need to connect to the system which will eventually outfall to the 25th Lane north of Santa Fe Drive. An example of a level three priority would be the construction of the Santa Fe Drive system. This system could be constructed at the time roadway improvements are constructed, thereby commingling roadway and drainage funds into a single more comprehensive project.

Presented on Table 7-1 is a Prioritization of the projects presented on the preliminary design plans. The priority of each system could be changed depending upon funding and development pressure. There is no specific ordering of each system within a level. Any level one system could be implemented, and its implementation will be dependent upon the amount of flooding which now exists and the potential for future development within the area tributary to the outfall system.

Table 7-1
Prioritization of Improvements

Description
Priority Level 1
Bessemer Ditch Stormwater Separation Structure
Aspen Road System(s)
21st Lane System
23rd Lane System North of Santa Fe Drive
25th Lane System North of Santa Fe Drive
27th Lane System North of Santa Fe Drive
29th Lane System North of Santa Fe Drive
Priority Level 2
Bessemer Ditch Siphon Overflow
Bessemer Basin Improvements
23rd Lane System South of Santa Fe Drive
25th Lane System South of Santa Fe Drive
27th Lane System South of Santa Fe Drive
29th Lane System South of Santa Fe Drive
30th Lane System
Priority Level 3
South Road Improvements
Manning Road Improvements
Baxter Road Improvements
Santa Fe Drive Improvements

APPENDIX A

SAMPLE SWMM INPUT DATA

BASELINE HYDROLOGIC CONDITION

ENVIRONMENTAL PROTECTION AGENCY - STORM WATER MANAGEMENT MODEL - VERSION PC.1

DEVELOPED BY METCALF + EDDY, INC.

UNIVERSITY OF FLORIDA

WATER RESOURCES ENGINEEERS, INC. (SEPTEMBER 1970)

UPDATED BY UNIVERSITY OF FLORIDA (JUNE 1973)

HYDROLOGIC ENGINEERING CENTER, CORPS OF ENGINEERS

MISSOURI RIVER DIVISION, CORPS OF ENGINEERS (SEPTEMBER 1974)

BOYLE ENGINEERING CORPORATION (MARCH 1985, JULY 1985)

0TAPE OR DISK ASSIGNMENTS

JIN(1)	JIN(2)	JIN(3)	JIN(4)	JIN(5)	JIN(6)	JIN(7)	JIN(8)	JIN(9)	JIN(10)
2	1	0	0	0	0	0	0	0	0

JOUT(1)	JOUT(2)	JOUT(3)	JOUT(4)	JOUT(5)	JOUT(6)	JOUT(7)	JOUT(8)	JOUT(9)	JOUT(10)
1	2	0	0	0	0	0	0	0	0

NSCRAT(1)	NSCRAT(2)	NSCRAT(3)	NSCRAT(4)	NSCRAT(5)
3	4	0	0	0

1

WATERSHED PROGRAM CALLED

*** ENTRY MADE TO RUNOFF MODEL ***

ST CHARLES MESA 100-YEAR BASELINE EXISTING CONDITION
COUNTY, PUEBLO, KIOWA ENGINEERING FILE:SCEX100.SIN

GUTTER NUMBER	GUTTER CONNECTION	NDP	NP		WIDTH OR DIAM (FT)	LENGTH (FT)	INVERT SLOPE (FT/FT)	SIDE SLOPES HORIZ TO VERT L	R	OVERBANK/SURCHARGE MANNING N	DEPTH (FT)	JK
200	299	0	4	CHANNEL	24.0	900.	.0300	.0	.0	.020	1.00	0
				OVERFLOW	24.0	0.	.0010	10.0	10.0	.100	2.00	
202	129	0	4	CHANNEL	2.0	1500.	.0060	2.0	2.0	.040	2.00	0
				OVERFLOW	10.0	0.	.0010	40.0	40.0	.150	10.00	
203	5	0	4	CHANNEL	2.0	1000.	.0030	2.0	2.0	.040	2.00	0
				OVERFLOW	10.0	0.	.0010	40.0	40.0	.150	10.00	
204	118	0	4	CHANNEL	30.0	1300.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	20.0	.100	10.00	
205	37	0	4	CHANNEL	1.0	650.	.0050	2.0	2.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.060	10.00	
206	39	0	4	CHANNEL	2.0	3380.	.0100	2.0	2.0	.040	2.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
207	41	0	4	CHANNEL	3.0	2600.	.0100	1.0	1.0	.060	3.00	0
				OVERFLOW	9.0	0.	.0010	50.0	50.0	.100	10.00	
208	117	0	4	CHANNEL	1.0	5020.	.0080	2.0	2.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
209	114	0	4	CHANNEL	3.0	1250.	.0100	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
210	89	0	4	CHANNEL	2.0	1600.	.0050	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
211	75	0	4	CHANNEL	3.0	2650.	.0040	1.0	1.0	.030	3.00	0
				OVERFLOW	9.0	0.	.0010	50.0	50.0	.100	10.00	
212	97	0	4	CHANNEL	3.0	1325.	.0100	1.0	1.0	.030	10.00	0
				OVERFLOW	9.0	0.	.0010	50.0	50.0	.030	10.00	
213	93	0	4	CHANNEL	2.0	2740.	.0120	2.0	2.0	.040	2.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
214	90	0	4	CHANNEL	10.0	1400.	.0040	10.0	10.0	.030	3.00	0
				OVERFLOW	10.0	0.	.0010	10.0	10.0	.100	10.00	
215	86	0	4	CHANNEL	5.0	1700.	.0080	1.0	1.0	.020	5.00	0

				OVERFLOW	13.0	0.	.0010	50.0	50.0	.060	10.00	
216	96	0	4	CHANNEL	1.0	1200.	.0150	1.0	1.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
217	99	0	4	CHANNEL	3.0	1520.	.0070	1.0	1.0	.060	5.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.100	10.00	
218	66	0	4	CHANNEL	2.0	2000.	.0020	.0	.0	.020	2.00	0
				OVERFLOW	11.0	0.	.0010	6.0	50.0	.150	10.00	
219	98	0	4	CHANNEL	3.0	1100.	.0020	1.0	1.0	.100	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
220	115	0	4	CHANNEL	3.0	600.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
221	77	0	4	CHANNEL	3.0	3000.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
222	72	0	4	CHANNEL	3.0	2600.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
223	116	0	4	CHANNEL	1.0	1200.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.100	10.00	
224	130	0	4	CHANNEL	1.0	3000.	.0080	10.0	10.0	.020	1.00	0
				OVERFLOW	20.0	0.	.0010	50.0	50.0	.150	10.00	
225	69	0	4	CHANNEL	1.0	700.	.0050	1.0	1.0	.020	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
226	77	0	4	CHANNEL	1.0	1250.	.0090	1.0	1.0	.020	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
227	116	0	4	CHANNEL	3.0	2750.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.100	10.00	
228	68	0	4	CHANNEL	3.0	2600.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.100	10.00	
229	27	0	4	CHANNEL	1.0	3200.	.0070	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.100	10.00	
230	70	0	4	CHANNEL	1.0	5100.	.0070	10.0	10.0	.060	1.00	0
				OVERFLOW	20.0	0.	.0010	50.0	50.0	.150	10.00	
231	27	0	4	CHANNEL	3.0	1200.	.0100	1.0	1.0	.060	3.00	0
				OVERFLOW	9.0	0.	.0010	50.0	6.0	.150	10.00	
232	26	0	4	CHANNEL	2.0	2600.	.0060	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
233	15	0	4	CHANNEL	2.0	1300.	.0090	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
234	68	0	4	CHANNEL	3.0	3900.	.0070	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.060	10.00	
235	55	0	4	CHANNEL	3.0	2600.	.0120	1.0	1.0	.020	3.00	0

				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
236	55	0	4	CHANNEL	2.0	1400.	.0100	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
237	54	0	4	CHANNEL	1.0	1400.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
238	22	0	4	CHANNEL	2.0	2800.	.0030	1.0	1.0	.020	2.00	0
				OVERFLOW	6.0	0.	.0010	6.0	50.0	.100	10.00	
239	23	0	4	CHANNEL	1.0	1300.	.0060	2.0	2.0	.020	1.50	0
				OVERFLOW	5.0	0.	.0010	6.0	50.0	.150	10.00	
240	24	0	4	CHANNEL	1.0	1250.	.0060	1.0	1.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	6.0	50.0	.150	10.00	
242	23	0	4	CHANNEL	2.0	1400.	.0060	1.0	1.0	.030	3.00	0
				OVERFLOW	6.0	0.	.0010	50.0	6.0	.150	10.00	
243	22	0	4	CHANNEL	3.0	1800.	.0150	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
244	71	0	4	CHANNEL	2.0	1350.	.0080	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	6.0	.150	10.00	
245	18	0	4	CHANNEL	2.0	1300.	.0020	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
246	27	0	4	CHANNEL	2.0	2600.	.0020	1.0	1.0	.020	2.00	0
				OVERFLOW	6.0	0.	.0010	6.0	50.0	.100	10.00	
247	39	0	4	CHANNEL	4.5	1350.	.0050	1.0	1.0	.030	4.00	0
				OVERFLOW	16.0	0.	.0010	50.0	50.0	.060	10.00	
248	21	0	4	CHANNEL	3.0	1320.	.0050	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
249	62	0	4	CHANNEL	1.0	3000.	.0180	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
250	59	0	4	CHANNEL	2.0	800.	.0220	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
251	102	0	4	CHANNEL	1.0	2200.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
252	51	0	4	CHANNEL	1.0	5100.	.0150	1.0	1.0	.050	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
253	73	0	4	CHANNEL	3.0	1000.	.0030	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
254	40	0	4	CHANNEL	2.0	1350.	.0030	1.0	1.0	.060	3.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
255	35	0	4	CHANNEL	4.0	1325.	.0030	1.0	1.0	.030	3.00	0
				OVERFLOW	10.0	0.	.0010	50.0	50.0	.100	10.00	
256	108	0	4	CHANNEL	4.0	2400.	.0100	1.0	1.0	.030	10.00	0

				OVERFLOW	10.0	0.	.0010	50.0	50.0	.100	10.00	
257	42	0	4	CHANNEL	3.0	1500.	.0100	1.0	1.0	.060	6.00	0
				OVERFLOW	9.0	0.	.0010	50.0	50.0	.150	10.00	
[illegible]	[illegible]	[illegible]	4	CHANNEL	[illegible]	[illegible]	[illegible]	.5	.5	[illegible]	[illegible]	[illegible]
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
259	120	0	4	CHANNEL	30.0	1500.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
260	121	0	4	CHANNEL	30.0	1100.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
261	122	0	4	CHANNEL	30.0	1800.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
262	123	0	4	CHANNEL	30.0	2600.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
263	124	0	4	CHANNEL	30.0	1000.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
264	125	0	4	CHANNEL	30.0	2100.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
265	126	0	4	CHANNEL	30.0	2400.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
266	127	0	4	CHANNEL	30.0	2200.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
267	3	0	4	CHANNEL	1.0	4240.	.0080	2.0	2.0	.080	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
268	13	0	4	CHANNEL	3.0	2900.	.0050	2.0	2.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.060	10.00	
269	9	0	4	CHANNEL	1.0	1610.	.0140	2.0	2.0	.080	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
270	74	0	4	CHANNEL	1.0	50.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
271	15	0	4	CHANNEL	1.0	1325.	.0050	2.0	2.0	.060	2.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
274	50	0	4	CHANNEL	1.0	5800.	.0080	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
275	79	0	4	CHANNEL	3.0	1950.	.0080	2.0	2.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
1	128	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
2	128	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
3	120	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
4	203	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
5	202	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
6	119	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
7	118	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
8	269	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
9	12	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
10	122	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
11	121	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
12	268	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
13	123	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
14	124	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
15	232	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
16	271	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
17	244	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
18	242	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
19	240	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
20	200	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
21	243	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
22	246	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
23	238	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
24	239	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
25	229	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
26	231	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
27	228	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
28	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
29	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
30	31	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
31	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
32	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
33	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
34	206	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
35	247	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
36	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
37	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
38	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
39	207	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
40	208	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
41	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
42	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
43	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
44	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
45	299	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0

46	126	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
47	125	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
48	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
49	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
50	252	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
51	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
52	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
53	252	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
54	236	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
55	234	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
56	224	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
57	230	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
58	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
59	251	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
60	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
61	249	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
62	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
63	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
64	226	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
65	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
66	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
67	217	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
68	227	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
69	223	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
70	221	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
71	248	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
72	70	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
73	209	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
74	211	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
75	212	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
76	214	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
77	220	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
78	213	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
79	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
80	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
81	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
82	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
83	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
84	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
85	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
86	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
87	270	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
88	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
89	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
90	210	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
91	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
92	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
93	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
94	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
95	216	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
96	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
97	215	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
98	218	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
99	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
100	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
101	250	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
102	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
103	233	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
104	237	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
105	235	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
106	245	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
107	28	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
108	205	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
109	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
110	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
111	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
112	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
113	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
114	275	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
115	219	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
116	222	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
117	257	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
118	258	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
119	259	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
120	260	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
121	261	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
122	262	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
123	263	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
124	264	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
125	265	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0

126	266	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
127	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
128	267	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
129	204	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
130	225	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0

0TOTAL NUMBER OF GUTTERS/PIPES, 202

1

APPENDIX B

SAMPLE SWMM INPUT DATA
SELECTED OUTFALL PLAN HYDROLOGIC CONDITION

ENVIRONMENTAL PROTECTION AGENCY - STORM WATER MANAGEMENT MODEL - VERSION PC.1

DEVELOPED BY METCALF + EDDY, INC.

UNIVERSITY OF FLORIDA

WATER RESOURCES ENGINEEERS, INC. (SEPTEMBER 1970)

UPDATED BY UNIVERSITY OF FLORIDA (JUNE 1973)

HYDROLOGIC ENGINEERING CENTER, CORPS OF ENGINEERS

MISSOURI RIVER DIVISION, CORPS OF ENGINEERS (SEPTEMBER 1974)

BOYLE ENGINEERING CORPORATION (MARCH 1985, JULY 1985)

0TAPE OR DISK ASSIGNMENTS

JIN(1)	JIN(2)	JIN(3)	JIN(4)	JIN(5)	JIN(6)	JIN(7)	JIN(8)	JIN(9)	JIN(10)
2	1	0	0	0	0	0	0	0	0

JOUT(1)	JOUT(2)	JOUT(3)	JOUT(4)	JOUT(5)	JOUT(6)	JOUT(7)	JOUT(8)	JOUT(9)	JOUT(10)
1	2	0	0	0	0	0	0	0	0

NSCRAT(1)	NSCRAT(2)	NSCRAT(3)	NSCRAT(4)	NSCRAT(5)
3	4	0	0	0

1

WATERSHED PROGRAM CALLED

*** ENTRY MADE TO RUNOFF MODEL ***

ST CHARLES MESA 100-YEAR SELECTED CONDITION
COUNTY, PUEBLO, KIOWA ENGINEERING FILE:SC100SEL.SIN

0NUMBER OF TIME STEPS 60
0INTEGRATION TIME INTERVAL (MINUTES), 5.00

25.0 PERCENT OF IMPERVIOUS AREA HAS ZERO DETENTION DEPTH
1

ST CHARLES MESA 100-YEAR SELECTED CONDITION
COUNTY, PUEBLO, KIOWA ENGINEERING FILE:SC100SEL.SIN

ST CHARLES MESA 100-YEAR SELECTED CONDITION
COUNTY, PUEBLO, KIOWA ENGINEERING FILE:SC100SEL.SIN

GUTTER NUMBER	GUTTER CONNECTION	NDP	NP		WIDTH OR DIAM (FT)	LENGTH (FT)	INVERT SLOPE (FT/FT)	SIDE SLOPES HORIZ TO VERT L	R	OVERBANK/SURCHARGE MANNING N	DEPTH (FT)	JK
200	299	0	4	CHANNEL	24.0	900.	.0300	.0	.0	.020	1.00	0
				OVERFLOW	24.0	0.	.0010	10.0	10.0	.100	2.00	
202	129	0	4	CHANNEL	2.0	1500.	.0060	2.0	2.0	.040	2.00	0
				OVERFLOW	10.0	0.	.0010	40.0	40.0	.150	10.00	
203	5	0	4	CHANNEL	2.0	1000.	.0030	2.0	2.0	.040	2.00	0
				OVERFLOW	10.0	0.	.0010	40.0	40.0	.150	10.00	
204	118	0	4	CHANNEL	30.0	1300.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	20.0	.100	10.00	
205	37	0	4	CHANNEL	1.0	650.	.0050	2.0	2.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.060	10.00	

206	39	0	4	CHANNEL	2.0	3380.	.0100	2.0	2.0	.040	2.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
207	41	0	5	PIPE	4.0	2600.	.0100	.0	.0	.060	4.00	0
				OVERFLOW	30.0	0.	.0010	10.0	10.0	.030	10.00	
208	117	0	4	CHANNEL	2.0	1750.	.0080	.5	.5	.030	6.00	0
				OVERFLOW	8.0	0.	.0010	10.0	10.0	.060	10.00	
209	114	0	4	CHANNEL	3.0	1250.	.0100	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
210	89	0	4	CHANNEL	2.0	1600.	.0050	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
211	75	0	4	CHANNEL	3.0	2650.	.0040	1.0	1.0	.030	3.00	0
				OVERFLOW	9.0	0.	.0010	50.0	50.0	.100	10.00	
212	97	0	5	PIPE	5.0	1325.	.0030	.0	.0	.020	5.00	0
				OVERFLOW	24.0	0.	.0010	10.0	10.0	.030	10.00	
213	93	0	4	CHANNEL	2.0	2740.	.0120	2.0	2.0	.040	2.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
214	90	0	4	CHANNEL	10.0	1400.	.0040	10.0	10.0	.030	3.00	0
				OVERFLOW	10.0	0.	.0010	10.0	10.0	.100	10.00	
215	86	0	5	PIPE	5.0	2000.	.0080	.0	.0	.020	5.00	0
				OVERFLOW	24.0	0.	.0010	10.0	10.0	.030	10.00	
216	96	0	4	CHANNEL	1.0	1200.	.0150	1.0	1.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
217	99	0	4	CHANNEL	3.0	1520.	.0070	1.0	1.0	.060	5.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.100	10.00	
218	112	0	4	CHANNEL	2.0	2500.	.0200	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	6.0	50.0	.150	10.00	
219	98	0	4	CHANNEL	4.0	900.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
220	115	0	4	CHANNEL	4.0	650.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
221	75	0	5	PIPE	4.5	1325.	.0030	.0	.0	.020	4.50	0
				OVERFLOW	24.0	0.	.0010	10.0	10.0	.030	10.00	
222	72	0	4	CHANNEL	3.0	2600.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	11.0	0.	.0010	50.0	50.0	.100	10.00	
223	116	0	4	CHANNEL	1.0	1850.	.0100	1.0	1.0	.030	3.50	0
				OVERFLOW	8.0	0.	.0010	10.0	10.0	.060	10.00	
224	69	0	4	CHANNEL	1.0	3200.	.0050	1.0	1.0	.040	3.50	0
				OVERFLOW	8.0	0.	.0010	10.0	10.0	.060	10.00	
225	130	0	5	PIPE	3.0	720.	.0080	.0	.0	.020	3.00	0
				OVERFLOW	30.0	0.	.0010	10.0	10.0	.060	10.00	
226	77	0	4	CHANNEL	1.0	1250.	.0090	1.0	1.0	.020	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
227	116	0	4	CHANNEL	1.0	2600.	.0020	1.0	1.0	.020	2.00	0
				OVERFLOW	7.0	0.	.0010	10.0	10.0	.060	10.00	
228	68	0	4	CHANNEL	3.0	2600.	.0020	1.0	1.0	.020	4.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.100	10.00	
229	27	0	4	CHANNEL	1.0	3200.	.0070	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.100	10.00	
230	70	0	4	CHANNEL	1.0	5100.	.0070	10.0	10.0	.060	1.00	0
				OVERFLOW	20.0	0.	.0010	50.0	50.0	.150	10.00	
231	27	0	4	CHANNEL	3.0	1200.	.0100	1.0	1.0	.060	3.00	0
				OVERFLOW	9.0	0.	.0010	50.0	6.0	.150	10.00	
232	26	0	4	CHANNEL	2.0	2600.	.0060	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
233	15	0	4	CHANNEL	2.0	1300.	.0090	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
234	68	0	4	CHANNEL	3.0	3900.	.0070	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.060	10.00	
235	55	0	4	CHANNEL	3.0	2600.	.0120	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
236	55	0	4	CHANNEL	2.0	1400.	.0100	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	
237	54	0	4	CHANNEL	1.0	1400.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
238	22	0	4	CHANNEL	2.0	2800.	.0030	1.0	1.0	.020	2.00	0
				OVERFLOW	6.0	0.	.0010	6.0	50.0	.100	10.00	
239	23	0	4	CHANNEL	1.0	1300.	.0060	2.0	2.0	.020	1.50	0
				OVERFLOW	5.0	0.	.0010	6.0	50.0	.150	10.00	
240	24	0	4	CHANNEL	1.0	1250.	.0060	1.0	1.0	.060	1.00	0
				OVERFLOW	5.0	0.	.0010	6.0	50.0	.150	10.00	
242	23	0	4	CHANNEL	2.0	1400.	.0060	1.0	1.0	.030	3.00	0
				OVERFLOW	6.0	0.	.0010	50.0	6.0	.150	10.00	
243	22	0	4	CHANNEL	3.0	1800.	.0150	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
244	71	0	4	CHANNEL	2.0	1350.	.0080	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	6.0	.150	10.00	
245	18	0	4	CHANNEL	2.0	1300.	.0020	1.0	1.0	.060	2.00	0
				OVERFLOW	6.0	0.	.0010	50.0	50.0	.150	10.00	

246	27	0	4	CHANNEL	2.0	2600.	.0020	1.0	1.0	.020	2.00	0
				OVERFLOW	6.0	0.	.0010	6.0	50.0	.100	10.00	
247	39	0	5	PIPE	4.0	1350.	.0100	.0	.0	.030	4.00	0
				OVERFLOW	30.0	0.	.0010	10.0	10.0	.030	10.00	
248	21	0	4	CHANNEL	3.0	1320.	.0050	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
249	101	0	4	CHANNEL	2.0	2600.	.0100	1.0	1.0	.050	3.50	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
250	59	0	4	CHANNEL	2.0	800.	.0220	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
251	102	0	4	CHANNEL	1.0	2200.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
252	51	0	4	CHANNEL	1.0	5100.	.0150	1.0	1.0	.050	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
253	73	0	4	CHANNEL	3.0	1000.	.0030	1.0	1.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
254	40	0	4	CHANNEL	2.0	1350.	.0030	.5	.5	.030	6.00	0
				OVERFLOW	8.0	0.	.0010	50.0	50.0	.150	10.00	
255	35	0	5	PIPE	4.0	1325.	.0100	.0	.0	.030	4.00	0
				OVERFLOW	30.0	0.	.0010	10.0	10.0	.030	10.00	
256	108	0	5	PIPE	4.5	2400.	.0100	.0	.0	.030	4.50	0
				OVERFLOW	30.0	0.	.0010	10.0	10.0	.030	10.00	
257	42	0	5	PIPE	4.5	1600.	.0400	1.0	1.0	.030	4.50	0
				OVERFLOW	9.0	0.	.0010	50.0	50.0	.060	10.00	
258	119	0	4	CHANNEL	30.0	1500.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
259	120	0	4	CHANNEL	30.0	1500.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
260	121	0	4	CHANNEL	30.0	1100.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
261	122	0	4	CHANNEL	30.0	1800.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
262	123	0	4	CHANNEL	30.0	2600.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
263	124	0	4	CHANNEL	30.0	1000.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
264	125	0	4	CHANNEL	30.0	2100.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
265	126	0	4	CHANNEL	30.0	2400.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
266	127	0	4	CHANNEL	30.0	2200.	.0020	.5	.5	.040	3.00	0
				OVERFLOW	33.0	0.	.0010	20.0	2.0	.100	10.00	
267	3	0	4	CHANNEL	1.0	4240.	.0080	2.0	2.0	.080	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
268	13	0	4	CHANNEL	3.0	2900.	.0050	2.0	2.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.060	10.00	
269	9	0	4	CHANNEL	1.0	1610.	.0140	2.0	2.0	.080	1.00	0
				OVERFLOW	5.0	0.	.0010	50.0	50.0	.150	10.00	
270	74	0	4	CHANNEL	1.0	50.	.0100	1.0	1.0	.060	1.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
271	15	0	4	CHANNEL	1.0	1325.	.0050	2.0	2.0	.060	2.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
274	77	0	4	CHANNEL	2.0	2600.	.0020	1.0	1.0	.020	3.00	0
				OVERFLOW	3.0	0.	.0010	50.0	50.0	.150	10.00	
275	79	0	4	CHANNEL	3.0	1950.	.0080	2.0	2.0	.020	3.00	0
				OVERFLOW	12.0	0.	.0010	50.0	6.0	.100	10.00	
1	128	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
2	128	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
3	120	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
4	203	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
5	202	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
6	119	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
7	118	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
8	269	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
9	12	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
10	122	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
11	121	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
12	268	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
13	123	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
14	124	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
15	232	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
16	271	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
17	244	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
18	242	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
19	240	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
20	200	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
21	243	0	3		1.0	1.	.1000	1.0	1.0	.010	1.00	0
22	255	4	3		1.0	1.	.1000	1.0	1.0	.010	1.00	246

DIVERSION TO GUTTER NUMBER 246 - TOTAL Q VS DIVERTED Q IN CFS

.0 .0 127.0 .0 300.0 173.0 500.0 373.0

23	256	4	3	1.0	1.	.1000	1.0	1.0	.010	1.00	238

DIVERSION TO GUTTER NUMBER 238 - TOTAL Q VS DIVERTED Q IN CFS

.0 .0 131.0 .0 300.0 170.0 500.0 370.0

24	239	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
25	229	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
26	231	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
27	254	4	3	1.0	1.	.1000	1.0	1.0	.010	1.00	228

DIVERSION TO GUTTER NUMBER 228 - TOTAL Q VS DIVERTED Q IN CFS

.0 .0 128.0 .0 300.0 172.0 500.0 372.0

28	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
29	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
30	31	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
31	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
32	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
33	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
34	206	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
35	247	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
36	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
37	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
38	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
39	207	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
40	208	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
41	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
42	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
43	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
44	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
45	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
46	126	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
47	125	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
48	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
49	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
50	252	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
51	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
52	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
53	252	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
54	236	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
55	234	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
56	224	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
57	230	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
58	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
59	251	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
60	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
61	249	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
62	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
63	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
64	226	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
65	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
66	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
67	217	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
68	253	4	3	1.0	1.	.1000	1.0	1.0	.010	1.00	227

DIVERSION TO GUTTER NUMBER 227 - TOTAL Q VS DIVERTED Q IN CFS

.0 .0 112.0 .0 300.0 118.0 500.0 388.0

69	225	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
70	221	4	3	1.0	1.	.1000	1.0	1.0	.010	1.00	274

DIVERSION TO GUTTER NUMBER 274 - TOTAL Q VS DIVERTED Q IN CFS

.0 .0 100.0 .0 300.0 200.0 500.0 400.0

71	248	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
72	70	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
73	209	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
74	211	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
75	212	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
76	214	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
77	220	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
78	213	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
79	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
80	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
81	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
82	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
83	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
84	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
85	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
86	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
87	270	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
88	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
89	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
90	210	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0

91	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
92	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
93	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
94	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
95	216	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
96	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
97	215	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
98	218	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
99	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
100	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
101	250	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
102	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
103	233	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
104	237	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
105	235	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
106	245	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
107	28	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
108	205	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
109	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
110	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
111	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
112	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
113	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
114	275	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
115	219	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
116	222	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
117	257	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
118	258	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
119	259	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
120	260	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
121	261	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
122	262	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
123	263	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
124	264	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
125	265	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
126	266	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
127	299	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
128	267	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
129	204	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0
130	223	0	3	1.0	1.	.1000	1.0	1.0	.010	1.00	0

0TOTAL NUMBER OF GUTTERS/PIPES, 202

1

ST CHARLES MESA 100-YEAR SELECTED CONDITION

COUNTY, PUEBLO, KIOWA ENGINEERING FILE:SC100SEL.SIN

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENSION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
4	97.	(DIRECT FLOW)		0 50.
203	65.	2.8		1 25.
5	156.	(DIRECT FLOW)		1 5.
202	89.	2.8		2 0.
129	89.	(DIRECT FLOW)		2 0.
7	45.	(DIRECT FLOW)		0 35.
204	89.	1.4		2 10.
2	219.	(DIRECT FLOW)		0 50.
1	119.	(DIRECT FLOW)		0 50.
118	89.	(DIRECT FLOW)		2 10.
128	338.	(DIRECT FLOW)		0 50.
6	205.	(DIRECT FLOW)		0 45.
258	88.	1.4		2 15.
267	22.	1.9		3 20.
119	236.	(DIRECT FLOW)		0 50.
3	176.	(DIRECT FLOW)		0 55.
259	225.	2.5		0 55.
56	198.	(DIRECT FLOW)		0 50.
8	253.	(DIRECT FLOW)		0 45.
120	400.	(DIRECT FLOW)		0 55.
224	104.	4.4		1 30.
17	293.	(DIRECT FLOW)		0 35.
269	23.	1.8		2 25.
11	178.	(DIRECT FLOW)		0 50.

APPENDIX C

SAMPLE DETENTION BASIN SIZING CRITERIA

CHAPTER 14 DETENTION

14.1 INTRODUCTION

The criteria presented in this section shall be used in the design and evaluation of all detention facilities for the County. The review of all planning submittals (refer to Chapter 2) will be based on the criteria presented in this section.

The main purpose of a detention facility is to store the excess storm runoff associated with an increased basin imperviousness and discharge this excess at a rate similar to the rate experienced from the basin without development. The value of such detention facilities is discussed in Section-3.3.6. Any special design conditions which cannot be defined by these CRITERIA shall be reviewed by the County Engineer before proceeding with design.

The various detention methods are defined on the basis of where the facility is constructed, such as open space detention, parking lot, underground or rooftop. The County permits all methods of detention except for rooftop (refer to Section 3.3.6).

14.2 WATER QUALITY ENHANCEMENT

Special detention design guidelines to include infiltration for detention ponds are presented in Chapter 15, "Water Quality Enhancement."

14.3 DESIGN CRITERIA

14.3.1 Volume and Release Rates

The minimum required volume shall be determined using the CUHP method or the following equations. These empirical equations were developed as part of the UD&FCD hydrology research program. The equations are based on a computer modeling study and represent average conditions. One of the most difficult aspects of storm drainage is obtaining consistent results between various methods for estimating detention requirements. These equations will provide consistent and more effective approaches to the sizing of onsite detention ponds. For larger water sheds where the Colorado Urban Hydrograph procedure can be used (i.e., ±90 acres), hydrograph routing procedures will be permitted in the design of these ponds, provided the historic imperviousness of two percent or less is used.

Minimum Detention Volume:

$$V = KA \quad \text{(Equation 1404)}$$

For the 100-year,

$$K_{100} = (1.78I - 0.002I^2 - 3.56)/1000 \quad \text{(Equation 1405)}$$

For the 10-year,

$$K_{10} = (0.95I - 1.90)/1000 \quad \text{(Equation 1406)}$$

Where V = required volume for the 100- or 10-year storm (acre-feet)

I = Developed basin imperviousness (%)

A = Tributary area (Acres)

The maximum release rates at the ponding depths corresponding to the 10- and 100-year volumes are as follows:

ALLOWABLE RELEASE RATES FOR DETENTION PONDS - CFS/ACRE

	SOIL GROUP		
CONTROL FREQUENCY	A	B	C & D
10-year	0.13	0.23	0.30
100-year	0.50	0.85	1.00

The predominate soil group for the total basin area tributary to the detention pond shall be used for determining the allowable release rate. Information on the soils in the County can be found in Reference-25.

14.3.2 Design Frequency

All detention facilities are to be designed for two storm frequencies: the 10-year and the 100-year recurrence interval floods.

14.3.3 Hydraulic Design

Hydraulic design data for sizing of detention facilities outlet works is as follows:

1. Weir flow

The general form of the equation for horizontal crested weirs is:

$$Q = CL(H)^{3/2} \quad \text{(Equation 1401)}$$

Where Q = discharge (cfs)

C = weir coefficient (Table 1401)

L = horizontal length (feet)

H = total energy head (feet)

Another common weir is the v-notch, whose equation is as follows:

$$Q = 2.5 \tan(\Theta/2)H^{5/2} \quad \text{(Equation 1402)}$$

Where Θ = angle of the notch at the apex (degrees)

When designing or evaluating weir flow, the effects of submergence must be considered. A single check on submergence can be made by comparing the tailwater to the headwater depth. The example calculation for a weir design on Fig. 1403 illustrates the submergence check.

2. Orifice Flow

The equation governing the orifice opening and plate is the orifice flow equation:

$$Q = C_d A (2gh)^{1/2} \quad \text{(Equation 1403)}$$

Where

Q = Flow (cfs)

C_d = Orifice coefficient

A = Area (ft^2)

g = Gravitational constant = 32.2 ft/sec^2

h = Head on orifice measured from centerline (ft)

An orifice coefficient (C-sub d) value of 0.65 shall be used for sizing of square edged orifice openings and plates.

14.4 DESIGN STANDARDS FOR OPEN SPACE DETENTION

14.4.1 State Engineer's Office

Any dam constructed for the purpose of storing water, with a surface area, volume, or dam height as specified in Colorado Revised Statues 37-87-105 as amended, shall require the approval of the plans by the State Engineer's Office. All detention storage areas shall be designed and constructed in accordance with these criteria. Those facilities subject to state statutes shall be designed and constructed in accordance with the criteria of the state.

14.4.2 Grading Requirements

Slopes on earthern embankments less than 5 feet in height shall not be steeper than 4 (horizontal) to 1 (vertical). For embankment heights between 5' and 10', the slopes shall not be steeper than 3 (horizontal) and 1 (vertical), but horizontal slope distance shall not be less than 20'. For embankments greater than 10 feet in height, the slopes shall be such to maintain slope stability, but horizontal slope distance shall not be less than 30 feet. Contact the County Engineer for additional requirements. All earthen slopes shall be covered with topsoil and revegetated with grass. Slopes on riprapped earthern embankments shall not be steeper than 3 (horizontal) to 1 (vertical). For grassed detention facilities, the minimum bottom slope shall be 0.5 percent measured perpendicular to the trickle channel.

14.4.3 Freeboard Requirements

The minimum required freeboard for open space detention facilities is 1.0-feet above the computed 100-year water surface elevation.

14.4.4 Trickle Flow Control

All grassed bottom detention ponds shall include a concrete trickle channel or equivalent performing materials and design. Trickle flow criteria is presented in Section 7.4.2.6(a).

14.4.5 Outlet Configuration

Presented on Figure-1401 are two examples for detention pond outlet configuration. A Type 1 outlet consists of a grated drop inlet, outlet pipe, and an overflow weir in the pond embankment. The control for the 10-year discharge shall be at the throat of the outlet pipe under the head of water as defined on Figure-1401. The grate must be designed to pass the 10-year flow with a minimum of 50 percent blockage (i.e., twice the 10-year flow). Since the minimum size of the outlet pipe is 12-inches, then a control orifice plate at the entrance of the pipe may be required to control the discharge of the design flow (see Section 14.4.2). An example orifice plate is shown on Figure-1402. Other outlet configurations will be allowed provided they meet the requirements of the permitted release rates at the required volume and include proper provisions for maintenance and reliability. The outlet shall be designed to minimize unauthorized modifications which effect proper function.

The difference between the 100-year discharge and the surcharged discharge on the 10-year outlet is released by the overflow weir or spillway. If sufficient pond depth is available, the drop inlet and the grate can be replaced by a depressed inlet with a headwall and trash rack. Depression of the inlet is required to reduce nuisance backup of flow into the pond during trickle flows. The maximum trash rack opening dimension shall be equal to the minimum opening in the orifice plate.

A Type 2 outlet consists of a drop inlet with an orifice controlled inlet for the 10-year discharge and a crest overflow and pipe inlet control for the 100-year discharge. The control for the 10-year discharge occurs at the orifice opening for the head as shown on the figure. The control for the 100-year discharge occurs at the throat of the outlet pipe as shown on the figure. However, the difference between the 100-year and 10-year discharge must pass over the weir and therefore the weir must be of adequate length. The effective weir length (L) occurs for three sides of the box. To ensure the 100-year control occurs at the throat of the outlet pipe, a 50 percent increase in the required weir length is recommended. In addition, the outlet pipe must have an adequate slope to ensure throat control in the pipe.

14.4.6 Embankment Protection

Whenever a detention pond uses an embankment to contain water, the embankment shall be protected from catastrophic failure due to overtopping. Overtopping can occur when the pond outlets become obstructed or when a larger than 100-year storm occurs. Failure protection for the embankment may be provided in the form of a buried heavy riprap layer on the entire downstream face of the embankment or a separate emergency spillway having a minimum capacity of twice the maximum release rate for the 100-year storm. Structures shall not be permitted in the path of the emergency spillway or overflow. The invert of the emergency spillway should be set equal to or above the 100-year water surface elevation.

14.4.7 Vegetation Requirements

All open space detention ponds shall be revegetated by either irrigated sod or natural dry-land grasses in accordance with the manual "Guidelines for Development and Maintenance of Natural Vegetation" by Donald H. Godi & Associates, Inc., July 23, 1984, available through the UD&FCD.

14.5 DESIGN STANDARDS FOR PARKING LOT DETENTION

The requirements for parking lot detention are as follows:

14.5.1 Depth Limitation

The maximum allowable design depth of the ponding is 18-inches for the 100-year flood and 12-inches for the 10-year flood.

14.5.2 Outlet Configuration

The minimum pipe size for the outlet is 12" diameter where a drop inlet is used to discharge to a storm sewer or drainageway. Where a weir and a small diameter outlet through a curb are used, the size and shape are dependent on the discharge/storage requirements. A minimum pipe size of 3" diameter is recommended.

14.5.3 Performance

To assure that the detention facility performs as designed, maintenance access shall be provided in accordance with Section 3.3.7. The outlet shall be designed to minimize unauthorized modifications which effect function. Any repaving of the parking lot shall be evaluated for impact on volume and release rates and are subject to approval by the Engineering Department prior to issuance. A sign shall be attached or posted in accordance with Section 14.4.5.

14.5.4 Flood Hazard Warning

All parking lot detention areas shall have a minimum of two signs posted identifying the detention pond area. The signs shall have a minimum area of 1.5 square feet and contain the following message:

"WARNING
This area is a detention pond and is subject
to periodic flooding to a depth of (provide
design depth for 10-year or 100-year storm,
whichever will be contained in parking lot)."

Any suitable materials and geometry of the sign are permissible, subject to approval by the Engineering Department.

14.6 DESIGN STANDARDS FOR UNDERGROUND DETENTION

The requirements for underground detention are as follows:

14.6.1 Materials

Underground detention shall be constructed using corrugated aluminum pipe (CAP) or reinforced concrete pipe (RCP). The pipe thickness cover, bedding, and backfill shall be designed to withstand HS-20 loading.

14.6.2 Configuration

Pipe segments shall be sufficient in number, diameter, and length to provide the required minimum storage volume for the 100-year design. As an option, the 10-year design can be stored in the pipe segments and the difference for the 100-year stored above the pipe in an open space detention (Section 14.4) or in a parking lot detention (Section 14.5). The minimum diameter of the pipe segments shall be 36 inches.

The pipe segments shall be placed side by side and connected at both ends by elbow tee fittings and across the fitting at the outlet (see Figure-1405). The pipe segments shall be continuously sloped at a minimum of 0.25% to the outlet. Manholes for maintenance access (see Section-14.6.4) shall be placed in the tee fittings and in the straight segments of the pipe, when required.

Permanent buildings or structures shall not be placed above the underground detention.

14.6.3 Inlet and Outlet Design

The outlet from the detention shall consist of a short (maximum 25 ft.) length(s) of CAP or RCP with a 12" minimum diameter. A two-pipe outlet may be required to control both design frequencies. The invert of the lowest outlet pipe shall be set at the lowest point in the detention pipes. The outlet pipe(s) shall discharge into a standard manhole (see Standard Detail SD-6) or into a drainageway with erosion protection provided per Sections 11.3.2, 12.2, and 12.3. If an orifice plate is required to control the release rates, the plate(s) shall be hinged to open into the detention pipes to facilitate back flushing of the outlet pipe(s).

Inlet to the detention pipes can be by way of surface inlets and/or by a local private storm sewer system.

14.6.4 Maintenance Access

Access easements to the detention site shall be provided in accordance with Section 3.3.7. To facilitate cleaning of the pipe segments, 3-feet diameter maintenance access ports shall be placed according to the following schedule:

MAINTENANCE ACCESS REQUIREMENTS

Detention Pipe Size	Maximum Spacing	Minimum Frequency
36" to 54"	150'	Every pipe segment
60" to 66"	200'	Every other pipe segment
>66"	200'	One at each end of the battery of pipes

The manholes shall be constructed in accordance with the detail on Figure-1405.

14.7 DESIGN EXAMPLES

Example 7: Detention Design

Given: A basin that has the following characteristics:

Basin Area (A) = 23 acres

Basin Imperviousness (I) = 55%

Predominate Soil Group = D

Required: 100-year and 10-year storage volumes and release rates.

Solution:

Step 1: Determine K_{100} using Equation 1405

$$K_{100} = (1.78I - 0.002I^2 - 3.56)/1000$$

$$= (1.78(55) - 0.002(55)^2 - 3.56)/1000$$

$$= 0.0883$$

Step 2: Determine K_{10} using Equation 1406

$$K_{10} = (0.95I - 1.90)/1000$$

$$= 0.0504$$

Step 3: Determine minimum required 100-year storage volume using Equation 1404

$$V = KA$$

$$= 0.0883 \times 23$$

$$= 2.03 \text{ acre-feet } (88{,}500 \text{ ft}^3)$$

Step 4: Repeat Step 3 for 10-year storage

$$V = KA$$

$$= 0.0504 \times 23$$

$$= 1.16 \text{ acre-feet } (50{,}500 \text{ ft}^3)$$

Step 5: Determine maximum allowed 100-year release rate

$$Q_{100} = 1.00\ A$$

$$= 1.00 \times 23$$

$$= 23.0 \text{ cfs}$$

Step 6: Repeat Step 5 for 10-year release rate

$$Q_{10} = 0.30\ A$$

$$= 0.30 \times 23$$

$$= 6.9 \text{ cfs}$$

Example 8: Detention Outlet Structure Design

Given: Detention pond with the following characteristics (see Example 7)

Maximum 100-yr release rate = 23.0 cfs

Maximum 10-year release rate = 6.9 cfs

Type 2 outlet (refer to Figure-1401)

100-year water surface elevation = 105.0

10-year water surface elevation = 103.0

100-year outlet pipe invert elevation = 98.0

10-year outlet orifice invert elevation = 100.0

18-inch diameter outlet pipe

Required: 10-year and 100-year outlet sizing

Solution: (see Figure 1404)

Step 1: Determine 10-year orifice opening size, depth to centerline of orifice = 2.5 ft

$$A = Q/(C_d\ (2gh)^{1/2}) \quad \text{(Rearranged Equation 1403)}$$

$$= 6.9/(0.65\ (2.(32.2)(2.5))^{1/2})$$

$$= 0.84 \text{ ft}^2$$

Step 2: Determine 10-year orifice diameter

$$\text{Diameter} = (4A/\pi)^{1/2}$$

$$= (4(0.84)/\pi)^{1/2}$$

$$= 1.0 \text{ feet (12-inches)}$$

Therefore, an orifice opening with a 12-inch diameter hole is required at the entrance to the outlet box.

Step 3: Determine discharge through 10-year outlet for 100-year headwater (h = 4.5 ft).

$Q = C_d A\ (2gh)^{1/2}$ (Equation 1403)

$= 0.65(.84)\ (2(32.2)(4.5))^{1/2}$

$= 9.3$ cfs

Step 4: Determine discharge for sizing of 100-year weir

$Q_{weir} = Q_{100} - Q$ (from Step 3)

$= 23.0 - 9.3$

$= 13.7$ cfs (for sizing weir only)

Step 5: Size weir plate for 100-year outlet (18" RCP, h = 6.25 ft)

$A = Q/(C_d(2gh)^{1/2})$ (Equation 1403)

$= 23.0/(0.65)(2.(32.2)(6.25))^{1/2})$

$A = 1.76\ ft^2$

Step 6: Determine 100-year orifice diameter

Diameter $= (4A/\pi)^{1/2}$

$= ((4)(1.76)/\pi)^{1/2}$

$= 1.5$ feet $= 18$ inches

Since orifice diameter is approximately equal to the pipe diameter (±15%), then no orifice plate is required.

Step 7: Determine minimum box dimensions (i.e., weir length) to assure control of the pipe inlet.

$L = Q_{weir}/(C(H)^{3/2})$ (Rearranged Equation 1401)

$C = 3.4$ from Table 1401

$L = 13.7/(3.4(2.0)^{3/2})$

$L = 1.4$ ft

Since required weir length is only 1.4 feet, selected box dimensions suit construction and maintenance access. A minimum size of 3' x 3' is recommended.

Step 8: Check minimum size for trash rack opening area

Min. area = 2 x orifice area

= (2)(1.76)

Min. area = $3.5\ ft^2$

Since box opening is 3 x 3 = 9 sq. ft., then design requirements are satisfied.

14.8 CHECKLIST

To aid the designer and reviewer, the following checklist has been prepared:

(1) Earth slopes are to be 4:1 or flatter.

(2) Minimum freeboard of 1 foot for the 100-year detention is required.

(3) Open space detention areas to include trickle channels.

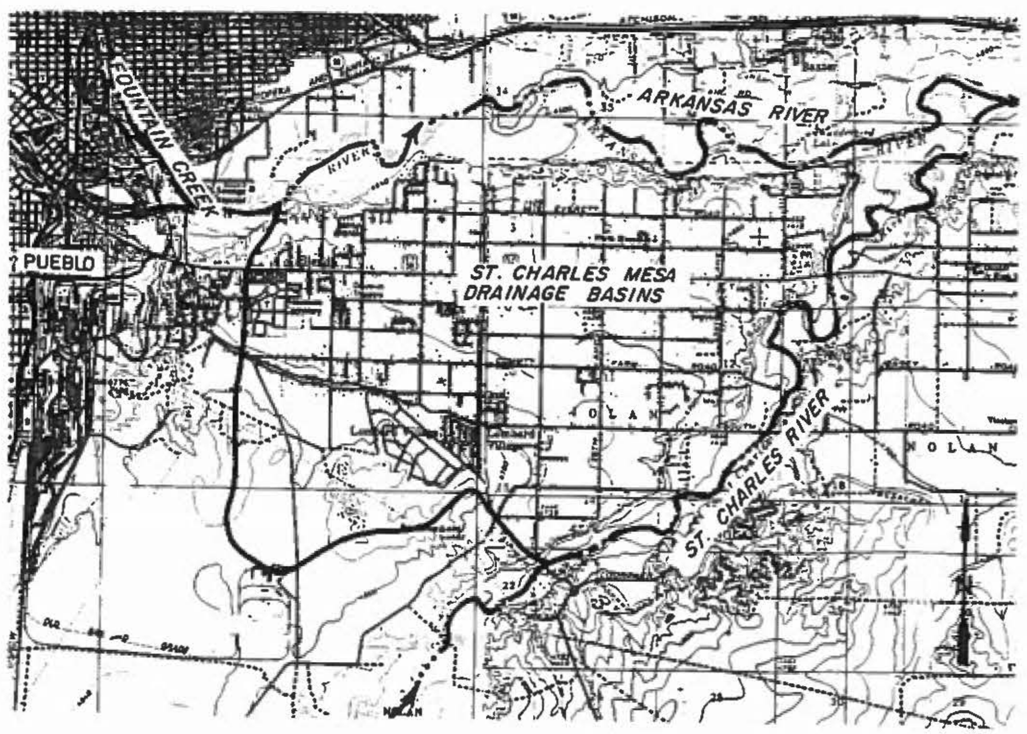
(4) Protect embankment for overtopping condition by adding riprap.

(4) Provide trash racks at all outlet structures.

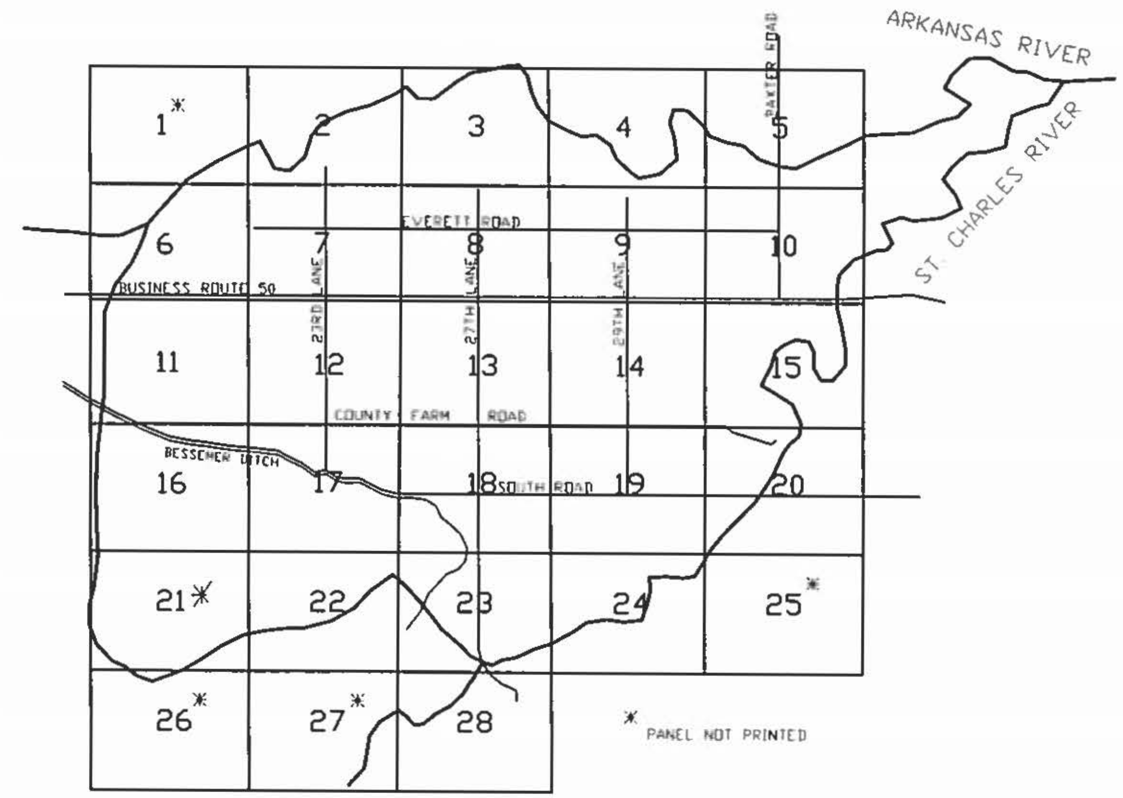
(5) Provide signs as required.

(6) Provide maintenance access.

ST. CHARLES MESA
DRAINAGE BASIN PLANNING STUDY
PUEBLO COUNTY, COLORADO



VICINITY MAP



GENERAL NOTES

1. THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.
2. THE CONVEYANCE SYSTEM CAPACITY IS BASED UPON THE 5-YEAR EXISTING DEVELOPMENT CONDITION. PEAK DISCHARGES ARE PRESENTED ON TABLE VI-1 OF THE REPORT. FUTURE DEVELOPMENT IS REQUIRED TO LIMIT DISCHARGES TO THE DISCHARGES SHOWN ON TABLE VI-1.
3. ALL TOPOGRAPHY AND ELEVATIONS SHOWN ON THE DRAWINGS HAVE BEEN OBTAINED THROUGH AERIAL PHOTOGRAMMETRIC METHODS, PREPARED BY LANDMARK MAPPING LTD., LAKEWOOD, COLORADO. ALL ELEVATIONS CORRESPOND TO THE NATIONAL GEODECTIC AND VERTICAL DATUM OF 1929, (I.E., USGS).
4. THE FINAL DESIGN AND CONSTRUCTION OF ALL FACILITIES SHALL BE COMPLETED IN CONFORMANCE WITH PUEBLO COUNTY DESIGN STANDARDS AND SPECIFICATIONS.
5. OVERFLOW FLOODING AREAS SHOWN ON THESE DRAWINGS REPRESENT AREAS WHICH COULD BE PRONE TO SHALLOW FLOODING (2 TO 3-FOOT DEPTHS), DURING THE 100-YEAR FREQUENCY. THE FLOODPLAINS ARE SHOWN FOR INFORMATION PURPOSES ONLY AND ARE NOT TO BE USED FOR THE ESTABLISHMENT OF REGULATORY FLOODPLAINS OR FLOODWAYS.

INDEX OF DRAWINGS	SHEET NUMBER
COVER SHEET	
PLANSHEETS	2-24,28
TYPICAL SECTIONS AND DETAILS	29,30

LEGEND

- BASIN BOUNDARY
- ROADSIDE DITCH
- IMPROVED CULVERT
- IMPROVED DRIVEWAY CULVERT
- PROPOSED STORM SEWER
- BOX BASE MANHOLE
- MANHOLE
- INLET
- INTERCEPTOR INLET
- CROSSPAN
- CURB & GUTTER
- OUTLET STRUCTURE
- 18 DESIGN POINT
- 201 SWMM CHANNEL ROUTING ELEMENT
- OVERFLOW FLOODING AREA

Kiowa Engineering Corporation
419 West Bijou Street
Colorado Springs, Colorado
80905-1308
(719) 630-7342

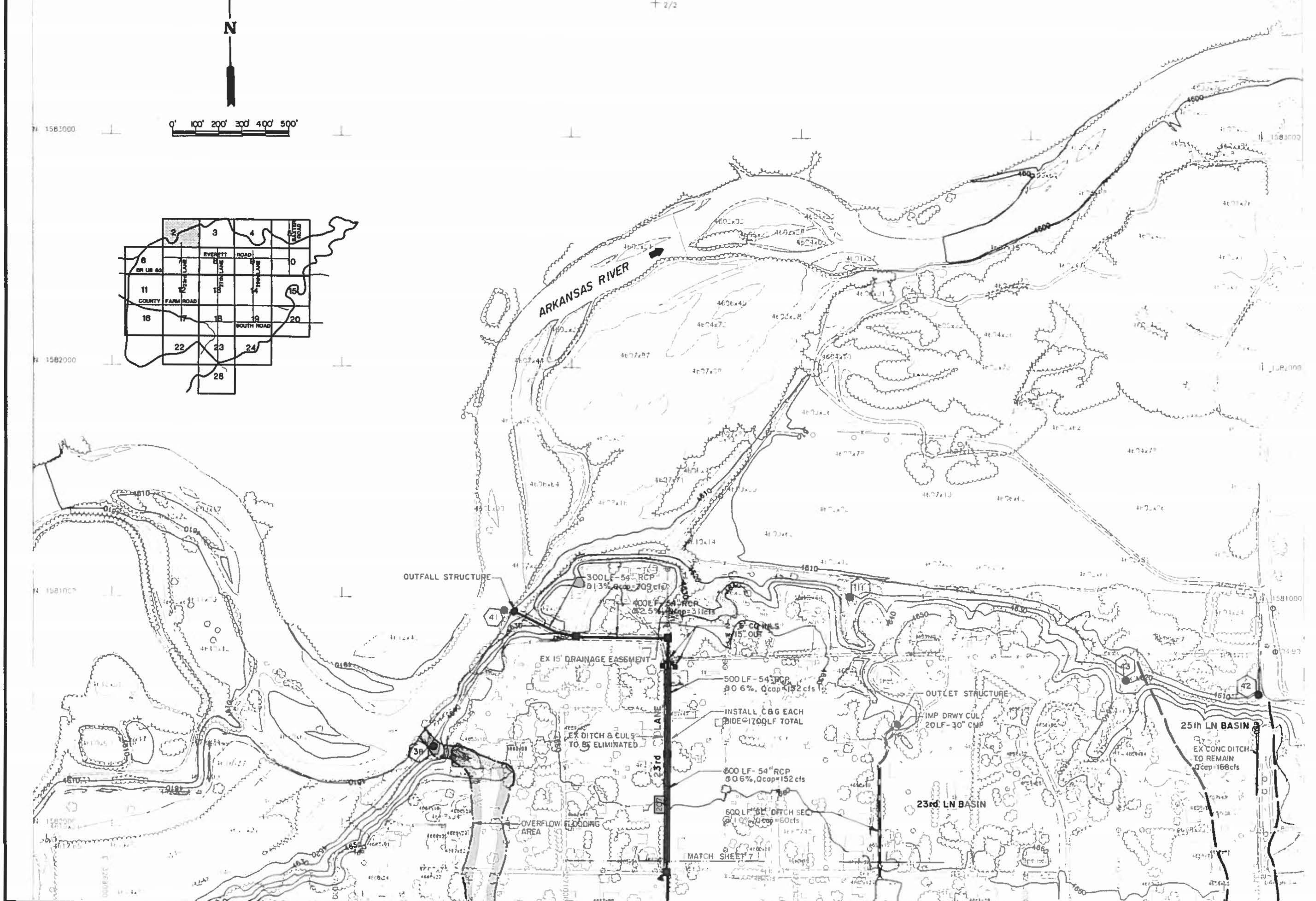
ST. CHARLES MESA
DRAINAGE BASIN PLANNING STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.: 94.01.01
Date: 3/94
Design:
Drawn:
Check:
Revisions:

COVER SHT

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.



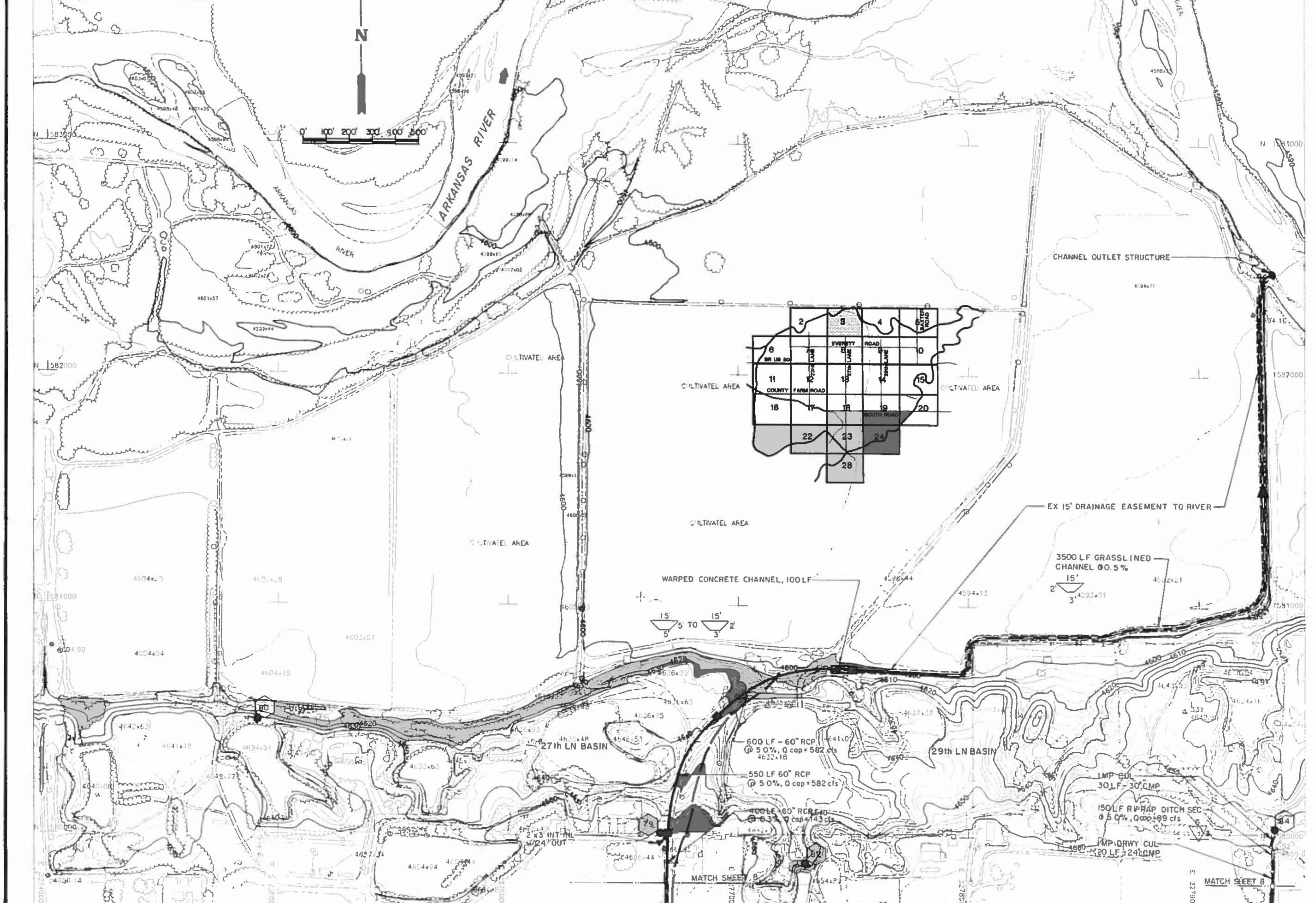
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.



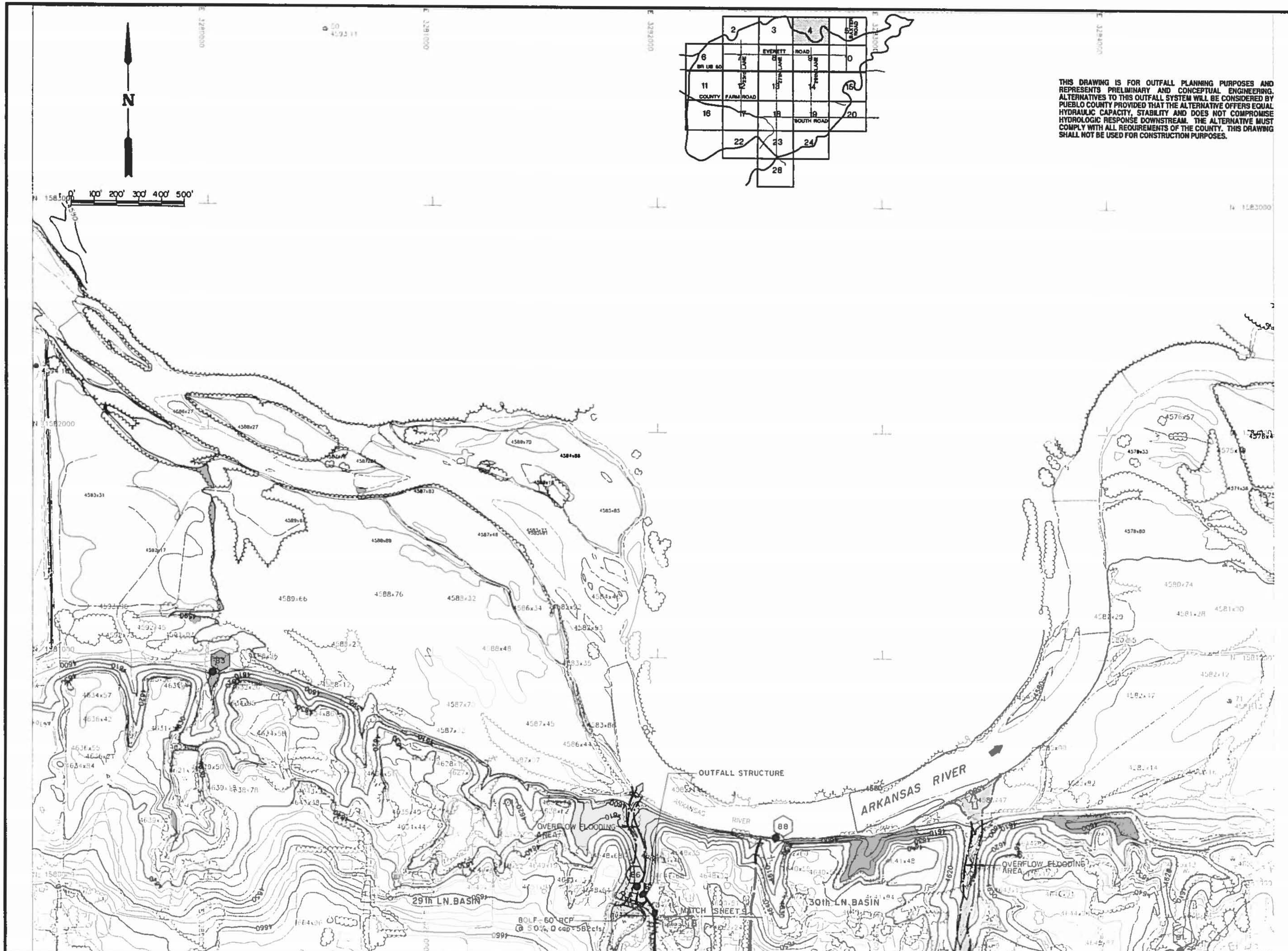
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

3



Kiowa Engineering Corporation

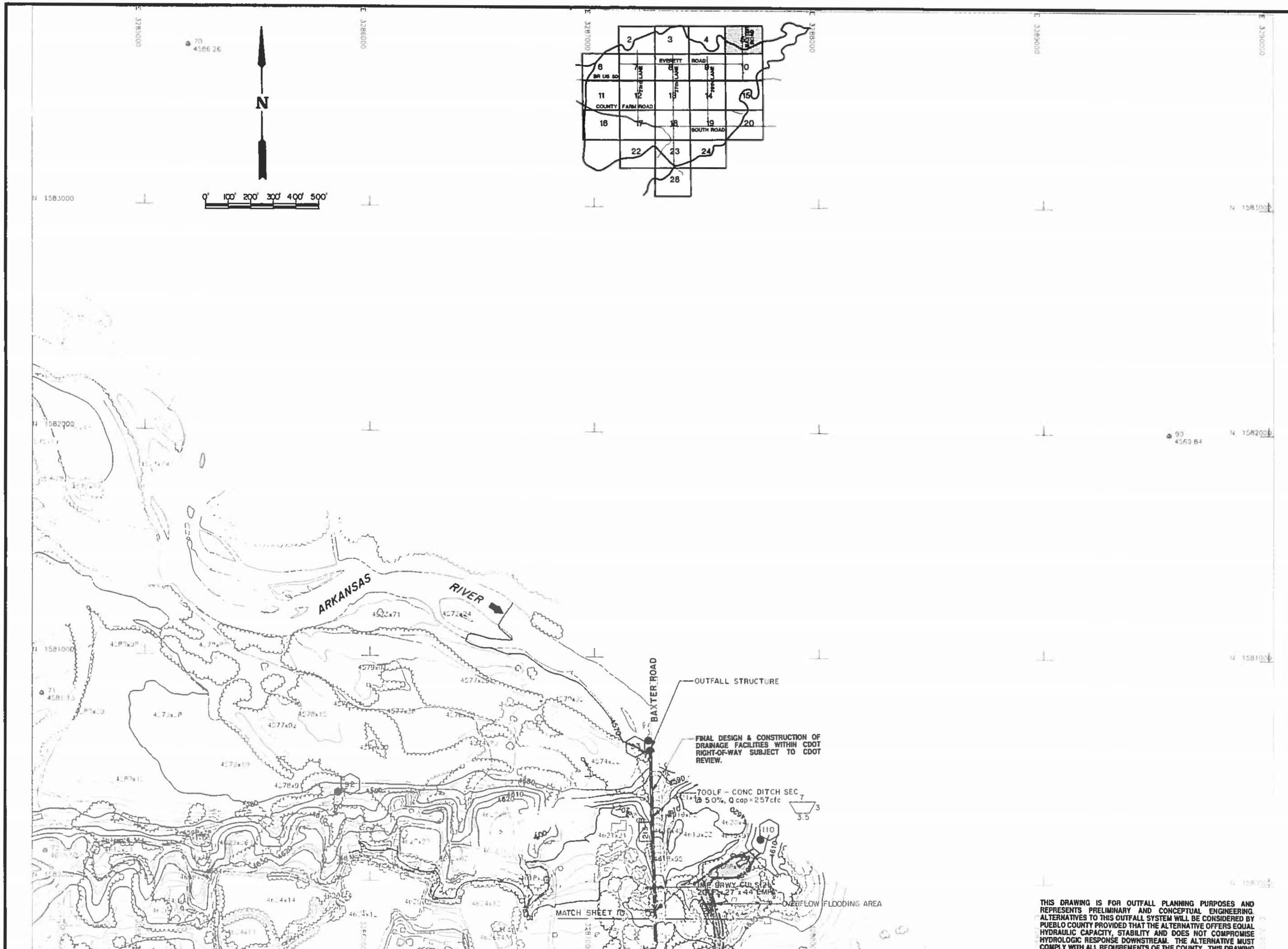
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

4



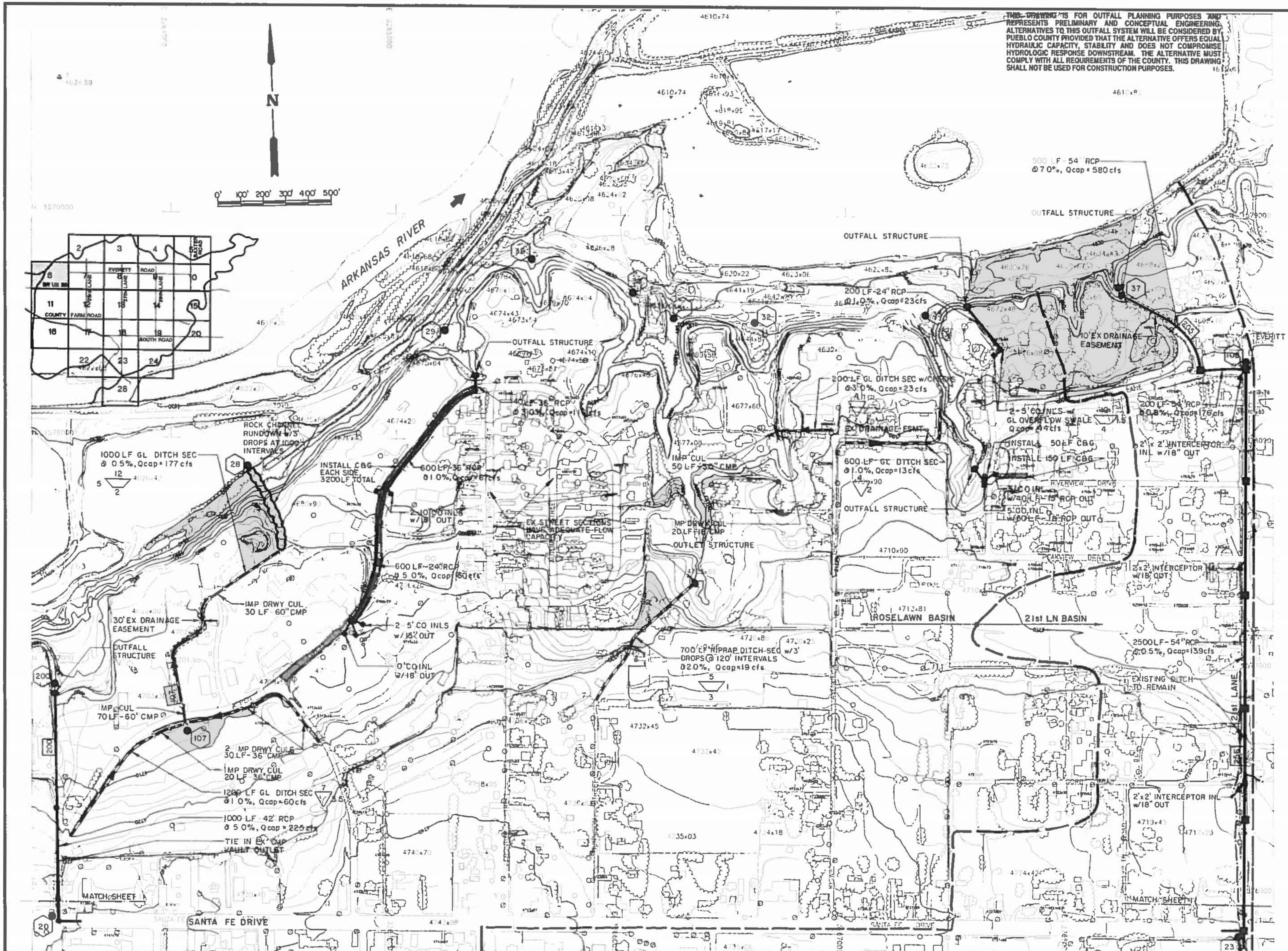
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

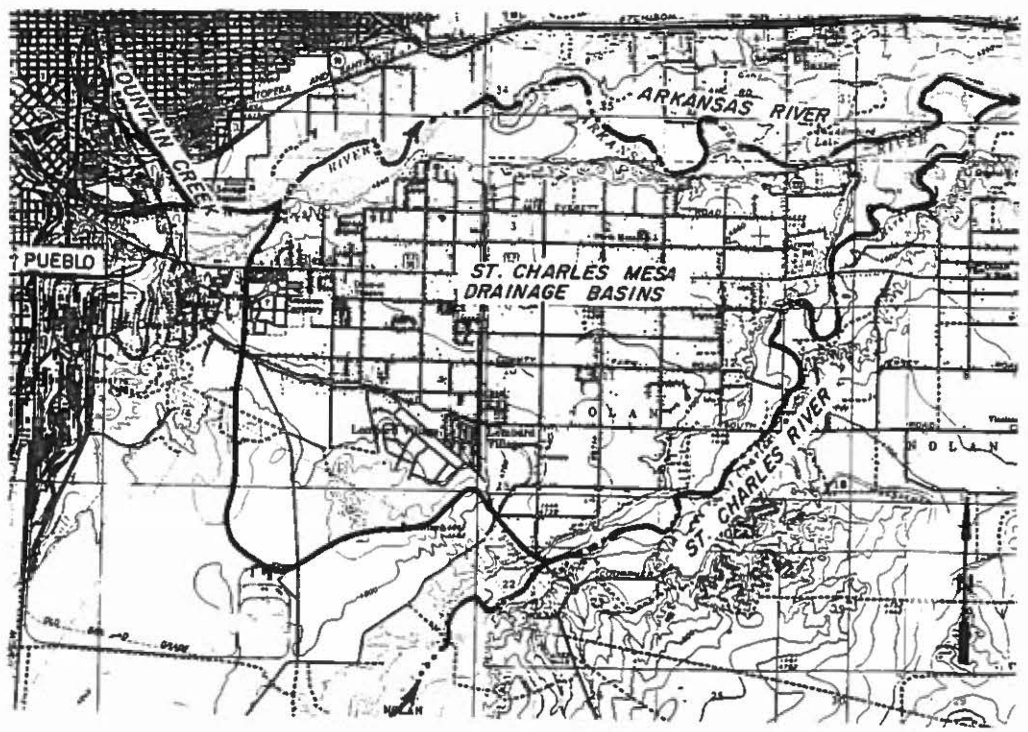
ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

6

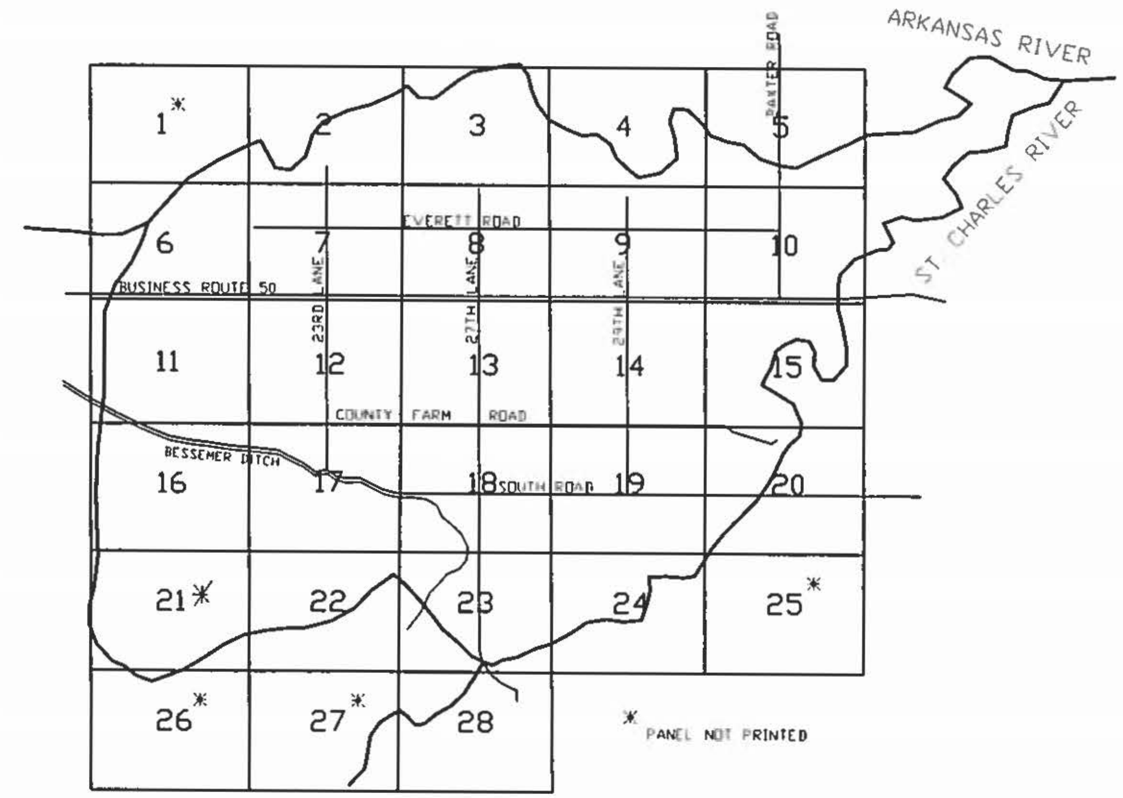
ST. CHARLES MESA
DRAINAGE BASIN PLANNING STUDY
PUEBLO COUNTY, COLORADO



VICINITY MAP

GENERAL NOTES

1. THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.
2. THE CONVEYANCE SYSTEM CAPACITY IS BASED UPON THE 5-YEAR EXISTING DEVELOPMENT CONDITION. PEAK DISCHARGES ARE PRESENTED ON TABLE VI-1 OF THE REPORT. FUTURE DEVELOPMENT IS REQUIRED TO LIMIT DISCHARGES TO THE DISCHARGES SHOWN ON TABLE VI-1.
3. ALL TOPOGRAPHY AND ELEVATIONS SHOWN ON THE DRAWINGS HAVE BEEN OBTAINED THROUGH AERIAL PHOTOGRAMMETRIC METHODS, PREPARED BY LANDMARK MAPPING LTD., LAKEWOOD, COLORADO. ALL ELEVATIONS CORRESPOND TO THE NATIONAL GEODECTIC AND VERTICAL DATUM OF 1929, (I.E., USGS).
4. THE FINAL DESIGN AND CONSTRUCTION OF ALL FACILITIES SHALL BE COMPLETED IN CONFORMANCE WITH PUEBLO COUNTY DESIGN STANDARDS AND SPECIFICATIONS.
5. OVERFLOW FLOODING AREAS SHOWN ON THESE DRAWINGS REPRESENT AREAS WHICH COULD BE PRONE TO SHALLOW FLOODING (2 TO 3-FOOT DEPTHS), DURING THE 100-YEAR FREQUENCY. THE FLOODPLAINS ARE SHOWN FOR INFORMATION PURPOSES ONLY AND ARE NOT TO BE USED FOR THE ESTABLISHMENT OF REGULATORY FLOODPLAINS OR FLOODWAYS.



INDEX OF DRAWINGS	SHEET NUMBER
COVER SHEET	
PLANSHEETS	2-24,28
TYPICAL SECTIONS AND DETAILS	29,30

LEGEND

- BASIN BOUNDARY
- ROADSIDE DITCH
- IMPROVED CULVERT
- IMPROVED DRIVEWAY CULVERT
- PROPOSED STORM SEWER
- BOX BASE MANHOLE
- MANHOLE
- INLET
- INTERCEPTOR INLET
- CROSSPAN
- CURB & GUTTER
- OUTLET STRUCTURE
- 18 DESIGN POINT
- 201 SWMM CHANNEL ROUTING ELEMENT
- OVERFLOW FLOODING AREA

Kiowa Engineering Corporation
419 West Bijou Street
Colorado Springs, Colorado
80905-1308
(719) 630-7342

ST. CHARLES MESA
DRAINAGE BASIN PLANNING STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.: 94.01.01
Date: 3/94
Design:
Drawn:
Check:
Revisions:

COVER SHT

COMMENTARY SHEET 2

FLOW PATH: 23rd Lane **DRAINAGE BASINS:** 23rd Lane

5-YEAR DESIGN: 34 to 92 cfs

EXISTING CONDITIONS:

This portion of the 23rd Lane Basin includes mostly residential uses. The existing drainage facilities include roadside ditches with culverts. The roadside ditch along 23rd Lane acts as an outfall system for drainage generated within the 23rd Lane Basin and it collects local runoff. The existing ditch and culverts are undersized.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

The proposed improvements along 23rd Lane consist of a storm sewer outfall system to convey the upper basin flows to the outfall at the Arkansas River. The existing roadside ditch and culverts along 23rd Lane can be eliminated and replaced with a curb and gutter street section. Intersecting roads may require minor regrading tp ensure that local drainage reaches the 23rd Lane street section.

FLOW PATH: 25th Lane **DRAINAGE BASINS:** 25th Lane

5-YEAR DESIGN: 180 to 195 cfs

EXISTING CONDITIONS:

This portion of the 25th Lane Basin is mostly residential. The existing concrete ditch along 25th Lane is adequate to convey upper basin flows.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

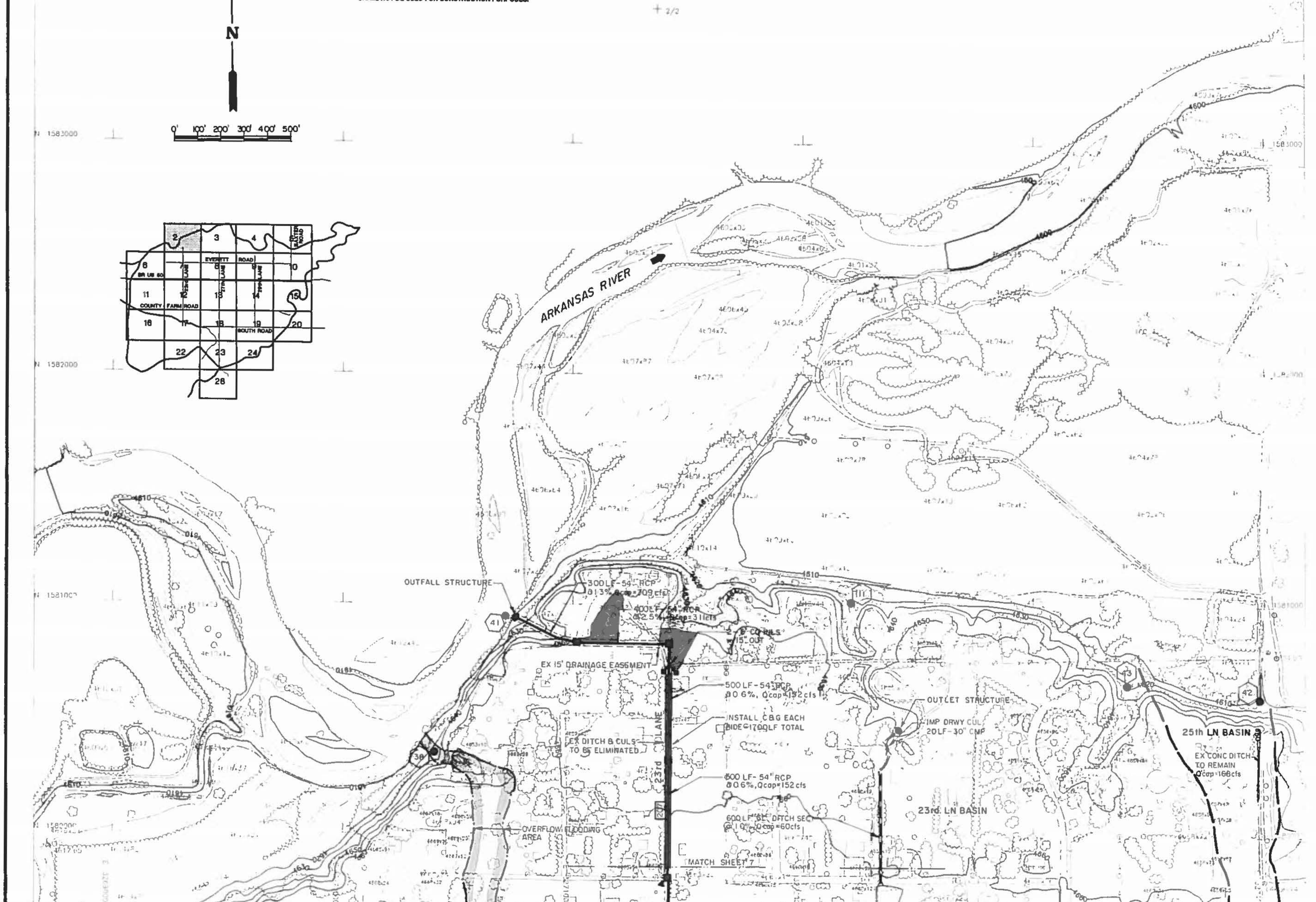
No improvements are proposed along 25th Lane.

Preliminary Design Cost Estimate Sheet 2

23rd Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
15" CMP	40	LF	$15	$6	$600	$240	$840
30" CMP	20	LF	$29	$10	$580	$200	$780
54 RCP	1700	LF	$78	$24	$132,600	$40,800	$173,400
Box Base Manhole	3	EA	$4,000	$1,000	$12,000	$3,000	$15,000
5' CO Inlet	2	EA	$2,500	$800	$5,000	$1,600	$6,600
Curb and Gutter	1700	LF	$4	$2	$6,800	$3,400	$10,200
Grasslined Channel	600	LF	$5	$15	$3,000	$9,000	$12,000
Street Paving	570	SY	$4	$4	$2,280	$2,280	$4,560
Pavement Replacement	945	SY	$15	$5	$14,175	$4,725	$18,900
Outfall Structure	2	EA	$25,000	$10,000	$50,000	$20,000	$70,000
Total Estimated Construction Cost					$227,035	$85,245	$312,280
Engineering and Contingency (20%)					$45,407	$17,049	$62,456
Total Estimated Cost					$272,442	$102,294	$374,736

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.



Kiowa Engineering Corporation

419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

2

COMMENTARY SHEET 3

FLOW PATH: 27th Lane **DRAINAGE BASINS:** 27th Lane

5-YEAR DESIGN: 136 to 139 cfs

EXISTING CONDITIONS:

This portion of the 27th Lane Basin contains mostly open space areas. The drainage facilities along 27th Lane provides the outfall for the majority of the 27th Lane Basin which extends south to the Bessemer Ditch. The existing roadside ditch and outfall facilities are inadequate to convey the 5-year flow.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of providing a storm sewer outfall system and grasslined channel to convey the runoff to the Arkansas River. The existing roadside ditch will remain to collect the street and local runoff.

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 22 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin contains mainly open spaces. The existing drainage facilities include inadequate roadside ditches and no culverts along 28th Lane. The 28th Lane right-of-way serves as a minor outfall for an area which extends south to Gale Road.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

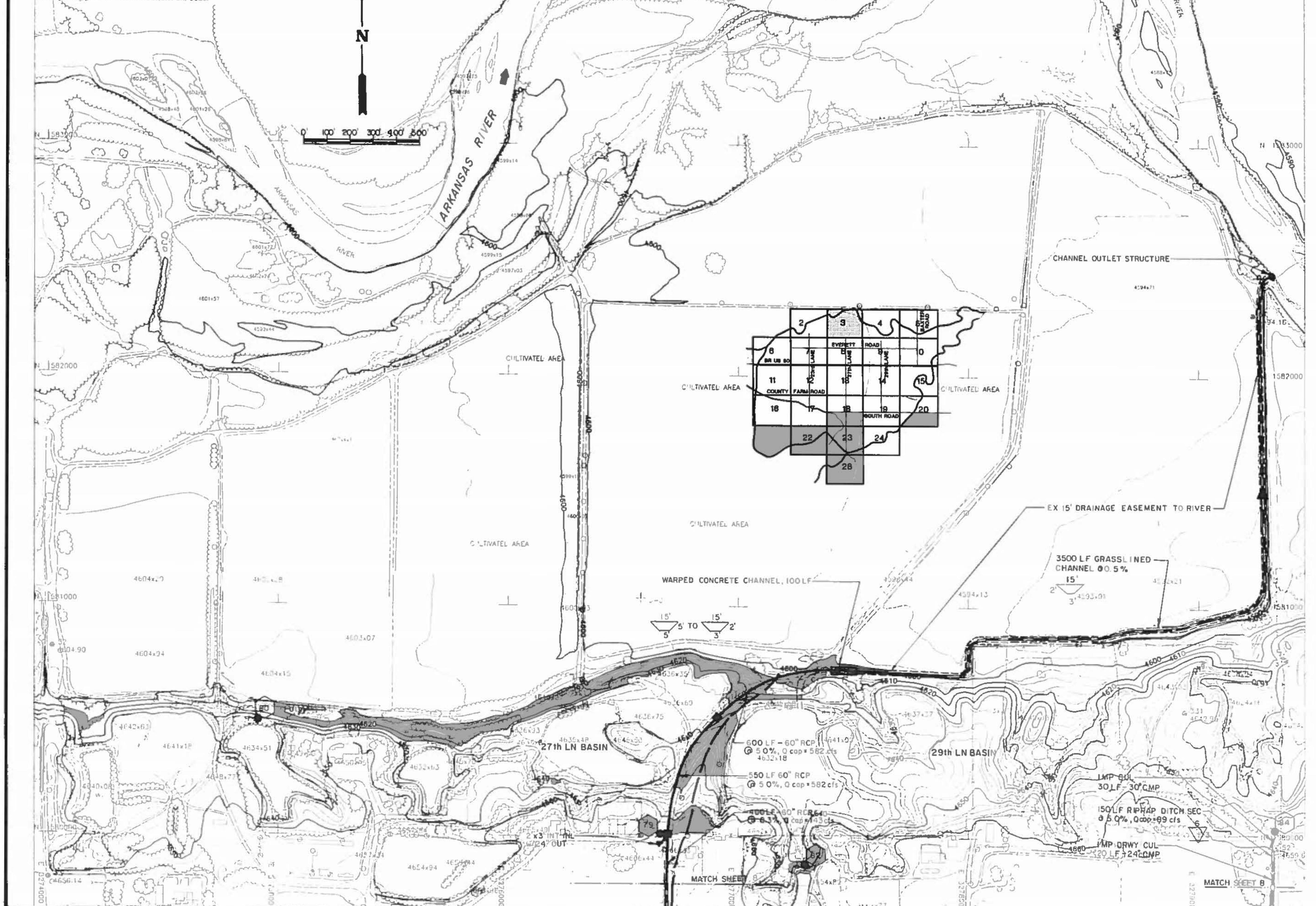
The proposed improvements consist of improving the roadside ditch and installing culverts along 28th Lane.

Preliminary Design Cost Estimate Sheet 3

27th Lane

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
54" RCP	1150	LF	$110	$24	$126,500	$27,600	$154,100
Box Base Manhole	1	EA	$4,000	$1,000	$4,000	$1,000	$5,000
Grasslined channel	3500	LF	$5	$15	$17,500	$52,500	$70,000
Concrete lined channel	225	LF	$60	$60	$13,500	$13,500	$27,000
Channel Transition	1	EA	$8,000	$10,000	$8,000	$10,000	$18,000
Outlet Structure	1	EA	$8,000	$3,000	$8,000	$3,000	$11,000
Total Estimated Construction Cost					$177,500	$107,600	$285,100
Engineering and Contingency (20%)					$35,500	$21,520	$57,020
Total Estimated Cost					$213,000	$129,120	$342,120

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

3

COMMENTARY SHEET 4

FLOW PATH: 29th Lane

DRAINAGE BASINS: 29th Lane

5-YEAR DESIGN: 145 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin is mostly open space at the edge of the Mesa. The existing private ditch system which provides an outfall for the area but it is not of sufficient to convey the 5-year discharge.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

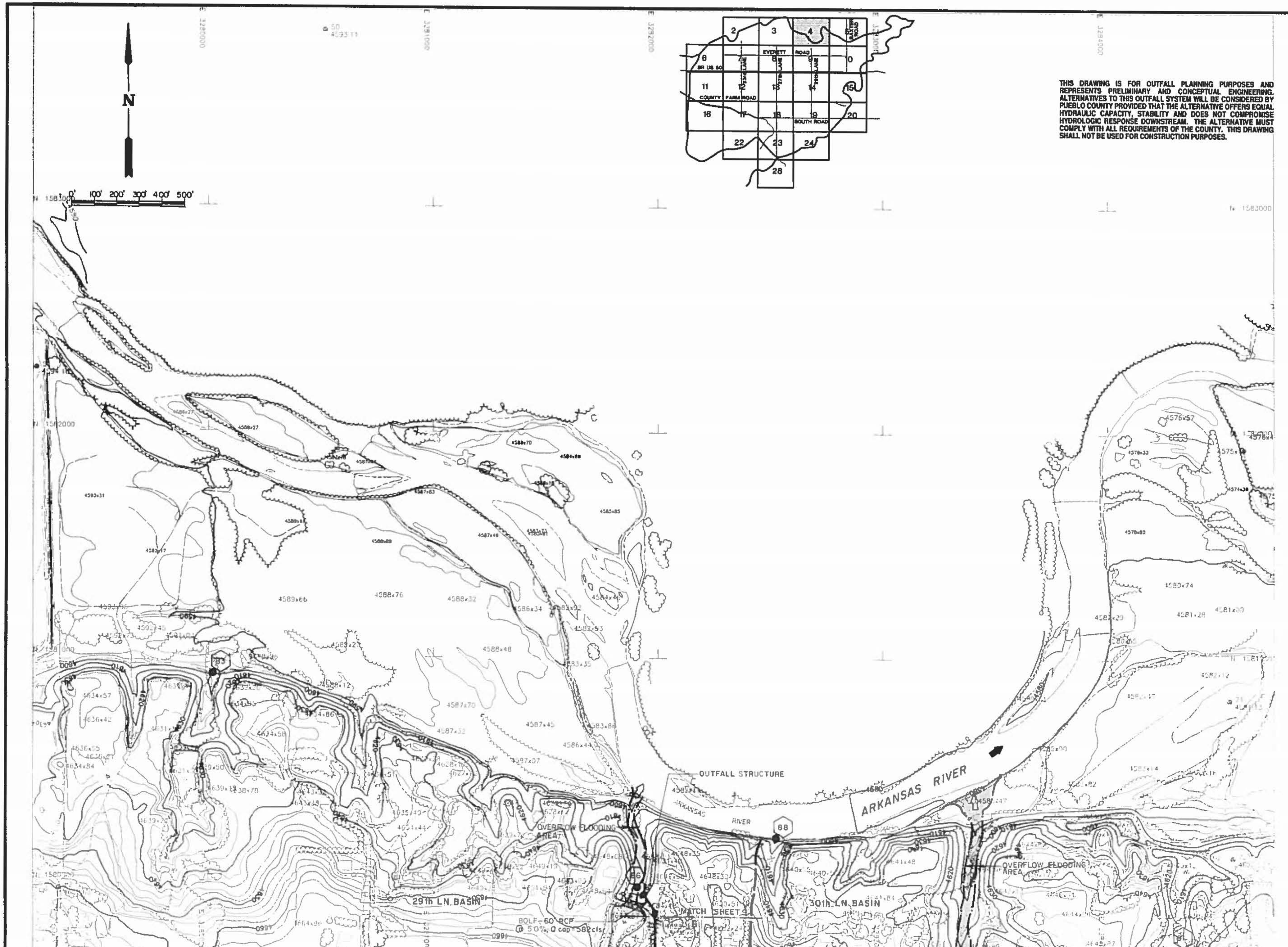
PROPOSED IMPROVEMENTS:

The proposed improvements consist of a storm sewer outfall system in 29th Lane, with an outfall structure at the mesa's edge.

Preliminary Design Cost Estimate Sheet 4

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
60" RCP	80	LF	$116	$24	$9,280	$1,920	$11,200
Box Base Manhole	1	EA	$4,000	$1,000	$4,000	$1,000	$5,000
Outfall Structure	1	EA	$25,000	$10,000	$25,000	$10,000	$35,000
Total Estimated Construction Cost					$38,280	$12,920	$51,200
Engineering and Contingency (20%)					$7,656	$2,584	$10,240
Total Estimated Cost					$45,936	$15,504	$61,440



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 5

FLOW PATH: Baxter Road

DRAINAGE BASINS: Baxter Road

5-YEAR DESIGN: 142 cfs

EXISTING CONDITIONS:

This portion of the Baxter Road Basin contains mostly open spaces. The existing drainage facility is a roadside ditch with culverts along Baxter Road. The ditch is insufficient for upper basin flows.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

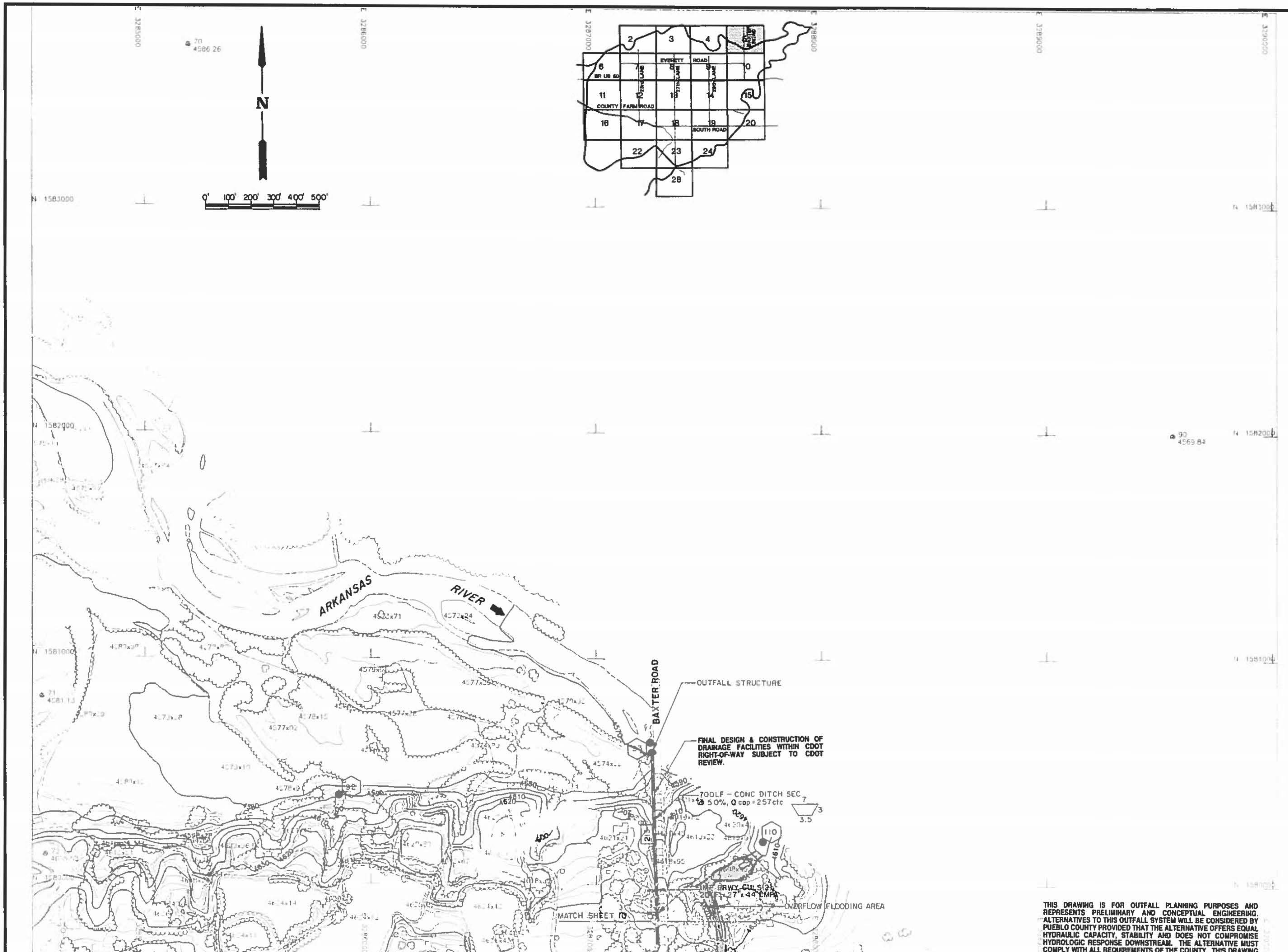
PROPOSED IMPROVEMENTS:

The proposed improvement is a concrete roadside ditch with culverts along Baxter Road and an outfall structure at the Arkansas River.

Preliminary Design Cost Estimate Sheet 5

Baxter Road Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
27" X 44" CMPA	40	LF	$70	$12	$2,800	$480	$3,280
Headwalls	2	EA	$400	$400	$800	$800	$1,600
Concrete lined channel	700	LF	$50	$50	$35,000	$35,000	$70,000
Outlet Structure	1	EA	$8,000	$3,000	$8,000	$3,000	$11,000
Total Estimated Construction Cost					$46,600	$39,280	$85,880
Engineering and Contingency (20%)					$9,320	$7,856	$17,176
Total Estimated Cost					$55,920	$47,136	$103,056



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 6

FLOW PATH: Aspen Circle **DRAINAGE BASINS:** Roselawn

5-YEAR DESIGN RANGE: 1 to 240 cfs

EXISTING CONDITIONS:

This portion of the Roselawn Basin includes areas of residential, commercial and industrial uses. Aspen Circle drainage characteristics include undersized roadside ditches and culverts. The residential areas contain adequate curbed streets and roadside ditches, but some have inadequate outfall facilities. Additional runoff enters this area from a low spot on Santa Fe Drive which collects runoff from areas south of Santa Fe Drive.

FUTURE CONDITIONS:

Future land use is anticipated to include increased industrial development. Future development shall be required to provide onsite detention to maintain flows to historic levels.

PROPOSED IMPROVEMENTS:

Major improvements occur along Aspen Circle. The southerly portion of Aspen Circle includes ditch and culvert upgrades with a improved outfall to the Arkansas River. The northerly portion of Aspen Circle will be curbed and a storm sewer system will be installed. The improvements to the residential areas include improved ditch sections, improved culverts and small storm sewer systems at various outfall locations. The offsite runoff will be intercepted by a storm sewer system originating in the Liberty Drive area, south of Santa Fe Drive. This system will outfall at the northerly end of Aspen Street.

FLOW PATH: 21st Lane **DRAINAGE BASINS:** 21st Lane

5-YEAR DESIGN RANGE: 20 to 131 cfs

EXISTING CONDITIONS:

This portion of the 21st Lane Basin contains primarily residential uses with a small commercial area adjacent to Santa Fe Drive. The existing roadside ditches and culverts are utilized for collection of localized drainage and as an outfall system for drainage generated south of Santa Fe Drive. This existing system is undersized which leads to overtopping and areas of shallow flooding.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

The proposed improvements include utilizing the existing ditches to collect and direct the local drainage and installing an outfall storm sewer system in 21st Lane to convey drainage from upper basin areas. An alternative to the roadside ditch along 21st Lane from Peakview Drive to Clearview Lane would be to install cur and gutter in this area and eliminating the roadside ditches. Peakview Drive, Riverview Drive and Clearview Lane might need regrading to ensure that local drainage reaches the 21st Lane system.

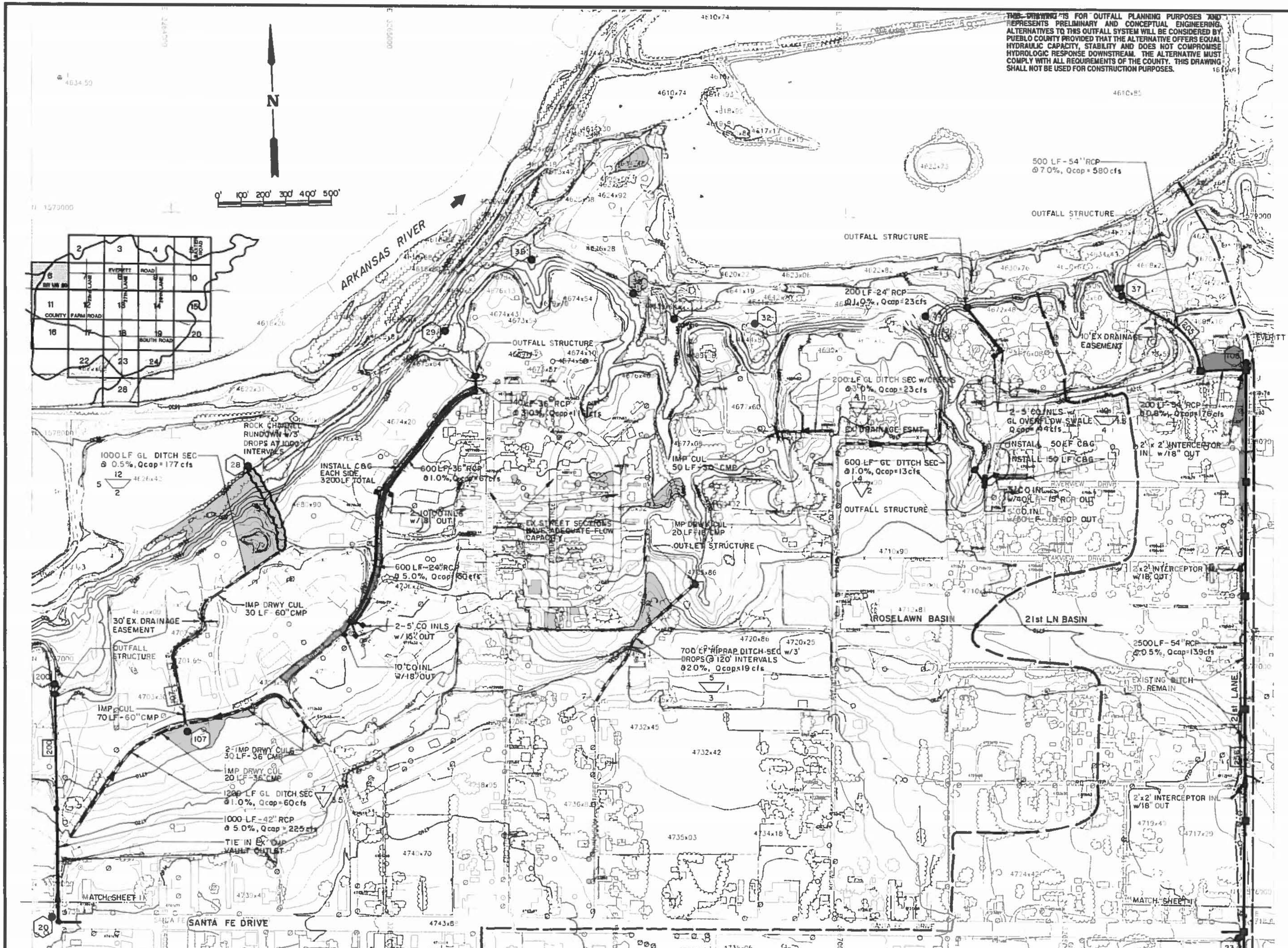
Preliminary Design Cost Estimate Sheet 6

21st Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
18" CMP	60	LF	$17	$6	$1,020	$360	$1,380
54" RCP	3200	LF	$78	$24	$249,600	$76,800	$326,400
2' X 2' Grated Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
Box Base Manhole	6	EA	$4,000	$1,000	$24,000	$6,000	$30,000
Pavement Replacement	3250	SY	$15	$5	$48,750	$16,250	$65,000
Outfall Structure	1	EA	$25,000	$10,000	$25,000	$10,000	$35,000
Total Estimated Construction Cost					$349,870	$109,910	$459,780
Engineering and Contingency (20%)					$69,974	$21,982	$91,956
Total Estimated Cost					$419,844	$131,892	$551,736

Aspen Street/Roselawn Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
60" CMP	100	LF	$70	$24	$7,000	$2,400	$9,400
42" RCP	1000	LF	$60	$15	$60,000	$15,000	$75,000
36" RCP	640	LF	$46	$10	$29,440	$6,400	$35,840
36" CMP	80	LF	$35	$10	$2,800	$800	$3,600
30"CMP	50	LF	$29	$10	$1,450	$500	$1,950
24" RCP	800	LF	$35	$6	$28,000	$4,800	$32,800
18" RCP	110	LF	$20	$6	$2,200	$660	$2,860
15" RCP	80	LF	$18	$6	$1,440	$480	$1,920
Manhole	4	EA	$2,000	$500	$8,000	$2,000	$10,000
5' CO inlet	6	EA	$2,500	$800	$15,000	$4,800	$19,800
10' CO Inlet	3	EA	$3,000	$1,000	$9,000	$3,000	$12,000
Grasslined channel	1000	LF	$5	$15	$5,000	$15,000	$20,000
Grasslined channel	800	LF	$5	$15	$4,000	$12,000	$16,000
Grasslined channel	1200	LF	$5	$15	$6,000	$18,000	$24,000
Riprap channel	700	LF	$5	$10	$3,500	$7,000	$10,500
Curb and gutter	3400	LF	$5	$2	$17,000	$6,800	$23,800
Paving	5800	SY	$4	$4	$23,200	$23,200	$46,400
Rock channel rundown	1	EA	$10,000	$5,000	$10,000	$5,000	$15,000
Headwalls	3	EA	$400	$400	$1,200	$1,200	$2,400
Drop Structues	7	EA	$6,000	$4,000	$42,000	$28,000	$70,000
Overflow swale	200	LF	$5	$10	$1,000	$2,000	$3,000
Outfall Structure	4	EA	$25,000	$10,000	$100,000	$40,000	$140,000
Total Estimated Construction Cost					$377,230	$199,040	$576,270
Engineering and Contingency (20%)					$75,446	$39,808	$115,254
Total Estimated Cost					$452,676	$238,848	$691,524



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

6

COMMENTARY SHEET 7

FLOW PATH: 23rd Lane **DRAINAGE BASINS:** 23rd Lane

5-YEAR DESIGN: 18 to 119 cfs

EXISTING CONDITIONS:

This portion of the 23rd Lane Basin includes residential and agricultural areas. The existing drainage facilities include roadside ditches with culverts. The facilities along Gale and Everett Roads are inadequate and need to be improved. The existing ditch and culverts adjacent to 23rd Lane are utilized for collection of localized drainage and as an outfall system for drainage generated south of Santa Fe Drive. This existing system is undersized which leads to ditch overtopping and areas of shallow flooding along 23rd Lane.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

Improved ditches and culverts are proposed along Gale and Everett Roads. A small storm sewer collector system is proposed in Everett Road east of 23rd Lane to drain a localized low area along the road right-of-way. The proposed improvements along 23rd Lane consist of installing a storm sewer outfall system to convey upper basin flows and intercept local flows at major intersections. The existing roadside ditch along 23rd Lane between Santa Fe Drive and Everett Road will remain to provide a collection system for local and street drainage. At the time of any development the ditch should be eliminated and curb and gutter installed along 23rd Lane. The future development shall maintain runoff to historic conditions and shall provide a connection to the proposed outfall facility. The existing ditch and culverts from Everett Road north shall be eliminated and curb and gutter installed along 23rd Lane. Intersecting roads from the west may require regrading to ensure that local drainage reaches 23rd Lane.

FLOW PATH: 25th Lane **DRAINAGE BASINS:** 25th Lane

5-YEAR DESIGN: 128 to 186 cfs

EXISTING CONDITIONS:

This portion of the 25th Lane Basin includes residential and agricultural areas. The existing drainage facilities include roadside ditches and culverts. The roadside ditch along Gale Road are insufficient and most of the culverts are less than the minimum length. The existing concrete ditch along 25th Lane intercepts local drainage and also provides the outfall system for drainage generated south of Santa Fe Drive. The existing ditch is adequate for these uses. The outfall system south of Santa Fe Drive is inadequate.

FUTURE CONDITIONS:

Future land use is anticipated to include commercial areas adjacent to Santa Fe Drive.

PROPOSED IMPROVEMENTS:

The roadside ditch system adjacent to Gale Road will be upgraded. The proposed improvements along 25th Lane consist of improving the storm sewer outfall system which conveys upper basin flows into the existing concrete channel.

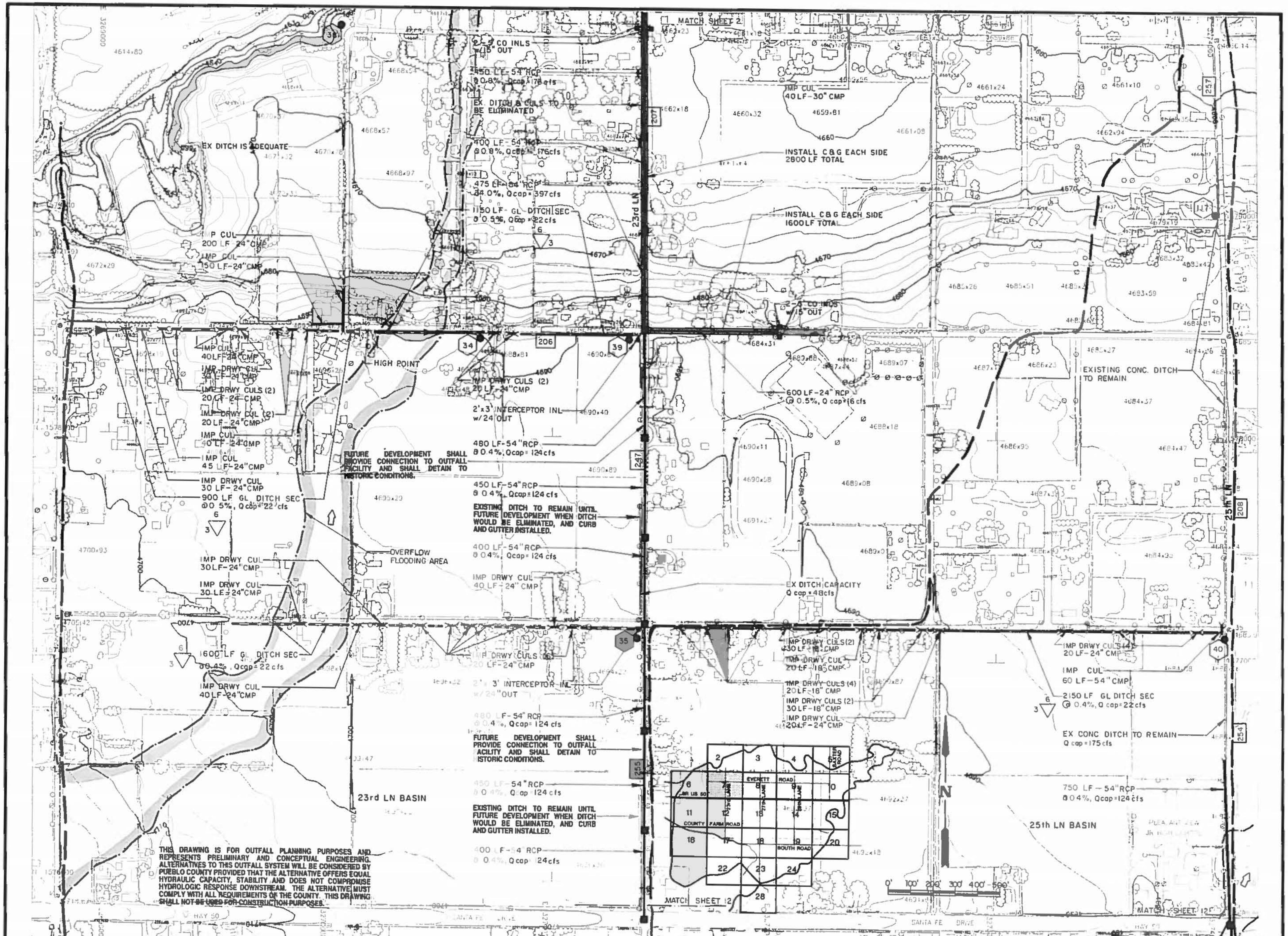
Preliminary Design Cost Estimate Sheet 7

25th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
18" CMP	220	LF	$17	$6	$3,740	$1,320	$5,060
24" CMP	750	LF	$22	$6	$16,500	$4,500	$21,000
54" RCP	750	LF	$78	$24	$58,500	$18,000	$76,500
54" CMP	750	LF	$60	$24	$45,000	$18,000	$63,000
Grasslined channels	2150	LF	$5	$15	$10,750	$32,250	$43,000
Headwall	15	EA	$400	$400	$6,000	$6,000	$12,000
Total Estimated Construction Cost					$140,490	$80,070	$220,560
Engineering and Contingency (20%)					$28,098	$16,014	$44,112
Total Estimated Cost					$168,588	$96,084	$264,672

23rd Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
30" CMP	40	LF	$29	$10	$1,160	$400	$1,560
54" RCP	3985	LF	$78	$24	$310,830	$95,640	$406,470
24" RCP	600	LF	$25	$6	$15,000	$3,600	$18,600
15" CMP	80	LF	$15	$6	$1,200	$480	$1,680
24" CMP	915	LF	$22	$6	$20,130	$5,490	$25,620
Box base manhole	9	EA	$4,000	$1,000	$36,000	$9,000	$45,000
5'manhole	1	EA	$2,000	$500	$2,000	$500	$2,500
2'x3' Intercepting inlet	2	EA	$1,400	$500	$2,800	$1,000	$3,800
5' CO Inlet	4	EA	$2,500	$800	$10,000	$3,200	$13,200
Curb and Gutter	4400	LF	$4	$2	$17,600	$8,800	$26,400
Grasslined channel	3650	LF	$5	$15	$18,250	$54,750	$73,000
Pavement Replacement	5340	SY	$15	$5	$80,100	$26,700	$106,800
Headwalls	23	EA	$400	$400	$9,200	$9,200	$18,400
Total Estimated Construction Cost					$524,270	$218,760	$743,030
Engineering and Contingency (20%)					$104,854	$43,752	$148,606
Total Estimated Cost					$629,124	$262,512	$891,636



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

7

COMMENTARY SHEET 8

FLOW PATH: 27th Lane **DRAINAGE BASINS:** 27th Lane

5-YEAR DESIGN: 112 to 136 cfs

EXISTING CONDITIONS:

This portion of the 27th Lane Basin contains mostly agricultural areas with some smaller residential areas. The existing drainage facilities include very flat gradient roadside ditches with culverts. The culvert at Santa Fe Drive and the ditch along 27th Lane provide the outfall system for drainage generated south of Santa Fe Drive. The ditch also collects local runoff, but the ditch is of insufficient capacity. Everett Road also has an insufficient ditch with culverts which do not meet the minimum length requirements.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential uses. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of installing a storm sewer outfall system in 27th Lane to convey upper basin flows to the Arkansas River. The existing roadside ditch along 27th Lane from Santa Fe Drive north will remain to collect street and local runoff. At the time of future development, the ditch can be eliminated and curb and gutter installed along 27th Lane. Local drainage will be intercepted at Gale and Everett Roads. The ditches and culverts along Gale and Everett Roads will be upgraded.

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 45 to 77 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin contains mainly agricultural uses with smaller areas of residential use. The existing drainage facilities include inadequate roadside ditches and culverts and some areas have insufficient outfall facilities due to the very flat topography in this area of the Mesa.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of improving the roadside ditches and culverts along 28th Lane and Everett Road and portions of Gale Road. The Everett Road system will outfall to 29th Lane and then continue northerly. The Gale Road system will be collected by a storm sewer system at 29th Lane and conveyed easterly.

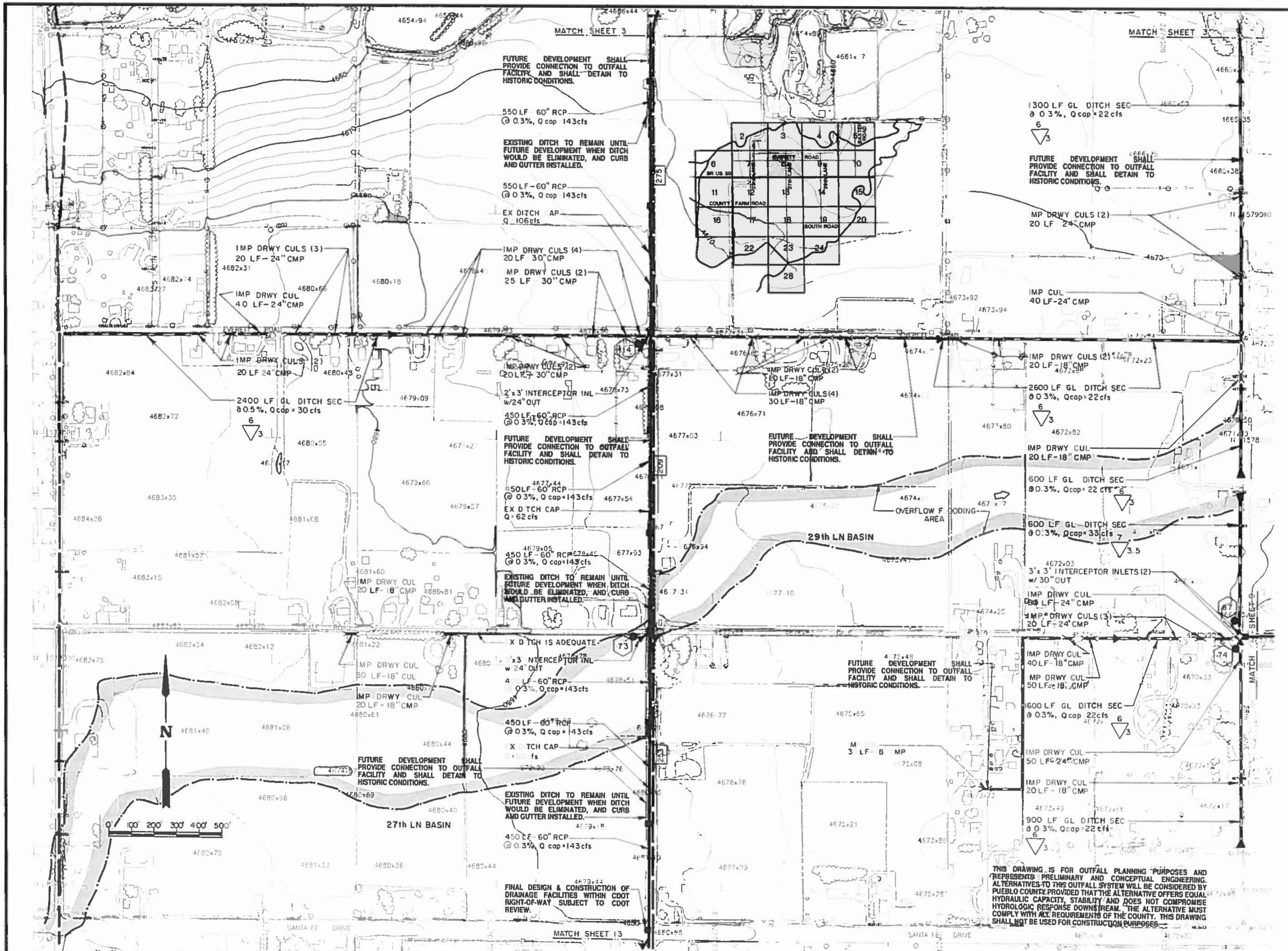
Preliminary Design Cost Estimate Sheet 8

27th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
60" RCP	3750	LF	$116	$24	$435,000	$90,000	$525,000
45" x 73" RCP	70	LF	$90	$24	$6,300	$1,680	$7,980
30" CMP	170	LF	$29	$10	$4,930	$1,700	$6,630
24" CMP	180	LF	$22	$6	$3,960	$1,080	$5,040
18" CMP	90	LF	$17	$6	$1,530	$540	$2,070
Box Base Manhole	9	EA	$4,000	$1,000	$36,000	$9,000	$45,000
Grasslined channel	2400	LF	$5	$15	$12,000	$36,000	$48,000
2' X 3' Intercepting Inlet	2	EA	$1,400	$500	$2,800	$1,000	$3,800
Headwalls	18	EA	$400	$400	$7,200	$7,200	$14,400
Total Estimated Construction Cost					$509,720	$148,200	$657,920
Engineering and Contingency (20%)					$101,944	$29,640	$131,584
Total Estimated Cost					$611,664	$177,840	$789,504

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
30" CMP	40	LF	$29	$10	$1,160	$400	$1,560
24" CMP	250	LF	$22	$6	$5,500	$1,500	$7,000
18" CMP	360	LF	$17	$6	$6,120	$2,160	$8,280
Box Base Manhole	1	EA	$4,000	$1,000	$4,000	$1,000	$5,000
Grasslined channel	7600	LF	$5	$15	$38,000	$114,000	$152,000
3' X 3' Intercepting Inlet	2	EA	$1,500	$500	$3,000	$1,000	$4,000
Headwalls	21	EA	$400	$400	$8,400	$8,400	$16,800
Total Estimated Construction Cost					$66,180	$128,460	$194,640
Engineering and Contingency (20%)					$13,236	$25,692	$38,928
Total Estimated Cost					$79,416	$154,152	$233,568



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

8

COMMENTARY SHEET 9

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 100 to 142 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin contains residential and agricultural areas. Portions of this area contain inadequate roadside ditches and other parts have no facilities at all. There are no ditches along 29th Lane and there are power poles located along the westerly edge.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff to historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of a storm sewer outfall system to serve areas south of Santa Fe Drive. Local drainage will be intercepted with collection inlets in the ditches and in sump areas. Any future development shall provide a suitable connection to the outfall facility and maintain runoff to historic conditions. A lateral system will extend west in Gale Road to provide an outfall for an area lying west of 28th Lane. The ditch and culverts will be improved along the eastern portion of Everett Road and will be intercepted at 29th Lane by the outfall system.

FLOW PATH: 30th Lane **DRAINAGE BASINS:** 30th Lane

5-YEAR DESIGN: 26 to 63 cfs

EXISTING CONDITIONS:

This portion of the 30th Lane Basin contains residential and agricultural uses. The existing drainage facilities include insufficient roadside ditches with culverts.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of improving the insufficient ditches and culverts in Gale and Everett Roads. A storm sewer is proposed along 30th Lane and a portion of Everett Road to convey runoff collected by the improved ditches to outfall at a natural ravine north of Everett Road. The storm sewer will be located in the ditch line area so that runoff from the low areas below the roads can be intercepted.

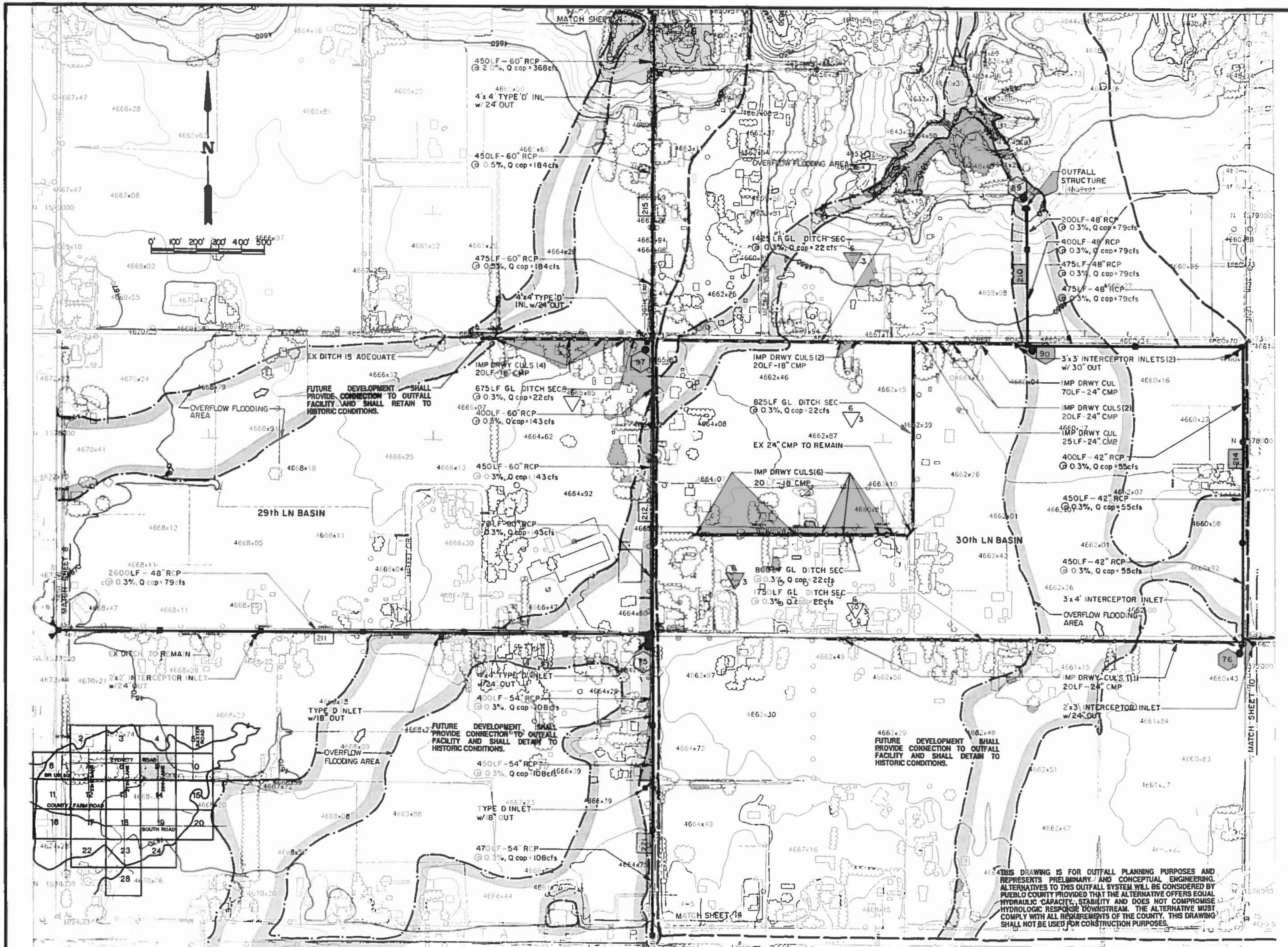
Preliminary Design Cost Estimate Sheet 9

30th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
48" RCP	1550	LF	$68	$18	$105,400	$27,900	$133,300
42" RCP	1300	LF	$60	$15	$78,000	$19,500	$97,500
30" CMP	40	LF	$29	$10	$1,160	$400	$1,560
24" CMP	375	LF	$22	$6	$8,250	$2,250	$10,500
18" CMP	160	LF	$17	$6	$2,720	$960	$3,680
Box Base Manhole	4	EA	$4,000	$1,000	$16,000	$4,000	$20,000
Manhole	2	EA	$2,000	$500	$4,000	$1,000	$5,000
4' x 3' Intercepting Inlet	1	EA	$2,500	$800	$2,500	$800	$3,300
3' x 3' Intercepting Inlet	2	EA	$1,500	$500	$3,000	$1,000	$4,000
2' x 3' Intercepting Inlet	1	EA	$1,400	$500	$1,400	$500	$1,900
Outfall Structure	1	EA	$25,000	$10,000	$25,000	$10,000	$35,000
Grasslined channel	4800	LF	$5	$15	$24,000	$72,000	$96,000
Headwalls	23	EA	$400	$400	$9,200	$9,200	$18,400
Total Estimated Construction Cost					$280,630	$149,510	$430,140
Engineering and Contingency (20%)					$56,126	$29,902	$86,028
Total Estimated Cost					$336,756	$179,412	$516,168

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
60" RCP	2695	LF	$116	$24	$312,620	$64,680	$377,300
54" RCP	1320	LF	$78	$24	$102,960	$31,680	$134,640
48" RCP	2600	LF	$68	$15	$176,800	$39,000	$215,800
24" CMP	80	LF	$22	$6	$1,760	$480	$2,240
18" CMP	120	LF	$17	$6	$2,040	$720	$2,760
Box Base Mnahole	14	EA	$4,000	$1,000	$56,000	$14,000	$70,000
2' x 2' Intercepting Inlet	1	EA	$1,200	$500	$1,200	$500	$1,700
2' x 3' Intercepting Inlet	3	EA	$1,400	$500	$4,200	$1,500	$5,700
Type D Inlet	2	EA	$1,500	$500	$3,000	$1,000	$4,000
Grasslined channel	675	LF	$5	$15	$3,375	$10,125	$13,500
Headwalls	4	EA	$400	$400	$1,600	$1,600	$3,200
Total Estimated Construction Cost					$665,555	$165,285	$830,840
Engineering and Contingency (20%)					$133,111	$33,057	$166,168
Total Estimated Cost					$798,666	$198,342	$997,008



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

9

COMMENTARY SHEET 10

FLOW PATH: 30th Lane **DRAINAGE BASINS:** 30th Lane

5-YEAR DESIGN: 55 cfs

EXISTING CONDITIONS:

This portion of the 30th Lane Basin contains residential and agricultural areas. This area contains inadequate roadside ditches and culverts along Gale Road. There is no outlet facility at the intersection of Gale Road and 30th Lane.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

The proposed improvement is an upgraded ditch section with improved culverts along Gale Road. The ditch will be intercepted by a storm sewer outfall system in 30th Lane.

FLOW PATH: Baxter Road **DRAINAGE BASINS:** Baxter Road

5-YEAR DESIGN: 45 to 142 cfs

EXISTING CONDITIONS:

This portion of the Baxter Road Basin contains residential and agricultural uses. The existing drainage facilities include roadside ditches with culverts, and streets with curb and gutter.

The ditches along Baxter Road near Gale and Everett Roads are inadequate, along with those along Everett and Gale Roads.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of improving the insufficient ditches and culverts in Baxter, Gale and Everett Roads. Curb, gutter, pavement and drainage facilities are proposed along Ford Road east of Baxter Road to convey runoff.

A local storm sewer with inlets is proposed at the intersection of Daniels Road and Consolidation Drive. This system will outfall to the Arkansas River. A drainage easement may be needed between Daniels Road and the outfall point at the River.

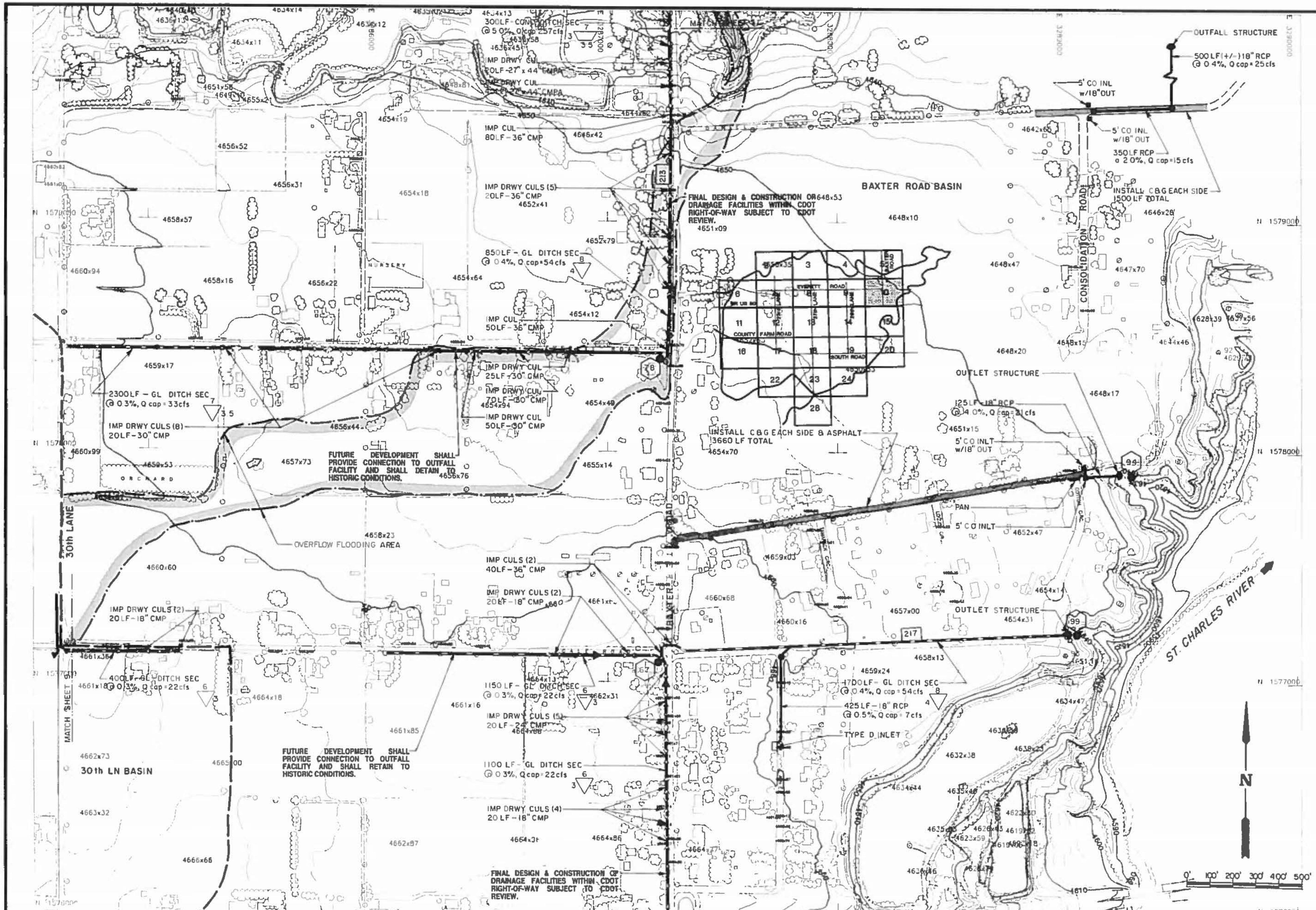
Preliminary Design Cost Estimate Sheet 10

30th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
18" CMP	40	LF	$17	$6	$680	$240	$920
Grasslined channel	400	LF	$5	$15	$2,000	$6,000	$8,000
Headwalls	2	EA	$400	$400	$800	$800	$1,600
Total Estimated Construction Cost					$3,480	$7,040	$10,520
Engineering and Contingency (20%)					$696	$1,408	$2,104
Total Estimated Cost					$4,176	$8,448	$12,624

Baxter Road Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
36" CMP	310	LF	$46	$10	$14,260	$3,100	$17,360
30" CMP	305	LF	$29	$10	$8,845	$3,050	$11,895
27" x 44" CMPA	60	LF	$55	$12	$3,300	$720	$4,020
24" CMP	100	LF	$22	$6	$2,200	$600	$2,800
18" RCP	1470	LF	$20	$6	$29,400	$8,820	$38,220
18" CMP	120	LF	$17	$6	$2,040	$720	$2,760
5' CO inlet	4	EA	$2,500	$800	$10,000	$3,200	$13,200
Type D inlet	1	EA	$2,500	$800	$2,500	$800	$3,300
5' Manhole	3	EA	$2,000	$500	$6,000	$1,500	$7,500
Cross-pan	180	SF	$8	$2	$1,440	$360	$1,800
Grasslined channel	2250	LF	$5	$15	$11,250	$33,750	$45,000
Grasslined channel	2300	LF	$5	$15	$11,500	$34,500	$46,000
Grasslined channel	2550	LF	$5	$15	$12,750	$38,250	$51,000
Concrete channel	300	LF	$50	$50	$15,000	$15,000	$30,000
Headwalls	33	EA	$400	$400	$13,200	$13,200	$26,400
Paving	6510	SY	$4	$4	$26,040	$26,040	$52,080
Curb and gutter	4410	LF	$4	$2	$17,640	$8,820	$26,460
Outfall structures	3	EA	$25,000	$10,000	$75,000	$30,000	$105,000
Total Estimated Construction Cost					$262,365	$222,430	$484,795
Engineering and Contingency (20%)					$52,473	$44,486	$96,959
Total Estimated Cost					$314,838	$266,916	$581,754



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94·01·01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

10

COMMENTARY SHEET 11

FLOW PATH: Aspen Circle **DRAINAGE BASINS:** Roselawn

5-YEAR DESIGN: 31 cfs

EXISTING CONDITIONS:

This portion of the Roselawn Basin includes the Roselawn Cemetery and smaller areas of residential and commercial use near Santa Fe Drive. The basin drainage characteristics include shallow sheet flow through the Cemetery and into the existing curbed streets. The drainage concentrates in a low spot at Santa Fe Drive and Carson Street.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential development. Future development shall be required to provide onsite detention to maintain flows to historic levels.

PROPOSED IMPROVEMENTS:

A storm sewer system of piping and inlets is proposed within the curbed areas to control runoff in this area. The system will intercept a portion of the flow before it reaches the low spot in Santa Fe Drive and will provide collection points at the low spot. The storm sewer begins at the intersection of Liberty Drive and Delta Street, continues into Santa Fe Drive (State Highway right-of-way), and heads northerly in Aspen Circle.

The Bessemer Ditch stormwater separation structure is proposed west of the Aspen Street intersection with the Ditch. This structure will reduce the flow in the Bessemer Ditch which enters the St. Charles Mesa basin to the maximum irrigation flow. Details of this structure are presented on Sheet 30 of the design plans.

FLOW PATH: 21st Lane **DRAINAGE BASINS:** 21st Lane

5-YEAR DESIGN RANGE: 20 to 131 cfs

EXISTING CONDITIONS:

This portion of the 21st Lane Basin contains residential and agricultural uses. The existing drainage facilities include areas of curbed streets, and roadside ditches with culverts. The roadside ditches and culverts along 20th and 21st Lanes are undersized which leads to ditch overtopping and areas of flooding. The existing culvert under Santa Fe Drive (State Highway right-of-way) is also undersized and contributes to ditch overtopping.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff to historic conditions.

PROPOSED IMPROVEMENTS:

The proposed improvements include ditch and culvert upgrades in conjunction with a storm sewer outfall system along 21st Lane. Ditch and culvert upgrades extend from County Farm Road to Hillside Road. The storm sewer begins at Zinno Blvd. and continues north in 21st Lane to Santa Fe Drive. The existing ditch along 21st Lane will remain to collect street and local drainage. At the time of any future development, the ditch should be eliminated with curb and gutter installed along 21st Lane. A lateral storm sewer system extends to 20th Lane in Santa Fe Drive (State Highway right-of-way). Upgraded ditch and culverts are proposed along 20th Lane from County Farm Road to Santa Fe Drive.

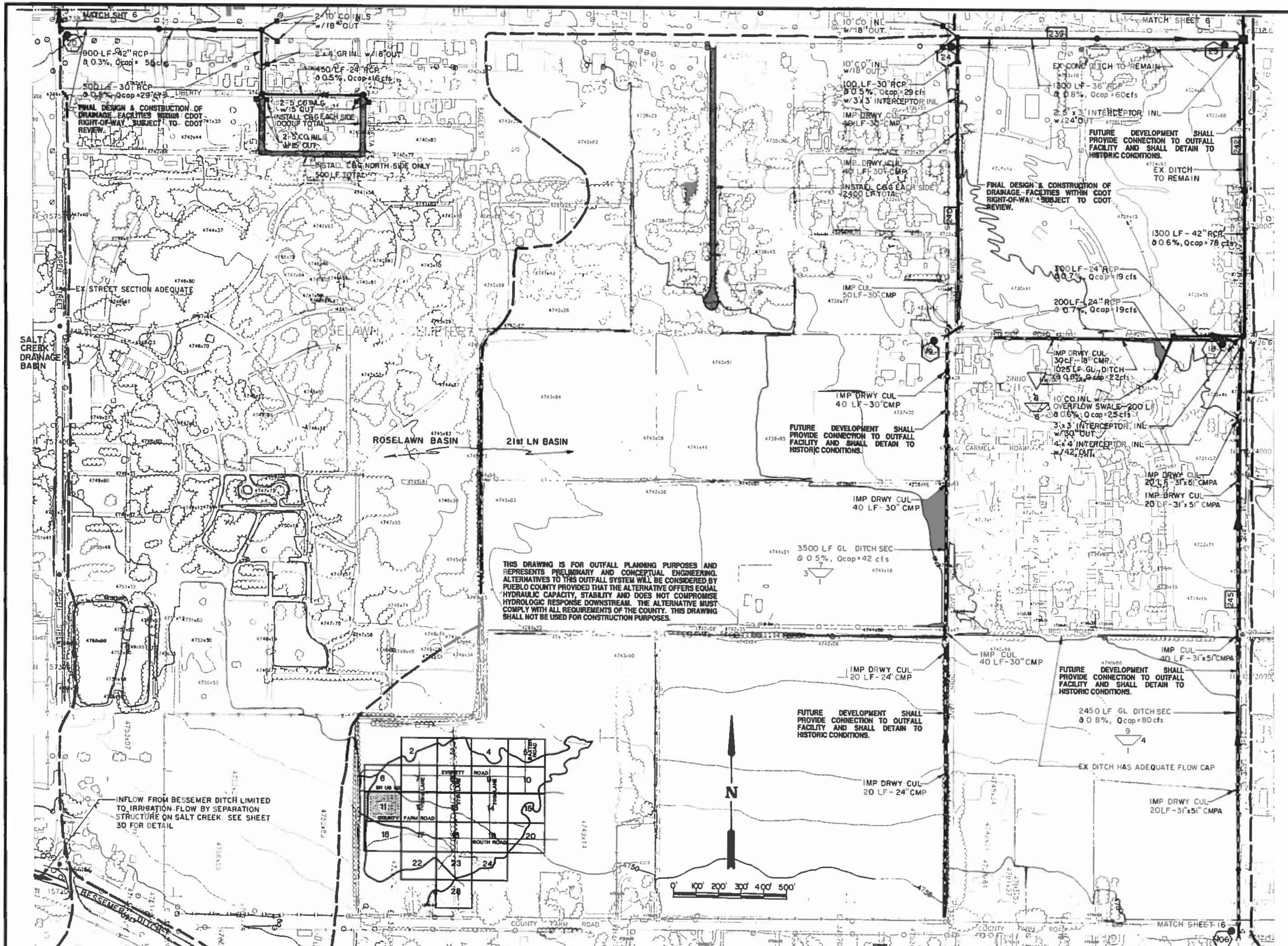
Preliminary Design Cost Estimate Sheet 11

21st Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
31" X 51" CMPA	100	LF	$60	$18	$6,000	$1,800	$7,800
42" RCP	1340	LF	$60	$15	$80,400	$20,100	$100,500
36" RCP	1300	LF	$46	$10	$59,800	$13,000	$72,800
30" RCP	100	LF	$38	$10	$3,800	$1,000	$4,800
30" CMP	270	LF	$29	$10	$7,830	$2,700	$10,530
24" CMP	60	LF	$22	$6	$1,320	$360	$1,680
24" RCP	500	LF	$25	$6	$12,500	$3,000	$15,500
18" CMP	70	LF	$17	$6	$1,190	$420	$1,610
Box Base Manhole	1	EA	$4,000	$1,000	$4,000	$1,000	$5,000
Manhole	5	EA	$2,000	$500	$10,000	$2,500	$12,500
4' x 4' Intercepting Inlet	1	EA	$2,500	$800	$2,500	$800	$3,300
3' x 3' Intercepting Inlet	2	EA	$1,500	$500	$3,000	$1,000	$4,000
2.5' x 3' Intercepting Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
10' CO Inlet	3	EA	$3,000	$1,000	$9,000	$3,000	$12,000
Pavement Replacement	3600	SY	$15	$5	$54,000	$18,000	$72,000
Grasslined channel	4525	LF	$5	$15	$22,625	$67,875	$90,500
Grasslined channel	2650	LF	$5	$15	$13,250	$39,750	$53,000
Curb and gutter	2400	LF	$4	$2	$9,600	$4,800	$14,400
Headwalls	13	EA	$400	$400	$5,200	$5,200	$10,400
Total Estimated Construction Cost					$307,515	$186,805	$494,320
Engineering and Contingency (20%)					$61,503	$37,361	$98,864
Total Estimated Cost					$369,018	$224,166	$593,184

Aspen Street/Roselawn Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
42" RCP	900	LF	$60	$18	$54,000	$16,200	$70,200
30" RCP	300	LF	$38	$10	$11,400	$3,000	$14,400
24" RCP	450	LF	$25	$6	$11,250	$2,700	$13,950
18" CMP	60	LF	$17	$6	$1,020	$360	$1,380
15" CMP	40	LF	$15	$6	$600	$240	$840
Manhole	5	EA	$2,000	$500	$10,000	$2,500	$12,500
10' CO Inlet	2	EA	$3,000	$1,000	$6,000	$2,000	$8,000
5' CO Inlet	4	EA	$2,500	$800	$10,000	$3,200	$13,200
Curb and Gutter	1600	LF	$4	$2	$6,400	$3,200	$9,600
Pavement Replacement	2250	SY	$15	$5	$33,750	$11,250	$45,000
Bessemer Separation struc	1	EA	$25,000	$15,000	$25,000	$15,000	$40,000
2' x 4' Grated Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
Total Estimated Construction Cost					$170,920	$60,150	$231,070
Engineering and Contingency (20%)					$34,184	$12,030	$46,214
Total Estimated Cost					$205,104	$72,180	$277,284



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

11

COMMENTARY SHEET 12

FLOW PATH: 23rd Lane **DRAINAGE BASINS:** 23rd Lane

5-YEAR DESIGN: 31 to 100 cfs

EXISTING CONDITIONS:

This portion of the 23rd Lane Basin is mostly residential with numerous agricultural areas. The existing drainage facilities include roadside ditches with culverts. Some ditches are inadequate and some smaller areas lack suitable outfall facilities.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements along 23rd Lane consist of a storm sewer system to convey upper basin flows and intercept local flows at major intersections. The existing roadside ditches will be used for local drainage Suitable outfall facilities are proposed for the smaller areas.

FLOW PATH: 25th Lane **DRAINAGE BASINS:** 25th Lane

5-YEAR DESIGN: 38 to 127 cfs

EXISTING CONDITIONS:

This portion of the 25th Lane Basin is mostly residential with small agricultural areas. The existing drainage facilities include roadside ditches with culverts and unsuitable outfalls for smaller areas. Existing facilities along 25th Lane are inadequate for upper basin flows.

There is an existing detention pond located near Iris Road and 25th Lane which will remain.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

The proposed improvements along 25th Lane consist of a storm sewer system to convey upper basin flows and intercept local flows at major intersections. The existing roadside ditches will be used for local drainage. Suitable outfall facilities are proposed for the smaller areas.

The system will have to cross Santa Fe Drive which is State Highway Right-of-way.

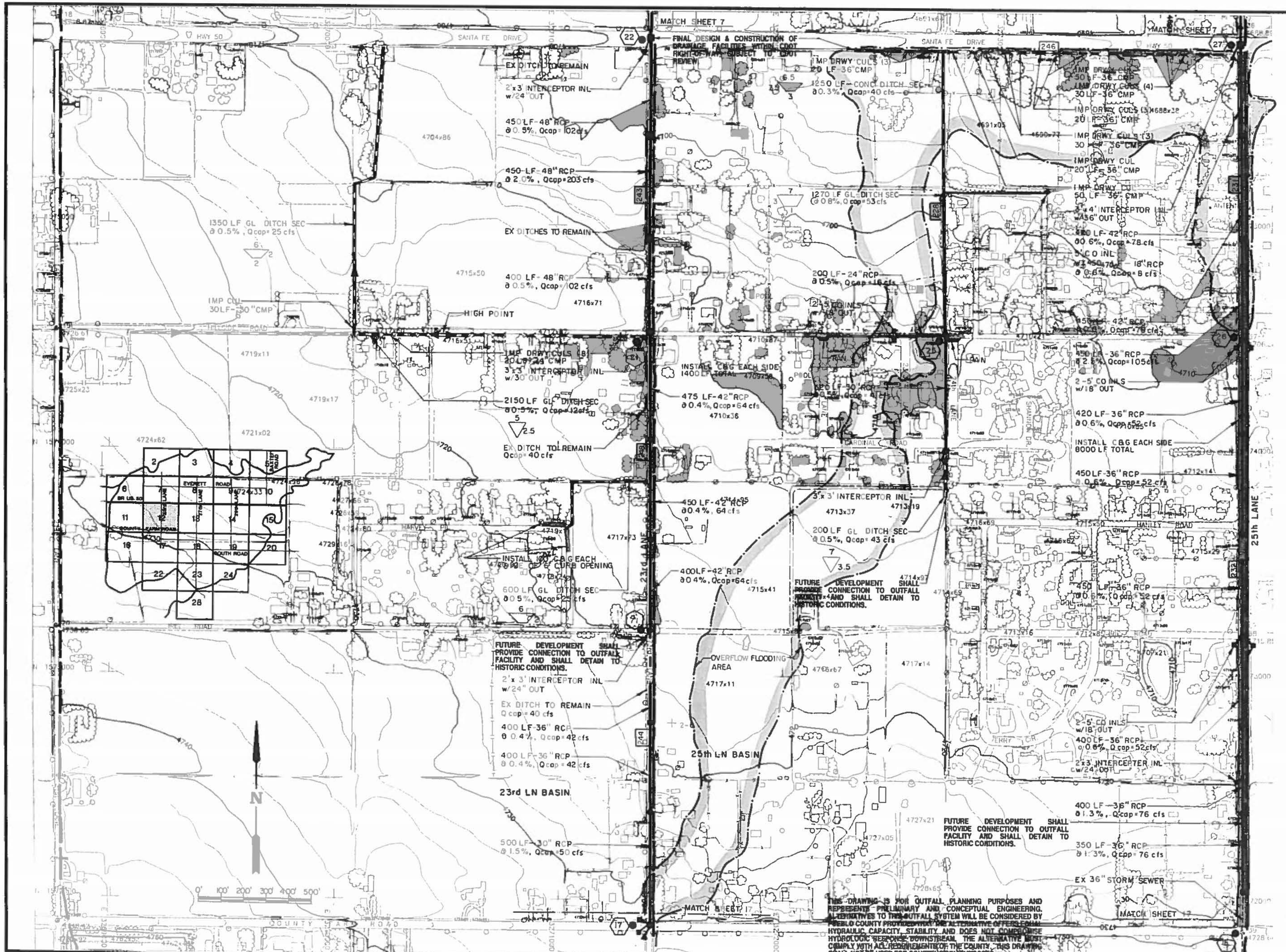
Preliminary Design Cost Estimate Sheet 12

23rd Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
48" RCP	1300	LF	$68	$18	$88,400	$23,400	$111,800
42" RCP	1325	LF	$60	$15	$79,500	$19,875	$99,375
36" RCP	800	LF	$46	$10	$36,800	$8,000	$44,800
30" RCP	500	LF	$38	$10	$19,000	$5,000	$24,000
30" CMP	50	LF	$29	$10	$1,450	$500	$1,950
24" CMP	220	LF	$22	$6	$4,840	$1,320	$6,160
Box Base Manhole	4	EA	$4,000	$1,000	$16,000	$4,000	$20,000
Manhole	5	EA	$2,000	$500	$10,000	$2,500	$12,500
2' x 3' Intercepting Inlet	2	EA	$1,400	$500	$2,800	$1,000	$3,800
3' x 3' Intercepting Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
Grasslined channel	4100	LF	$5	$15	$20,500	$61,500	$82,000
Pavement Replacement	4350	SY	$15	$5	$65,250	$21,750	$87,000
Curb and Gutter	200	LF	$4	$2	$800	$400	$1,200
Headwalls	9	EA	$400	$400	$3,600	$3,600	$7,200
Total Estimated Construction Cost					$350,440	$153,345	$503,785
Engineering and Contingency (20%)					$70,088	$30,669	$100,757
Total Estimated Cost					$420,528	$184,014	$604,542

25th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
42" RCP	970	LF	$60	$18	$58,200	$17,460	$75,660
36" RCP	2920	LF	$46	$10	$134,320	$29,200	$163,520
36" CMP	470	LF	$35	$10	$16,450	$4,700	$21,150
30" RCP	520	LF	$38	$10	$19,760	$5,200	$24,960
24" RCP	240	LF	$25	$6	$6,000	$1,440	$7,440
18" RCP	570	LF	$20	$6	$11,400	$3,420	$14,820
Manhole	9	EA	$2,000	$500	$18,000	$4,500	$22,500
Box Base Manhole	1	EA	$4,000	$1,000	$4,000	$1,000	$5,000
5' CO Inlet	7	EA	$2,500	$800	$17,500	$5,600	$23,100
3' x 4' Grated Inlet	1	EA	$2,000	$700	$2,000	$700	$2,700
3' x 3' Grated Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
3' x 2' Grated Inlet	2	EA	$1,400	$500	$2,800	$1,000	$3,800
Pavement Replacement	4330	SY	$15	$5	$64,950	$21,650	$86,600
Paving	4530	SY	$4	$4	$18,120	$18,120	$36,240
Curb and gutter	1400	LF	$4	$2	$5,600	$2,800	$8,400
Cross pan	400	SF	$8	$2	$3,200	$800	$4,000
Headwalls	16	EA	$400	$400	$6,400	$6,400	$12,800
Concrete channel	1250	LF	$50	$50	$62,500	$62,500	$125,000
Grasslined channel	1470	LF	$5	$15	$7,350	$22,050	$29,400
Total Estimated Construction Cost					$460,050	$209,040	$669,090
Engineering and Contingency (20%)					$92,010	$41,808	$133,818
Total Estimated Cost					$552,060	$250,848	$802,908



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94-01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

12

COMMENTARY SHEET 13

FLOW PATH: 27th Lane **DRAINAGE BASINS:** 27th Lane

5-YEAR DESIGN: 64 to 112 cfs

EXISTING CONDITIONS:

This portion of the 27th Lane Basin contains residential and agricultural areas. The existing drainage facilities include roadside ditches with culverts, and streets with curb and gutter. The ditch along 27th Lane is insufficient for upper basin flows. Hillside and Iris roads both have insufficient capacity ditches and culverts.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential and commercial uses. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of improving the culverts along 27th Lane from Iris Road to Hillside Road. A storm sewer outfall system begins at Hillside Road and continues northerly in 27th Lane. The ditch sections and culverts will be upgraded along Iris and Hillside roads.

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 47 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin contains residential and agricultural uses. The existing drainage facilities include streets with curb and gutter, and roadside ditches.

The major outfall for this area is the low ground in between 27th and 28th Lanes. Currently there are no facilities in this area.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential and commercial uses. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of providing facilities through the low areas from County Farm Road to Santa Fe Drive. Curb and gutter is proposed along the south side of Hillside with a storm sewer to direct flow to a low spot near Toltec Gorge Lane. A new concrete channel is proposed along Santa Fe Drive (State Highway right-of-way) to convey the runoff easterly.

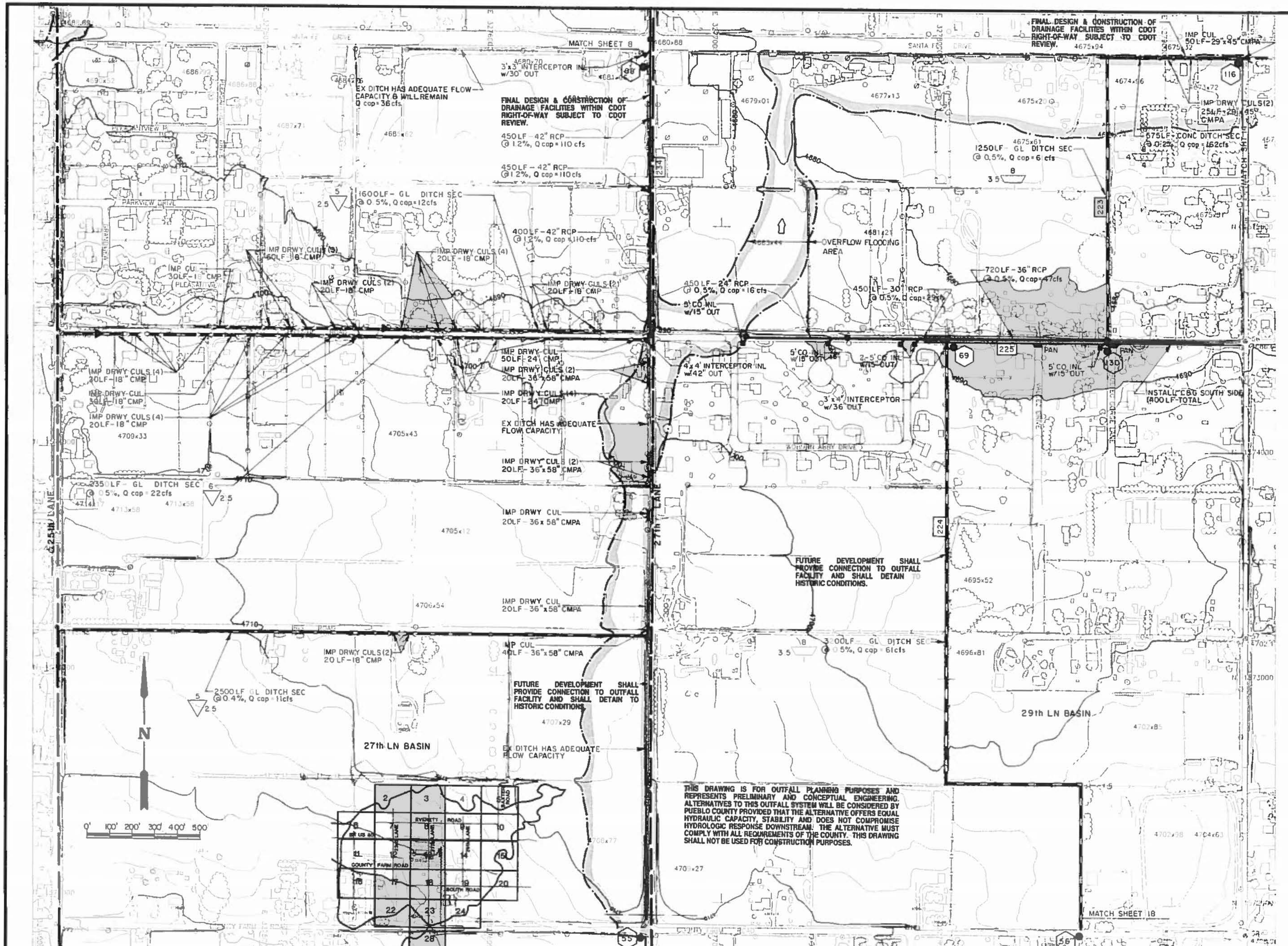
Preliminary Design Cost Estimate Sheet 13

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
36" RCP	720	LF	$46	$10	$33,120	$7,200	$40,320
29" x 45" CMPA	100	LF	$59	$12	$5,900	$1,200	$7,100
30" RCP	450	LF	$38	$10	$17,100	$4,500	$21,600
24" RCP	450	LF	$25	$6	$11,250	$2,700	$13,950
15" CMP	80	LF	$15	$6	$1,200	$480	$1,680
Manhole	2	EA	$2,000	$500	$4,000	$1,000	$5,000
3' x 4' Intercepting Inlet	1	EA	$2,000	$700	$2,000	$700	$2,700
5' CO Inlet	5	EA	$2,500	$800	$12,500	$4,000	$16,500
Grasslined channel	4450	LF	$5	$15	$22,250	$66,750	$89,000
Concrete channel	575	LF	$60	$60	$34,500	$34,500	$69,000
Curb and Gutter	1400	LF	$4	$2	$5,600	$2,800	$8,400
Cross pan	400	SF	$8	$2	$3,200	$800	$4,000
Headwalls	3	EA	$400	$400	$1,200	$1,200	$2,400
Total Estimated Construction Cost					$153,820	$127,830	$281,650
Engineering and Contingency (20%)					$30,764	$25,566	$56,330
Total Estimated Cost					$184,584	$153,396	$337,980

27th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
42" CMP	1320	LF	$42	$15	$55,440	$19,800	$75,240
24" CMP	130	LF	$22	$6	$2,860	$780	$3,640
18" CMP	600	LF	$17	$6	$10,200	$3,600	$13,800
30" CMP	20	LF	$29	$10	$580	$200	$780
36" X 58" CMPA	160	LF	$52	$18	$8,320	$2,880	$11,200
3' X 3' Intercepting Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
4' X 4' Intercepting Inlet	1	EA	$2,500	$800	$2,500	$800	$3,300
Grasslined channel	2350	LF	$5	$15	$11,750	$35,250	$47,000
Grasslined channel	3900	LF	$5	$15	$19,500	$58,500	$78,000
5' Manhole	3	EA	$2,000	$500	$6,000	$1,500	$7,500
Headwalls	35	EA	$400	$400	$14,000	$14,000	$28,000
Total Estimated Construction Cost					$132,650	$137,810	$270,460
Engineering and Contingency (20%)					$26,530	$27,562	$54,092
Total Estimated Cost					$159,180	$165,372	$324,552



Kiowa Engineering Corporation

419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

13

COMMENTARY SHEET 14

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 25 to 100 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin contains residential and agricultural areas. The existing roadside ditch and culverts along 29th Lane are inadequate for upper basin flows

The existing roadside ditches along Hillside Road and Santa Fe Drive are also inadequate.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of improving the ditches and culverts along Hillside Road, Iris Road and Santa Fe Drive (State Highway right-of-way). A storm sewer outfall system begins at the intersection of 29th Lane and Iris Road to convey runoff to the north. The existing roadside ditch along 29th Lance from Iris Road to Hillside Road will remain to collect street and local runoff. At the time of future development, the ditch can be eliminated and curb and gutter installed along 29th Lane. The existing ditch and culverts from Hillside Road to Santa Fe Drive shall be eliminated and curb and gutter installed along 29th Lane.

FLOW PATH: Santa Fe Drive **DRAINAGE BASINS:** Santa Fe

5-YEAR DESIGN: 26 to 63 cfs

EXISTING CONDITIONS:

This portion of the Santa Fe Drive Basin contains residential and agricultural uses. The existing drainage facilities include roadside ditches with culverts, insufficient in some areas. Some low areas have insufficient capacity outfall facilities.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of improving the insufficient ditch and culvert areas, and providing suitable outfalls for the low areas.

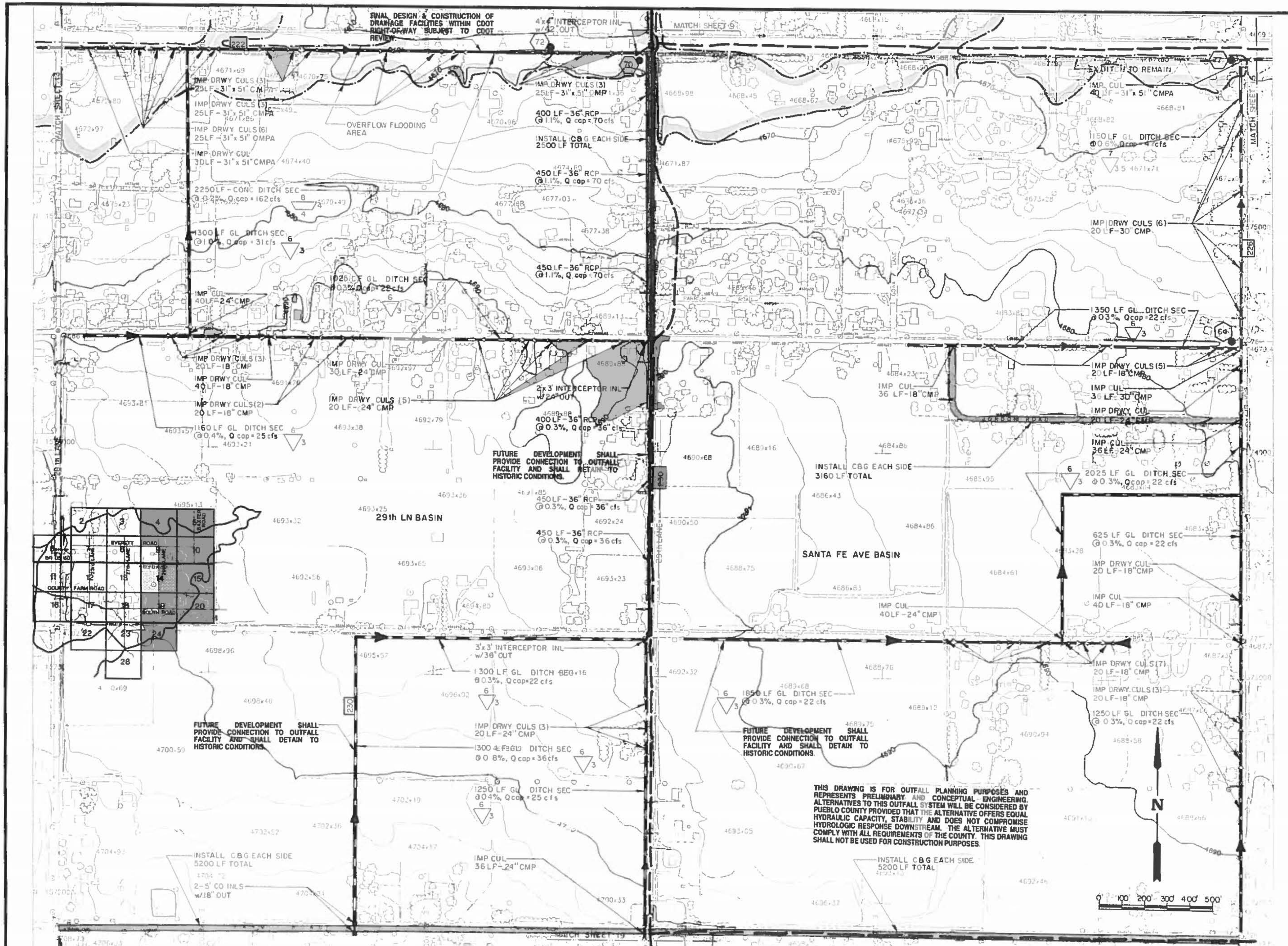
Preliminary Design Cost Estimate Sheet 14

Santa Fe Avenue Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
30" CMP	156	LF	$29	$10	$4,524	$1,560	$6,084
31" x 51" CMPA	40	LF	$60	$18	$2,400	$720	$3,120
24" CMP	76	LF	$22	$6	$1,672	$456	$2,128
18" CMP	376	LF	$17	$6	$6,392	$2,256	$8,648
Grasslined channel	7100	LF	$5	$15	$35,500	$106,500	$142,000
Grasslined channel	1150	LF	$5	$15	$5,750	$17,250	$23,000
Curb and Gutter	8360	LF	$4	$2	$33,440	$16,720	$50,160
Headwalls	28	EA	$400	$400	$11,200	$11,200	$22,400
Total Estimated Construction Cost					$100,878	$156,662	$257,540
Engineering and Contingency (20%)					$20,176	$31,332	$51,508
Total Estimated Cost					$121,054	$187,994	$309,048

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
42" CMP	20	LF	$42	$10	$840	$200	$1,040
36" CMP	20	LF	$35	$10	$700	$200	$900
36" RCP	2600	LF	$46	$10	$119,600	$26,000	$145,600
18" CMP	140	LF	$17	$6	$2,380	$840	$3,220
24" CMP	286	LF	$22	$6	$6,292	$1,716	$8,008
31" x 51" CMPA	405	LF	$60	$18	$24,300	$7,290	$31,590
2' x 3' Intercepting inlet	1	EA	$1,400	$500	$1,400	$500	$1,900
3' x 3' Intercepting inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
4' x 4' Intercepting Inlet	1	EA	$2,500	$800	$2,500	$800	$3,300
5' CO Inlet	2	EA	$2,500	$800	$5,000	$1,600	$6,600
Box Base Manhole	1	EA	$4,000	$1,000	$4,000	$1,000	$5,000
5' manhole	6	EA	$2,000	$500	$12,000	$3,000	$15,000
Grasslined channel	7335	LF	$5	$15	$36,675	$110,025	$146,700
Concrete channel	2250	LF	$50	$50	$112,500	$112,500	$225,000
Pavement Replacement	3450	SY	$15	$5	$51,750	$17,250	$69,000
Curb and gutter	7700	LF	$4	$2	$30,800	$15,400	$46,200
Headwalls	33	EA	$400	$400	$13,200	$13,200	$26,400
Total Estimated Construction Cost					$425,437	$312,021	$737,458
Engineering and Contingency (20%)					$85,087	$62,404	$147,492
Total Estimated Cost					$510,524	$374,425	$884,950



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 15

FLOW PATH: Santa Fe Drive **DRAINAGE BASINS:** Santa Fe

5-YEAR DESIGN: 63 to 80 cfs

EXISTING CONDITIONS:

This portion of the Santa Fe Basin is mostly residential development. Existing drainage patterns include roadside ditches. The ditch along the western portion Santa Fe Drive is inadequate for upper basin flows.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

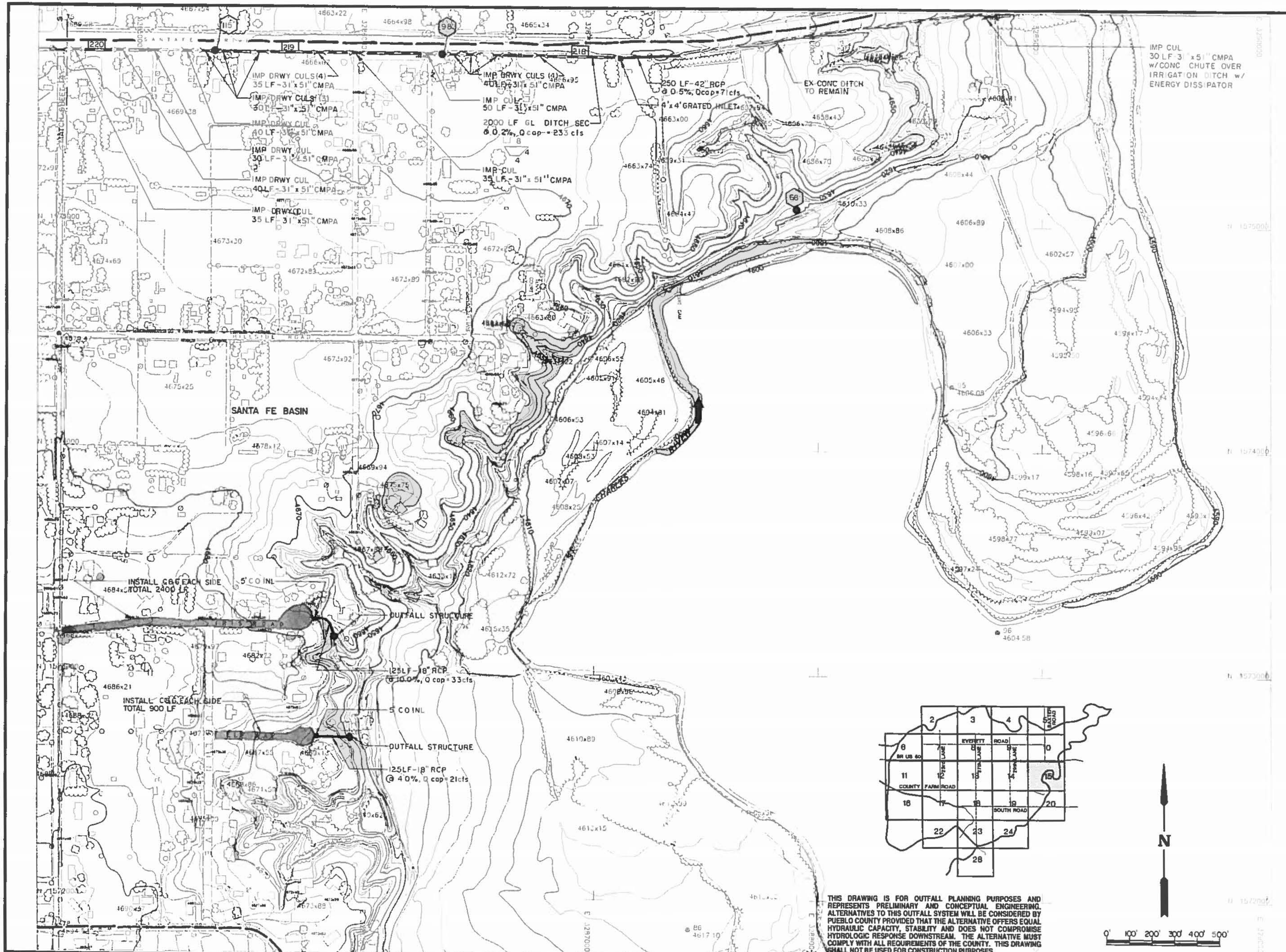
PROPOSED IMPROVEMENTS:

An improved ditch is proposed along the western portion Santa Fe Drive. Curb and gutter is proposed along Elf Way and Iris Road to help convey runoff.

Preliminary Design Cost Estimate Sheet 15

Santa Fe Drive Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
42" RCP	250	LF	$42	$15	$10,500	$3,750	$14,250
31" x 51" CMPA	650	LF	$60	$18	$39,000	$11,700	$50,700
18" CMP	250	LF	$17	$6	$4,250	$1,500	$5,750
Grasslined channel	2000	LF	$5	$15	$10,000	$30,000	$40,000
4' X 4' Grated Inlet	1	EA	$2,500	$800	$2,500	$800	$3,300
5' CO Inlet	2	EA	$2,500	$800	$5,000	$1,600	$6,600
Curb and Gutter	3300	LF	$4	$2	$13,200	$6,600	$19,800
Paving	5600	SY	$4	$4	$22,400	$22,400	$44,800
Energy dissapator	1	EA	$6,000	$6,000	$6,000	$6,000	$12,000
Outfall Structures	2	EA	$25,000	$10,000	$50,000	$20,000	$70,000
Headwalls	18	EA	$400	$400	$7,200	$7,200	$14,400
Total Estimated Construction Cost					$170,050	$111,550	$281,600
Engineering and Contingency (20%)					$34,010	$22,310	$56,320
Total Estimated Cost					$204,060	$133,860	$337,920



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94.01.01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

15

COMMENTARY SHEET 16

FLOW PATH: Bessemer Ditch　　**DRAINAGE BASINS:** Bessemer

5-YEAR FLOW RANGE: 16 to 42 cfs
100-YEAR FLOW RANGE: 89 to 400 cfs

EXISTING CONDITIONS:

This portion of the Bessemer Basin is largely undeveloped, with small areas of residential development along La Salle Road. The undeveloped areas include agricultural and open space uses. Existing drainage patterns consist of numerous areas of sheetflow into the Bessemer Ditch with shallow ponding in various low areas south of La Salle Road.

FUTURE CONDITIONS:

Future land use is not anticipated to change from the present conditions.

PROPOSED IMPROVEMENTS:

A system of roadside ditches and curb and gutter, along La Salle Road, will be used to direct the drainage to various low spots. These low spots will be used as collection points and a small storm sewer system will convey the drainage to the Bessemer Ditch. This system will alleviate the ponding areas along La Salle Road.

FLOW PATH: 21st Lane　　**DRAINAGE BASINS:** 21st Lane

5-YEAR DESIGN: 69 cfs

EXISTING CONDITIONS:

This portion of the 21st Lane Basin primarily contains residential development. The existing drainage facilities include roadside ditches, driveway culverts and curb and gutter along County Farm Road. The existing system along 21st has undersized culverts which triggers ditch overtopping.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of ditch and driveway culvert upgrades along 21st Lane.

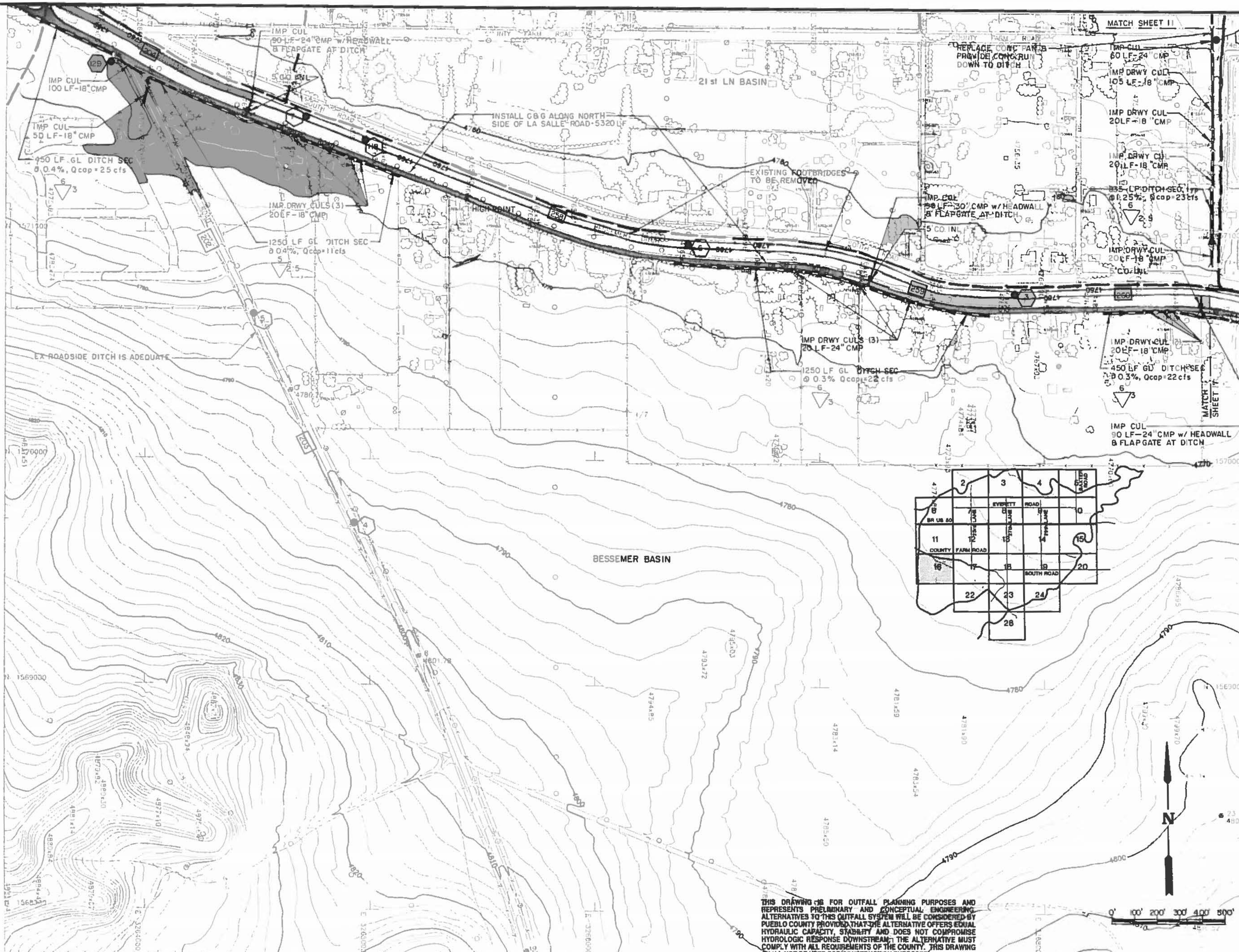
Preliminary Design Cost Estimate Sheet 16

21st Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
24" CMP	60	LF	$22	$6	$1,320	$360	$1,680
18" CMP	165	LF	$17	$6	$2,805	$990	$3,795
Grasslined channel	835	LF	$15	$15	$12,525	$12,525	$25,050
Concrete rundown	1	EA	$5,000	$5,000	$5,000	$5,000	$10,000
Concrete Cross pan	200	SF	$8	$2	$1,600	$400	$2,000
Headwalls	5	EA	$400	$400	$2,000	$2,000	$4,000
Total Estimated Construction Cost					$25,250	$21,275	$46,525
Engineering and Contingency (20%)					$5,050	$4,255	$9,305
Total Estimated Cost					$30,300	$25,530	$55,830

Bessemer Ditch Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
30" CMP	90	LF	$29	$10	$2,610	$900	$3,510
24" CMP	240	LF	$22	$6	$5,280	$1,440	$6,720
18" CMP	270	LF	$17	$6	$4,590	$1,620	$6,210
Ditch Headwall	3	EA	$800	$800	$2,400	$2,400	$4,800
Flap Gates	3	EA	$700	$400	$2,100	$1,200	$3,300
5' CO Inlet	3	EA	$2,500	$800	$7,500	$2,400	$9,900
Grasslined channel	2150	LF	$5	$15	$10,750	$32,250	$43,000
Grasslined channel	1250	LF	$5	$15	$6,250	$18,750	$25,000
Curb and Gutter	5320	LF	$4	$2	$21,280	$10,640	$31,920
Paving	2365	SY	$4	$4	$9,460	$9,460	$18,920
Headwalls	14	EA	$400	$400	$5,600	$5,600	$11,200
Total Estimated Construction Cost					$77,820	$86,660	$164,480
Engineering and Contingency (20%)					$15,564	$17,332	$32,896
Total Estimated Cost					$93,384	$103,992	$197,376



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 17

FLOW PATH: Bessemer Ditch **DRAINAGE BASINS:** Bessemer

5-YEAR FLOW RANGE: 18 to 91 cfs
100-YEAR FLOW RANGE: 178 to 432 cfs

EXISTING CONDITIONS:

This portion of the Bessemer Basin is mainly residential development with some large open space areas. Existing drainage patterns include roadside ditches and culverts in some areas with minimal outfall facilities into the Bessemer Ditch. La Salle Road and Lombard Avenue both contain low areas which experience shallow ponding.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

A system of roadside ditches, small storm sewer systems, unlined ditches and curbed streets will be used to direct the drainage to the Bessemer Ditch. The north side of LaSalle Road will be curb and guttered and inlets will be placed in the low spots to intercept street runoff. The ditches and culverts on the south side of LaSalle Road will be improved to drain the low areas. These low areas will be outfalled to the Bessemer Ditch.

FLOW PATH: 23rd Lane **DRAINAGE BASINS:** 23rd Lane

5-YEAR DESIGN: 64 cfs

EXISTING CONDITIONS:

This portion of the 23rd Lane Basin contains residential and agricultural areas. The existing drainage facilities include roadside ditches with culverts and curb and gutter along County Farm Road. The ditch along 23rd Lane south of County Farm Road is adequate but the culverts are undersized which causes ditch overtopping. North of County Farm Road the ditch is undersized.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of culvert upgrades along 23rd Lane south of County Farm Road. Beginning at County Farm Road will be a storm sewer system to convey drainage. The existing ditch will be used for local drainage only.

A paved street with curb and gutter is proposed for 22nd Lane to enhance the drainage in this area and to provide an adequate outfall for the cul-de-sac location.

FLOW PATH: 25th Lane **DRAINAGE BASINS:** 25th Lane

5-YEAR DESIGN: 43 to 73 cfs

EXISTING CONDITIONS:

This portion of the 25th Lane Basin contains residential and agricultural areas. The existing drainage facilities include roadside ditches with culverts and curb and gutter along County Farm Road.

The ditch and culverts along 25th Lane south of County Farm Road are deficient. There is a partial storm sewer system in 25th Lane at the County Farm Road intersection. North of County Farm Road the ditch is undersized.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of ditch and culvert upgrades along 25th Lane south of County Farm Road. The inlet to the existing storm sewer will be improved and the system will be extended north. Ditch and culvert upgrades are also proposed for Preston Road.

Preliminary Design Cost Estimate Sheet 17

23rd Lane Basin

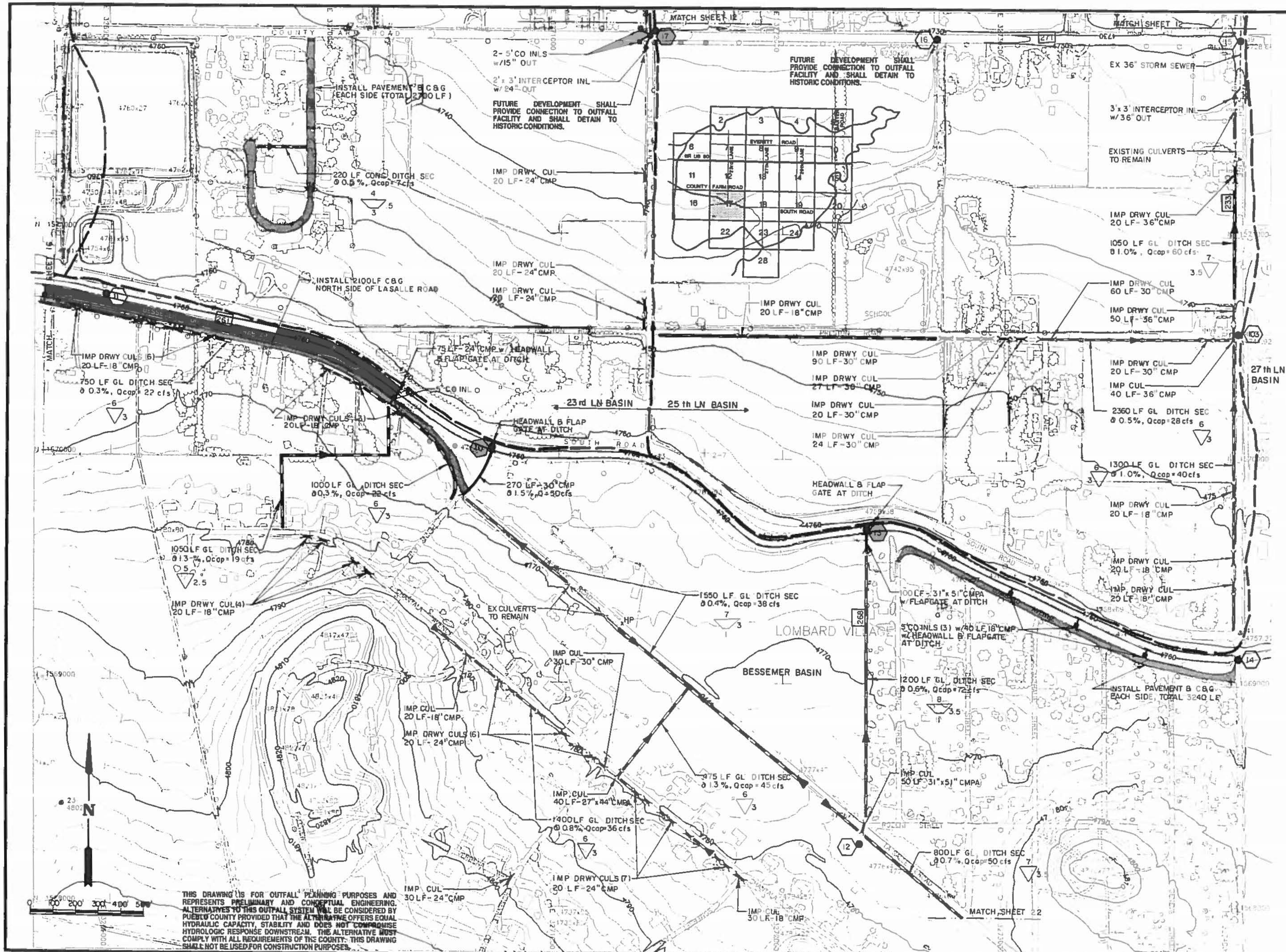
Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
24" CMP	60	LF	$25	$6	$1,500	$360	$1,860
2' x 3' Intercepting Inlet	1	EA	$1,400	$500	$1,400	$500	$1,900
5' CO Inlet	2	EA	$2,500	$800	$5,000	$1,600	$6,600
Paving	4800	SY	$4	$4	$19,200	$19,200	$38,400
Concrete channel	220	LF	$25	$25	$5,500	$5,500	$11,000
Curb and Gutter	2700	LF	$4	$2	$10,800	$5,400	$16,200
Headwalls	3	EA	$400	$400	$1,200	$1,200	$2,400
Total Estimated Construction Cost					$43,100	$33,400	$76,500
Engineering and Contingency (20%)					$8,620	$6,680	$15,300
Total Estimated Cost					$51,720	$40,080	$91,800

25th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
36" CMP	110	LF	$35	$10	$3,850	$1,100	$4,950
30" CMP	241	LF	$29	$10	$6,989	$2,410	$9,399
18" CMP	80	LF	$17	$6	$1,360	$480	$1,840
3' x 3' Grated Inlet	1	EA	$1,500	$500	$1,500	$500	$2,000
Grasslined Channel	3660	LF	$5	$15	$18,300	$54,900	$73,200
Grasslined Channel	1050	LF	$5	$15	$5,250	$15,750	$21,000
Headwalls	13	EA	$400	$400	$5,200	$5,200	$10,400
Total Estimated Construction Cost					$42,449	$80,340	$122,789
Engineering and Contingency (20%)					$8,490	$16,068	$24,558
Total Estimated Cost					$50,939	$96,408	$147,347

Bessemer Ditch Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
31" x 51" CMPA	150	LF	$60	$18	$9,000	$2,700	$11,700
27" x 44" CMPA	40	LF	$55	$10	$2,200	$400	$2,600
24" CMP	365	LF	$22	$10	$8,030	$3,650	$11,680
30" CMP	300	LF	$29	$10	$8,700	$3,000	$11,700
18" CMP	430	LF	$17	$6	$7,310	$2,580	$9,890
Ditch Headwall	7	EA	$800	$1,000	$5,600	$7,000	$12,600
Flap gates	6	EA	$2,000	$800	$12,000	$4,800	$16,800
5' CO Inlet	4	EA	$2,500	$800	$10,000	$3,200	$13,200
Grasslined channel	3150	LF	$5	$15	$15,750	$47,250	$63,000
Grasslined channel	1050	LF	$5	$15	$5,250	$15,750	$21,000
Grasslined channel	800	LF	$5	$15	$4,000	$12,000	$16,000
Grasslined channel	1200	LF	$5	$15	$6,000	$18,000	$24,000
Grasslined channel	475	LF	$5	$15	$2,375	$7,125	$9,500
Grasslined channel	1550	LF	$5	$15	$7,750	$23,250	$31,000
Paving	13225	SY	$4	$4	$52,900	$52,900	$105,800
Curb and Gutter	5340	LF	$4	$2	$21,360	$10,680	$32,040
Headwalls	31	EA	$400	$400	$12,400	$12,400	$24,800
Total Estimated Construction Cost					$190,625	$226,685	$417,310
Engineering and Contingency (20%)					$38,125	$45,337	$83,462
Total Estimated Cost					$228,750	$272,022	$500,772



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 18

FLOW PATH: Manning Road **DRAINAGE BASINS:** Manning Road

5-YEAR DESIGN: 23 cfs

EXISTING CONDITIONS:

This portion of the Manning Road Basin includes residential and agricultural areas. Existing drainage patterns include overland flow, roadside ditches and culverts in some areas. The ditch and culverts along 28th Lane are inadequate.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:

An improved roadside ditch and culverts are proposed for this flow path.

FLOW PATH: 27th Lane **DRAINAGE BASINS:** 27th Lane

5-YEAR DESIGN: 11 to 64 cfs

EXISTING CONDITIONS:

This portion of the 27th Lane Basin contains residential and agricultural areas. The existing drainage facilities are acceptable and include roadside ditches and curb and gutter along County Farm Road. However, Preston Road lacks a desirable outfall facility.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of providing and improving the ditches from Preston Road to 27th Lane.

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 47 cfs

EXISTING CONDITIONS:

This portion of the 29th Lane Basin contains mainly residential development. The existing drainage facilities include streets with curb and gutter, and roadside ditches.

There are two outfalls for this area. The first consists of a concrete detention vault at Torchey Way and County Farm Road which intercepts flow from upstream street areas and discharges to the 27th Lane ditch. The remainder of the area outfalls to a low area along County Farm Road and proceeds northerly along low ground.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:

The proposed improvements consist of directing all runoff to an outfall area at the low spot in County Farm Road. This will be done by installing curb and gutter along County Farm Road, and installing storm sewer from Torchey Way to the outfall location. A ditch section is proposed to convey flow northerly. The concrete detention vault could be eliminated with these improvements.

Preliminary Design Cost Estimate Sheet 18

Manning Road Basin

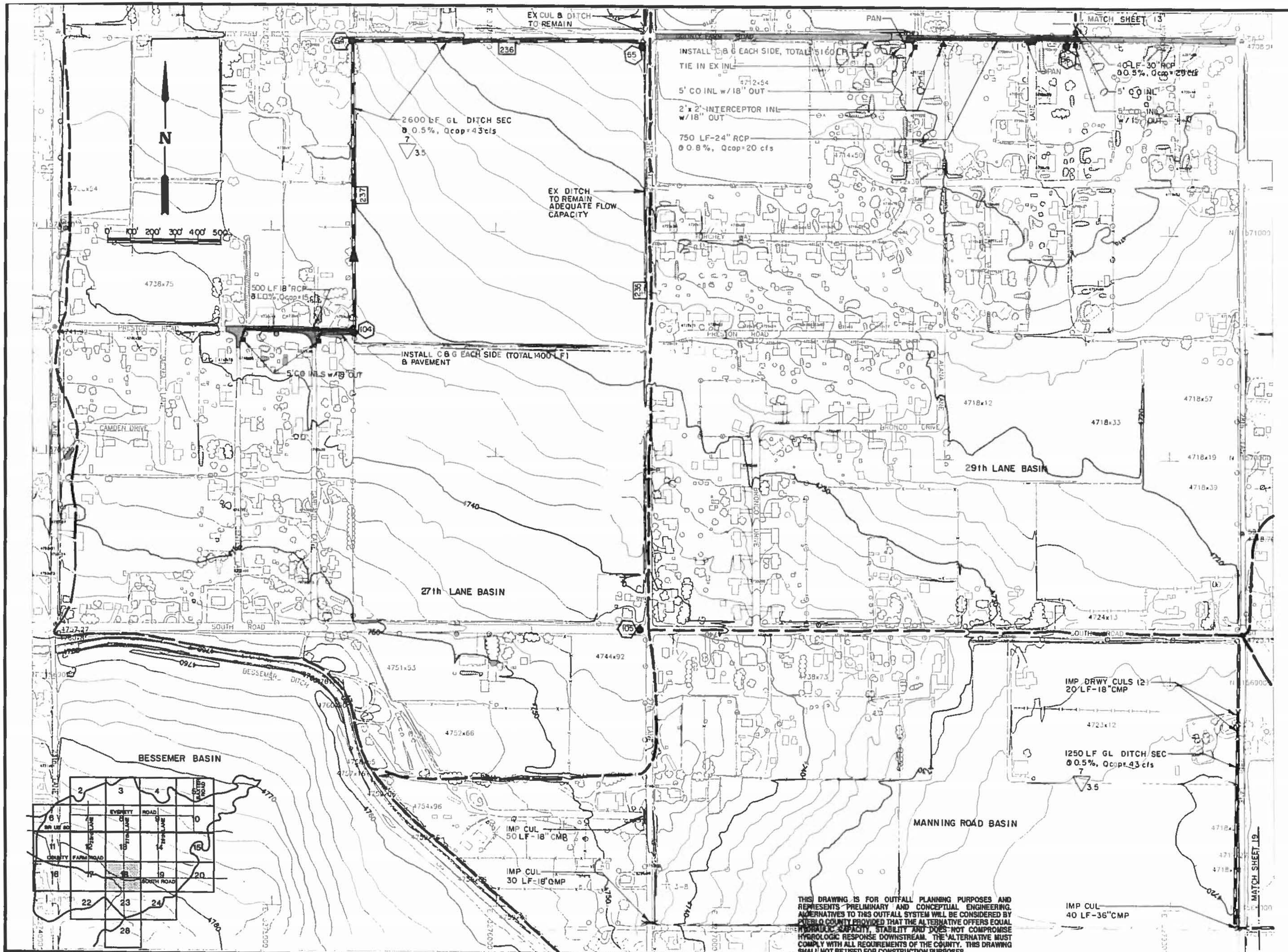
Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
36" CMP	40	LF	$35	$10	$1,400	$400	$1,800
18" CMP	120	LF	$17	$6	$2,040	$720	$2,760
Headwalls	5	EA	$400	$400	$2,000	$2,000	$4,000
Grasslined channel	1250	LF	$5	$15	$6,250	$18,750	$25,000
Total Estimated Construction Cost					$11,690	$21,870	$33,560
Engineering and Contingency (20%)					$2,338	$4,374	$6,712
Total Estimated Cost					$14,028	$26,244	$40,272

27th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
Grasslined Channel	2600	LF	$5	$15	$13,000	$39,000	$52,000
18" RCP	540	LF	$20	$6	$10,800	$3,240	$14,040
Curb and Gutter	1400	LF	$4	$2	$5,600	$2,800	$8,400
Paving	540	SY	$4	$4	$2,160	$2,160	$4,320
5' CO Inlet	2	EA	$2,500	$800	$5,000	$1,600	
Total Estimated Construction Cost					$36,560	$48,800	$78,760
Engineering and Contingency (20%)					$7,312	$9,760	$15,752
Total Estimated Cost					$43,872	$58,560	$94,512

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
24" RCP	750	LF	$25	$6	$18,750	$4,500	$23,250
30" RCP	40	LF	$38	$10	$1,520	$400	$1,920
18" CMP	40	LF	$17	$6	$680	$240	$920
15" CMP	20	LF	$15	$6	$300	$120	$420
5' CO Inlet	3	EA	$2,500	$800	$7,500	$2,400	$9,900
2' x 2' Intercepting Inlet	1	EA	$1,200	$500	$1,200	$500	$1,700
Manhole	2	EA	$2,000	$500	$4,000	$1,000	$5,000
Pavement Replacement	855	SY	$15	$5	$12,825	$4,275	$17,100
Curb and Gutter	5160	LF	$4	$2	$20,640	$10,320	$30,960
Total Estimated Construction Cost					$67,415	$23,755	$91,170
Engineering and Contingency (20%)					$13,483	$4,751	$18,234
Total Estimated Cost					$80,898	$28,506	$109,404



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 19

FLOW PATH: Manning Road **DRAINAGE BASINS:** Manning Road

5-YEAR DESIGN: 23 to 41 cfs

EXISTING CONDITIONS:
This portion of the Manning Road Basin includes residential and agricultural areas. Existing drainage patterns include curb and gutter, and insufficient ditches.

FUTURE CONDITIONS:
Future land use is not anticipated to change.

PROPOSED IMPROVEMENTS:
An improved ditch is proposed to outfall 28th Lane and Cliffdale Lane.

FLOW PATH: 29th Lane **DRAINAGE BASINS:** 29th Lane

5-YEAR DESIGN: 25 cfs

EXISTING CONDITIONS:
This portion of the 29th Lane Basin contains residential and agricultural areas. The existing roadside ditch and culverts along 29th Lane are inadequate.

FUTURE CONDITIONS:
Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:
The proposed improvements consist of improving the ditches and culverts along 29th Lane.

FLOW PATH: South Road **DRAINAGE BASINS:** South Road

5-YEAR DESIGN: 8 to 38 cfs

EXISTING CONDITIONS:
This portion of the South Road Basin contains mainly residential development with some open space areas. The existing drainage facilities include roadside ditches with culverts, insufficient in some areas.

FUTURE CONDITIONS:
Future land use is anticipated to include increased residential use. Onsite detention shall be required to maintain runoff at historic levels.

PROPOSED IMPROVEMENTS:
The proposed improvements consist of improving the insufficient ditch and culvert areas along 30th Lane.

Preliminary Design Cost Estimate Sheet 19

Manning Road Basin

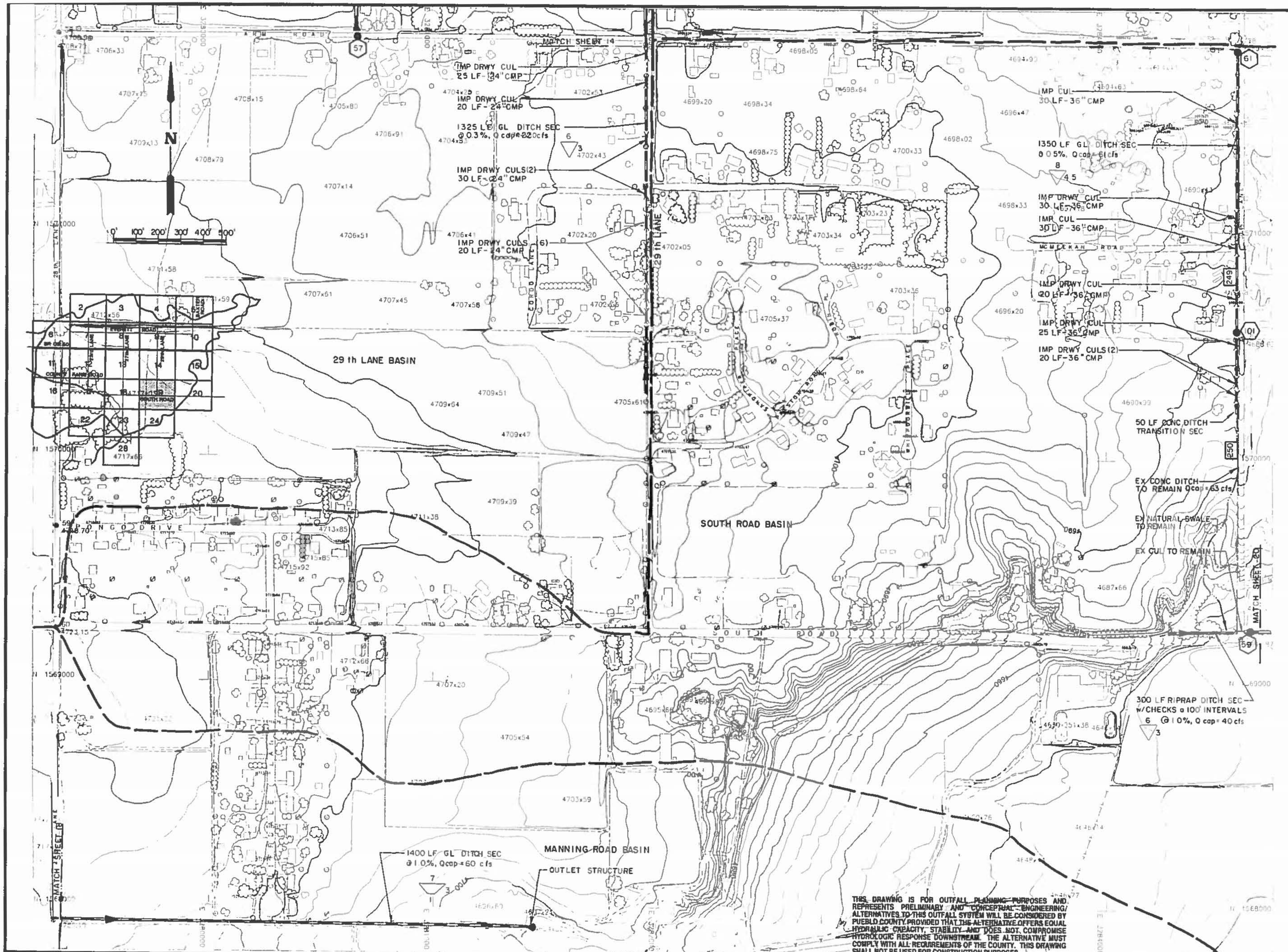
Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
Outlet Structure	1	EA	$10,000	$3,000	$10,000	$3,000	$13,000
Grasslined channel	1400	LF	$5	$15	$7,000	$21,000	$28,000
Total Estimated Construction Cost					$17,000	$24,000	$41,000
Engineering and Contingency (20%)					$3,400	$4,800	$8,200
Total Estimated Cost					$20,400	$28,800	$49,200

South Road Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
36" CMP	175	LF	$58	$10	$10,150	$1,750	$11,900
Grasslined channel	1350	LF	$5	$15	$6,750	$20,250	$27,000
Riprap channel	300	LF	$5	$15	$1,500	$4,500	$6,000
Concrete transition	1	EA	$500	$500	$500	$500	$1,000
Ditch checks	3	EA	$2,000	$500	$6,000	$1,500	$7,500
Headwalls	7	EA	$400	$400	$2,800	$2,800	$5,600
Total Estimated Construction Cost					$27,700	$31,300	$59,000
Engineering and Contingency (20%)					$5,540	$6,260	$11,800
Total Estimated Cost					$33,240	$37,560	$70,800

29th Lane Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
24" CMP	225	LF	$28	$6	$6,300	$1,350	$7,650
Grasslined channel	1325	LF	$5	$15	$6,625	$19,875	$26,500
Headwalls	10	EA	$400	$400	$4,000	$4,000	$8,000
Total Estimated Construction Cost					$16,925	$25,225	$42,150
Engineering and Contingency (20%)					$3,385	$5,045	$8,430
Total Estimated Cost					$20,310	$30,270	$50,580



Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 20

FLOW PATH: South Road

DRAINAGE BASINS: South Road

5-YEAR DESIGN: 8 to 14 cfs

EXISTING CONDITIONS:

This portion of the South Road Basin includes residential and agricultural areas. Existing drainage patterns include roadside ditches. The ditch along South Road is inadequate.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential use. Future development shall be required to provide onsite detention to maintain flows to historic levels.

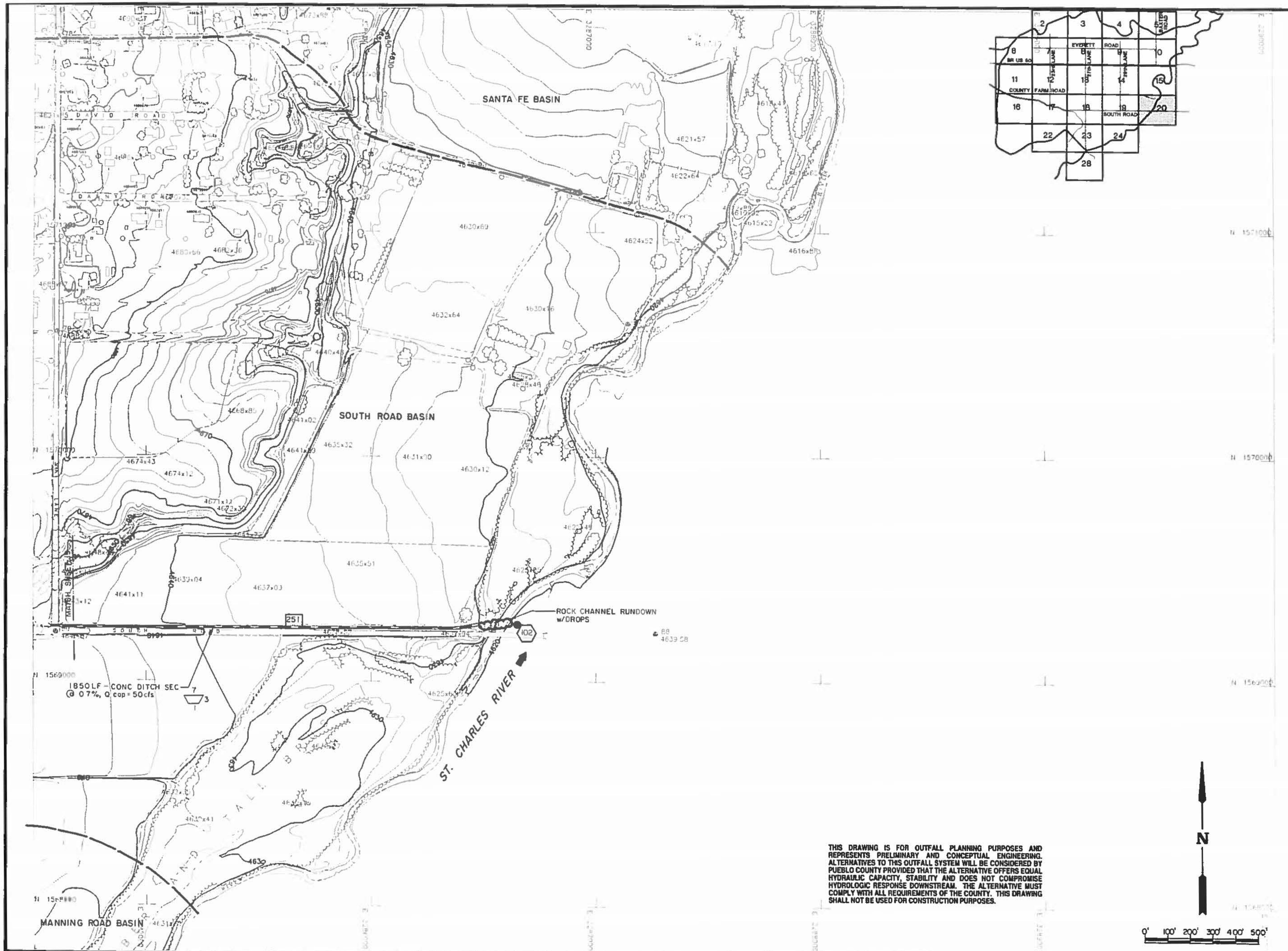
PROPOSED IMPROVEMENTS:

An improved ditch is proposed along South Road with a rock channel rundown at the St. Charles River.

Preliminary Design Cost Estimate Sheet 20

South Road Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
Type M riprap rundown	150	CY	$20	$6	$3,000	$900	$3,900
Concrete Ditch Checks	3	EA	$600	$300	$1,800	$900	$2,700
Grasslined channel	1850	LF	$5	$15	$9,250	$27,750	$37,000
Total Estimated Construction Cost					$14,050	$29,550	$43,600
Engineering and Contingency (20%)					$2,810	$5,910	$8,720
Total Estimated Cost					$16,860	$35,460	$52,320



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 22

FLOW PATH: La Salle Road **DRAINAGE BASINS:** Bessemer

5-YEAR DESIGN: 31 to 63 cfs

EXISTING CONDITIONS:

This portion of the Bessemer Basin is largely undeveloped, with small areas of residential development. The undeveloped areas contain mainly open spaces. Existing drainage characteristics include roadside ditches and culverts in some areas with no facilites in other areas. However, some ditches and culverts are undersized.

The Lakeside Manor Estates area contains an existing detention pond which will remain.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

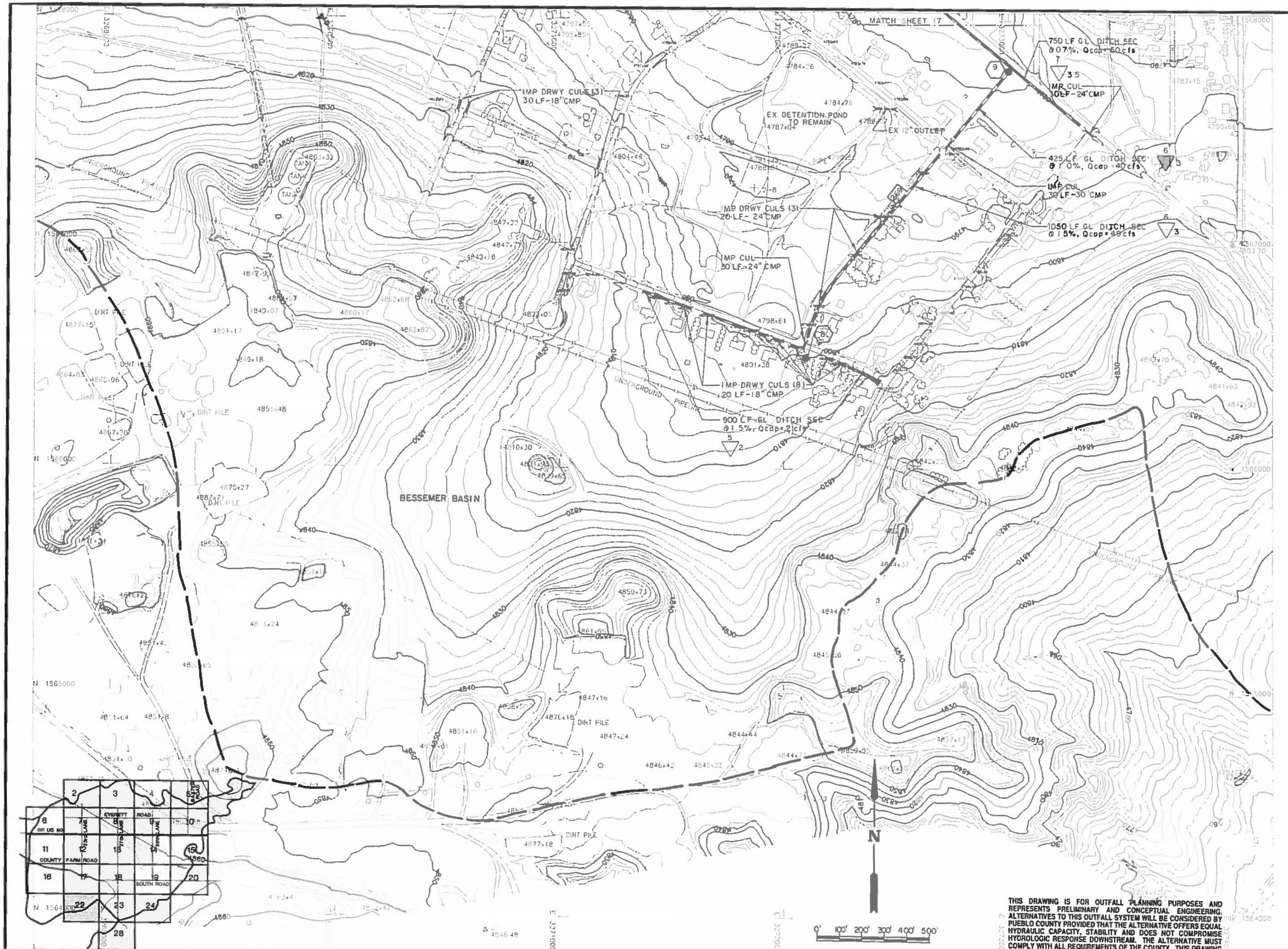
PROPOSED IMPROVEMENTS:

A system of adequate roadside ditches and culverts is proposed in this area..

Preliminary Design Cost Estimate Sheet 22

Bessemer Ditch Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
30" CMP	30	LF	$29	$10	$870	$300	$1,170
24" CMP	120	LF	$22	$6	$2,640	$720	$3,360
18" CMP	250	LF	$17	$6	$4,250	$1,500	$5,750
Grasslined channel	1475	LF	$5	$15	$7,375	$22,125	$29,500
Grasslined channel	750	LF	$5	$15	$3,750	$11,250	$15,000
Grasslined channel	900	LF	$5	$15	$4,500	$13,500	$18,000
Headwalls	17	EA	$400	$400	$6,800	$6,800	$13,600
Total Estimated Construction Cost					$30,185	$56,195	$86,380
Engineering and Contingency (20%)					$6,037	$11,239	$17,276
Total Estimated Cost					$36,222	$67,434	$103,656



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 23

FLOW PATH: Manning Road

DRAINAGE BASINS: Manning Road

5-YEAR DESIGN: 18 to 23 cfs

EXISTING CONDITIONS:

This portion of the Manning Basin is largely undeveloped and used for agricultural purposes. Existing drainage characteristics include overland flow with adequate roadside ditches.

FUTURE CONDITIONS:

Future land use is anticipated to include increased residential uses. Future development shall be required to provide onsite detention to maintain flows to historic flows.

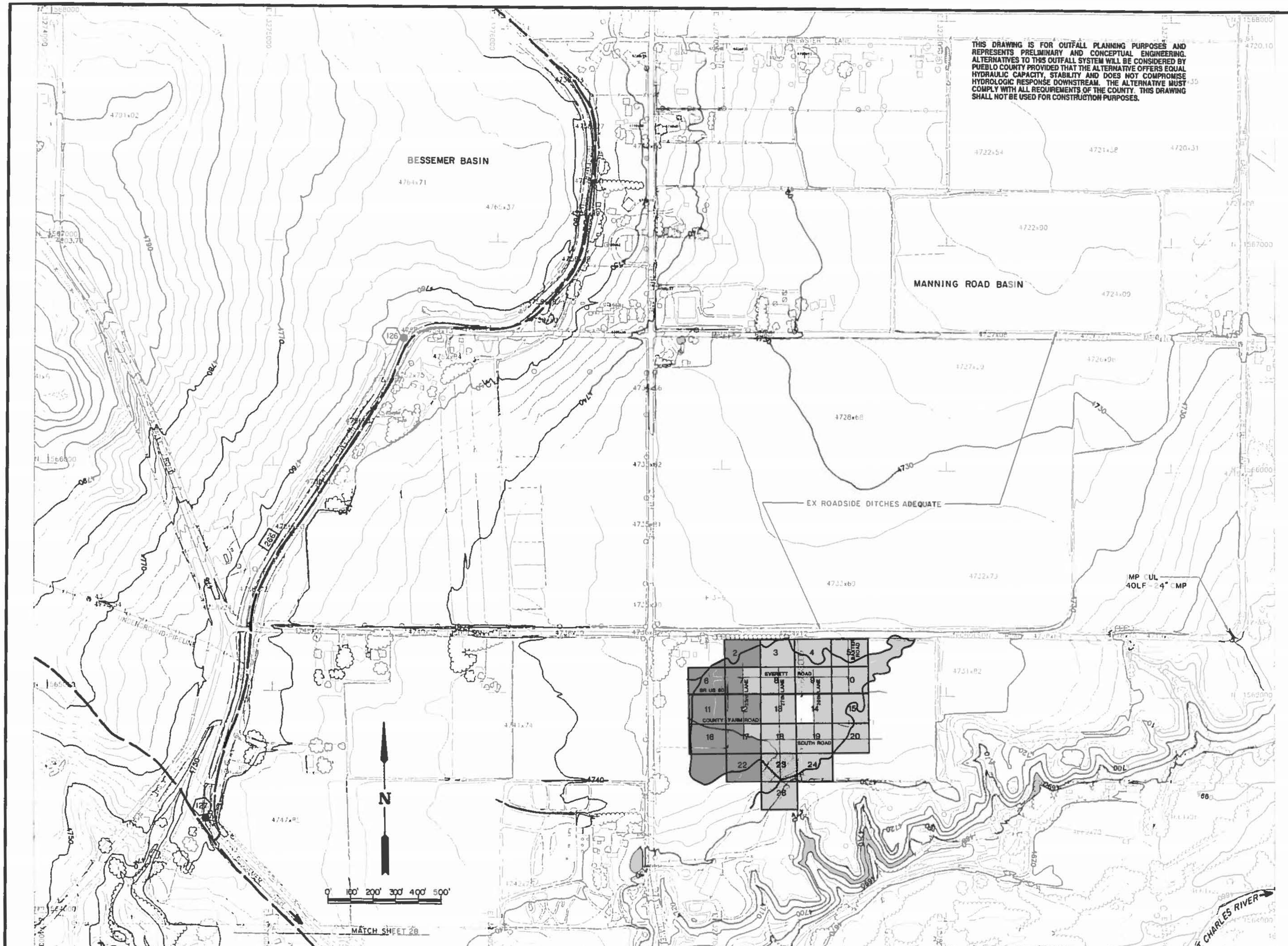
PROPOSED IMPROVEMENTS:

One culvert is proposed to help facilitate drainage under Nicholson Road.

Preliminary Design Cost Estimate Sheet 23

Manning Road Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
24" CMP	40	LF	$22	$6	$880	$240	$1,120
Headwalls	1	EA	$400	$400	$400	$400	$800
Total Estimated Construction Cost					$1,280	$640	$1,920
Engineering and Contingency (20%)					$256	$128	$384
Total Estimated Cost					$1,536	$768	$2,304



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94-01-01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 24

FLOW PATH: Manning Road

DRAINAGE BASINS: Manning Road

5-YEAR DESIGN: 27 to 41 cfs

EXISTING CONDITIONS:

This portion of the Manning Basin is largely undeveloped and used for agricultural purposes. Existing drainage characteristics include overland flow with adequate roadside ditches.

FUTURE CONDITIONS:

Future land use is not anticipated to change.

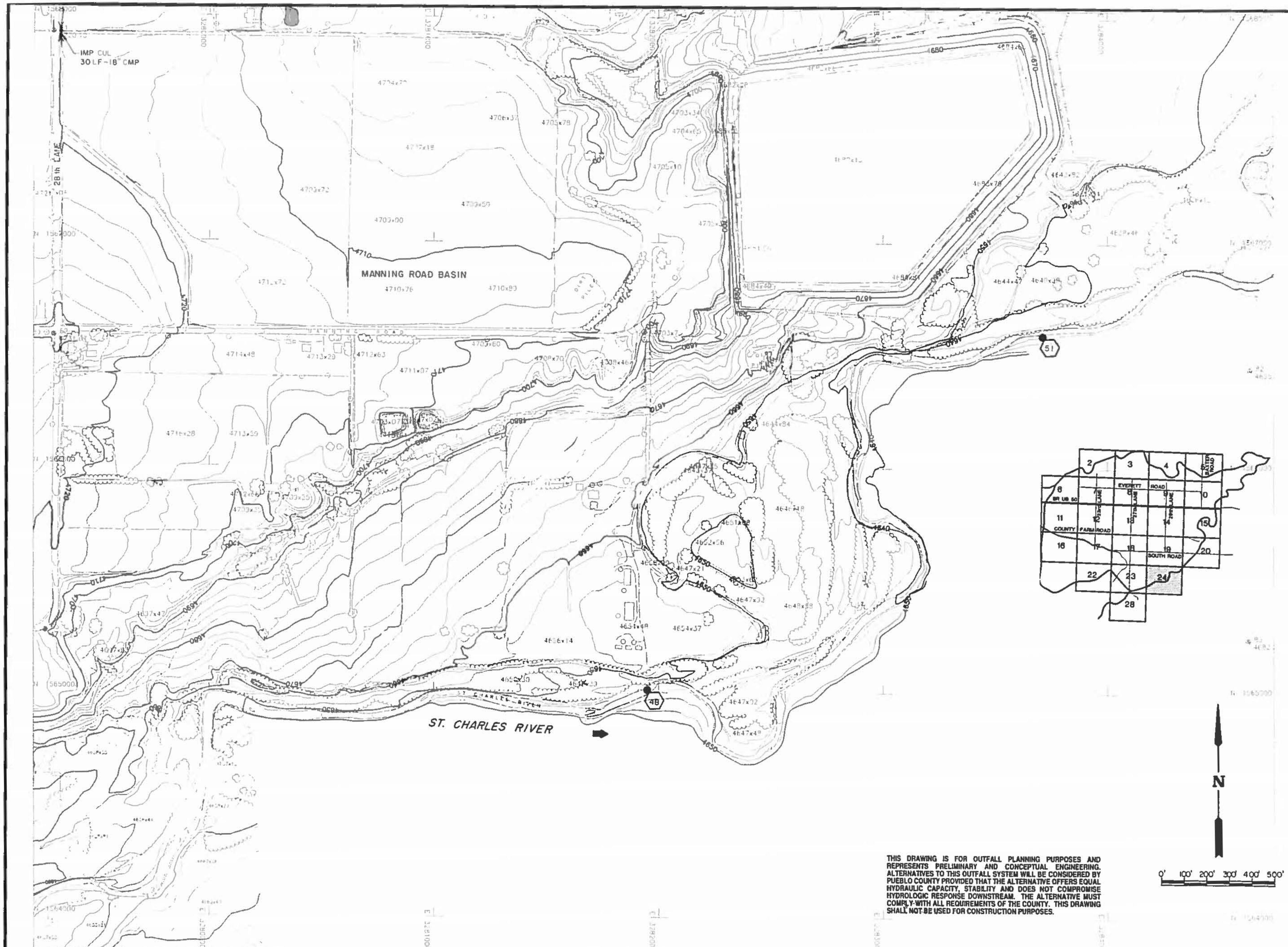
PROPOSED IMPROVEMENTS:

One culvert is proposed to help facilitate drainage at the intersection of Manning Road and 28th Lane.

Preliminary Design Cost Estimate Sheet 24

Manning Road Basin

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
18" CMP	30	LF	$17	$6	$510	$180	$690
Headwalls	1	EA	$400	$400	$400	$400	$800
Total Estimated Construction Cost					$910	$580	$1,490
Engineering and Contingency (20%)					$182	$116	$298
Total Estimated Cost					$1,092	$696	$1,788



THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA
MASTER DRAINAGE STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No	94 01 01
Date:	2/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

COMMENTARY SHEET 28

FLOW PATH: Bessemer Ditch **DRAINAGE BASINS:** Bessemer Ditch

5-YEAR FLOW RANGE: 74 cfs
100-YEAR FLOW RANGE: 559 cfs

EXISTING CONDITIONS:

This is the entrance for the Bessemer Ditch to the existing siphon under the St. Charles River.

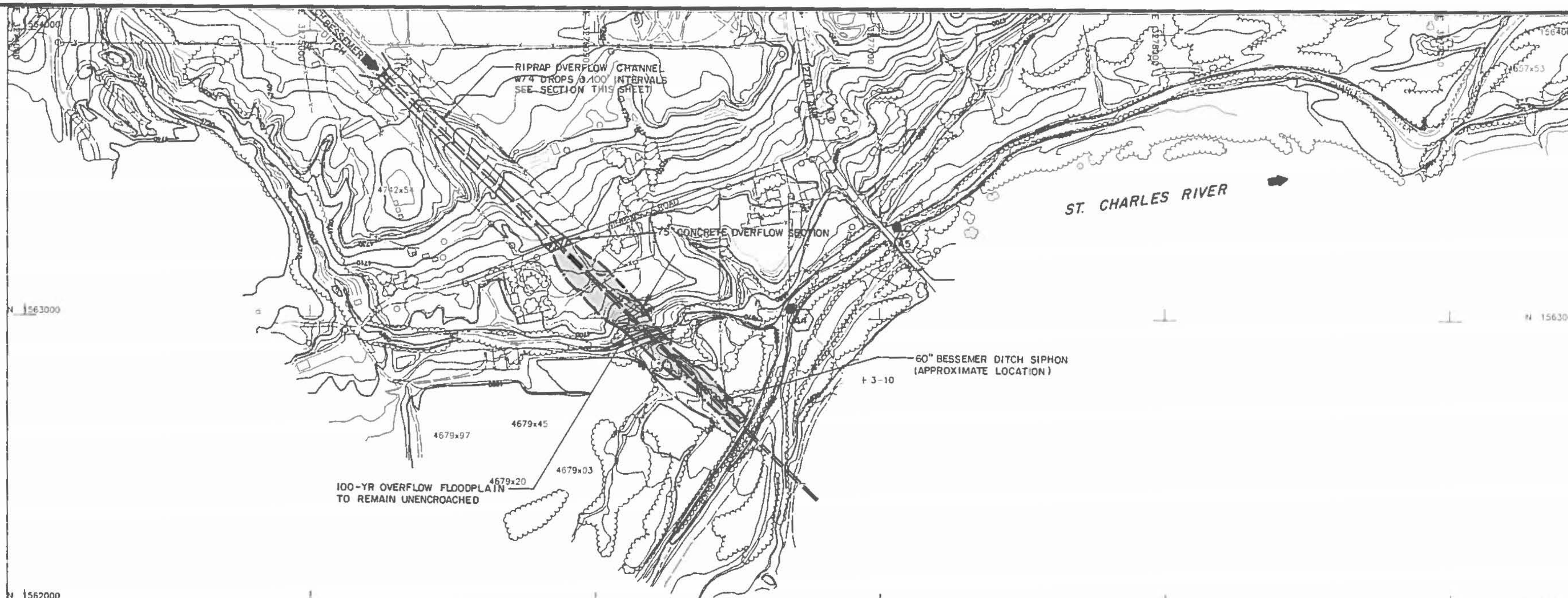
PROPOSED IMPROVEMENTS:

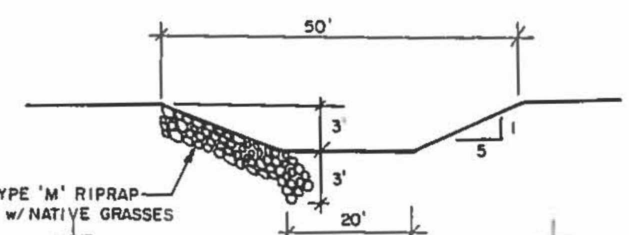
The proposed improvement is an overflow structure that will convey stormwater within the Bessemer Ditch to the St. Charles River. This structure will include an overflow swale with vertical drop structures to convey flow in excess of the siphon's capacity. Downstream of Williams Road a residual floodplain has been defined which will need to remain unencroached.

Preliminary Design Cost Estimate Sheet 28

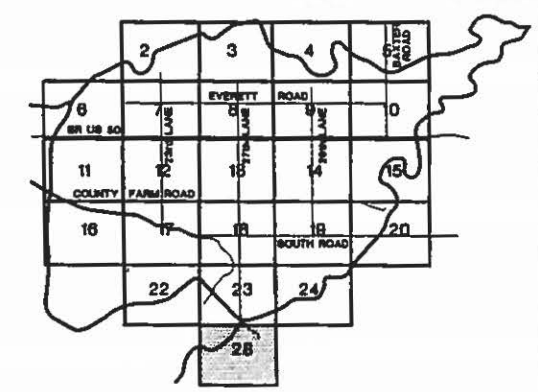
Bessemer Ditch

Improvement	Quantity	Unit	Unit Cost Material	Unit Cost Installation	Total Material	Total Installation	Total
Williams Rd. wier	1	EA	$15,000	$10,000	$15,000	$10,000	$25,000
Drop structures	4	EA	$4,000	$3,000	$16,000	$12,000	$28,000
Riprap Channel	820	LF	$75	$50	$61,500	$41,000	$102,500
Total Estimated Construction Cost					$92,500	$63,000	$155,500
Engineering and Contingency (20%)					$18,500	$12,600	$31,100
Total Estimated Cost					$111,000	$75,600	$186,600





BESSEMER DITCH OVERFLOW
nts



N

0' 100' 200' 300' 400' 500'

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

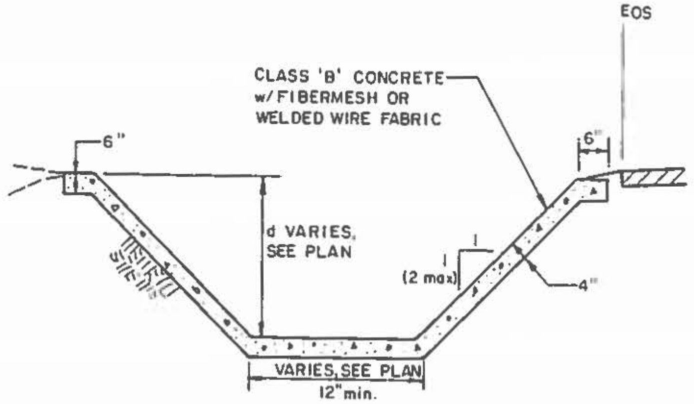
Kiowa Engineering Corporation
419 W. Bijou Street
Colorado Springs, Colorado
80905-1308

ST. CHARLES MESA MASTER DRAINAGE STUDY PUEBLO COUNTY, COLORADO

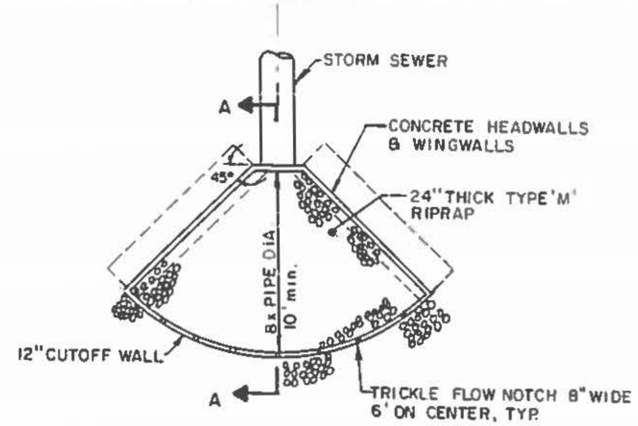
PRELIMINARY DESIGN PLANS

Project No.	94 01 01
Date:	3/94
Design:	CAB
Drawn:	EAK
Check:	RNW
Revisions:	

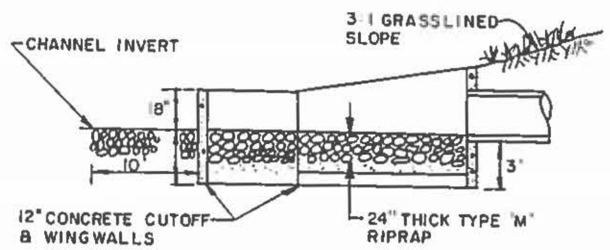
THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.



TYPICAL ROADSIDE DITCH
CONCRETE LINED

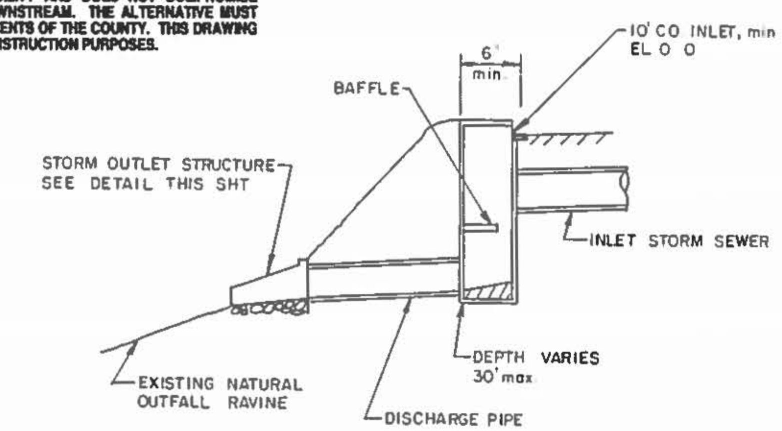


PLAN VIEW

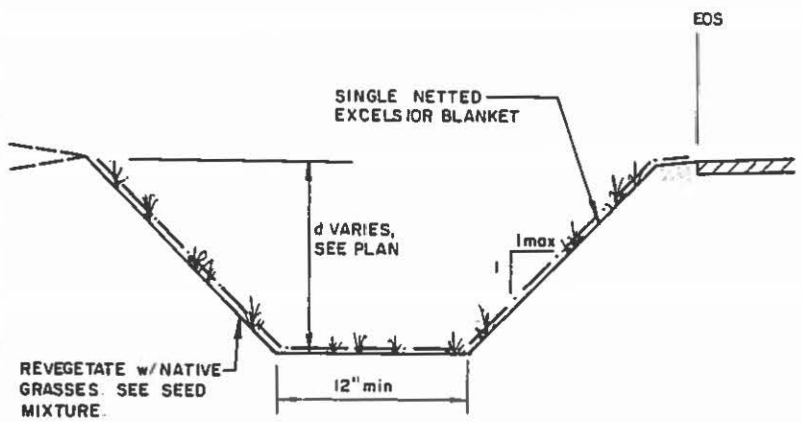


SECTION A-A

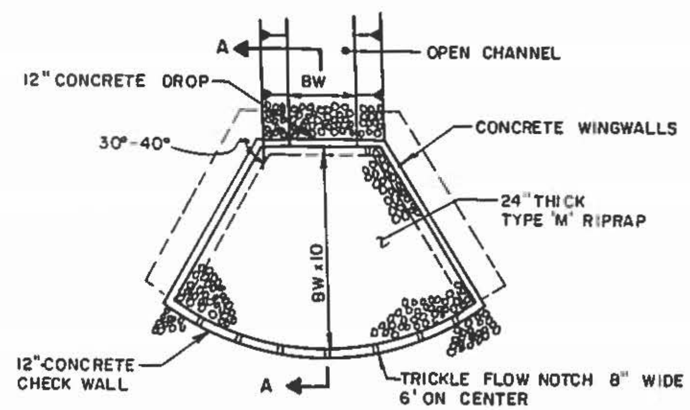
TYPICAL STORM SEWER OUTLET STRUCTURE
nts



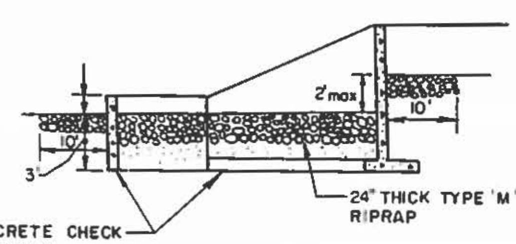
TYPICAL OUTFALL STRUCTURE
nts



TYPICAL ROADSIDE DITCH
GRASSLINED

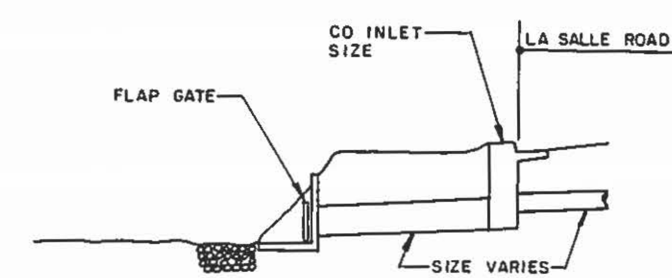


PLAN VIEW

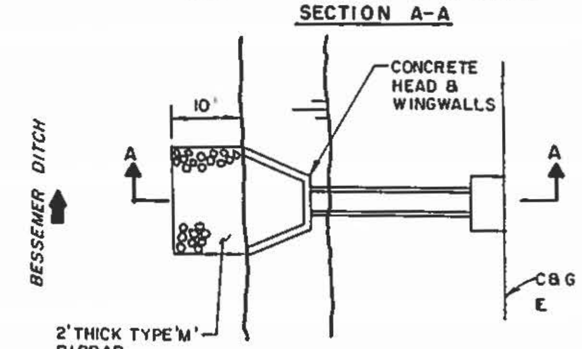


SECTION A-A

TYPICAL OPEN CHANNEL OUTLET STRUCTURE
nts



SECTION A-A



PLAN VIEW

TYPICAL BESSEMER DITCH OUTLET STRUCTURE

Sandy Soil Seed Mix

Common & Botanical name	Growth Season[b]	Growth Form	Seeds/ Pound	Pounds of PLS/acre
Blue grama *Bouteloua gracilis*	Warm	Sod-forming bunchgrass	825,000	0.5
Camper little bluestem *Schizachyrium scoparium 'Camper'*	Warm	Bunch	240,000	1.0
Prairie sandreed *Calamovilfa longifolia*	Warm	Open sod	274,000	1.0
Sand dropseed *Sporobolus cryptandrus*	Cool	Bunch	5,298,000	0.25
Vaughn sideoats grama *Bouteloua curtipendula 'Vaughn'*	Warm	Sod	191,000	2.0
Arriba western wheatgrass *Agropyron smithii 'Arriba'*	Cool	Sod	110,000	5.5
			Total:	10.25

Kiowa Engineering Corporation
419 West Bijou Street
Colorado Springs, Colorado
80905-1308
(719) 630-7342

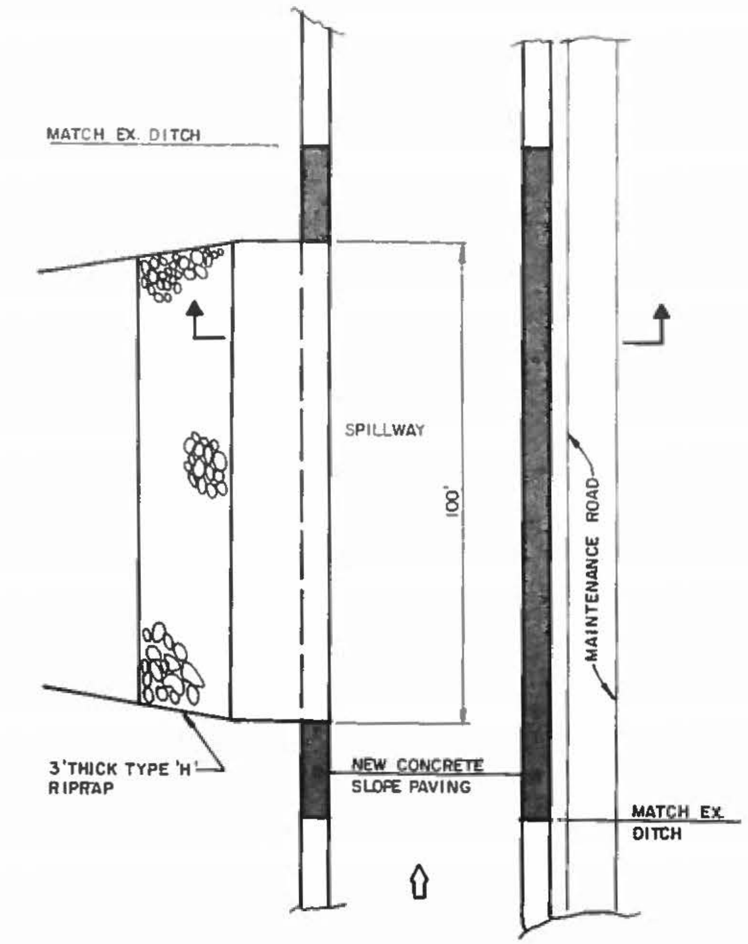
ST. CHARLES MESA
DRAINAGE BASIN PLANNING STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

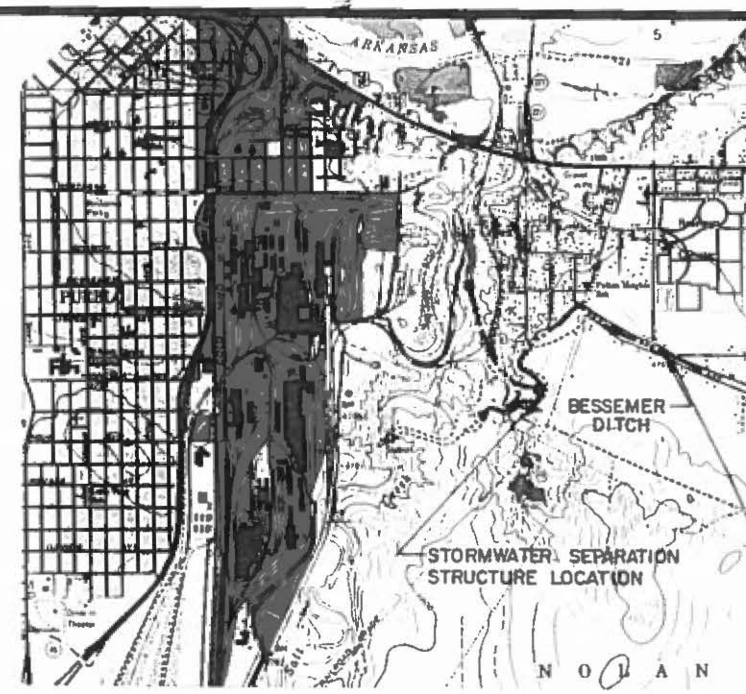
Project No.: 94.01.01
Date: 3/94
Design:
Drawn:
Check:
Revisions:

29

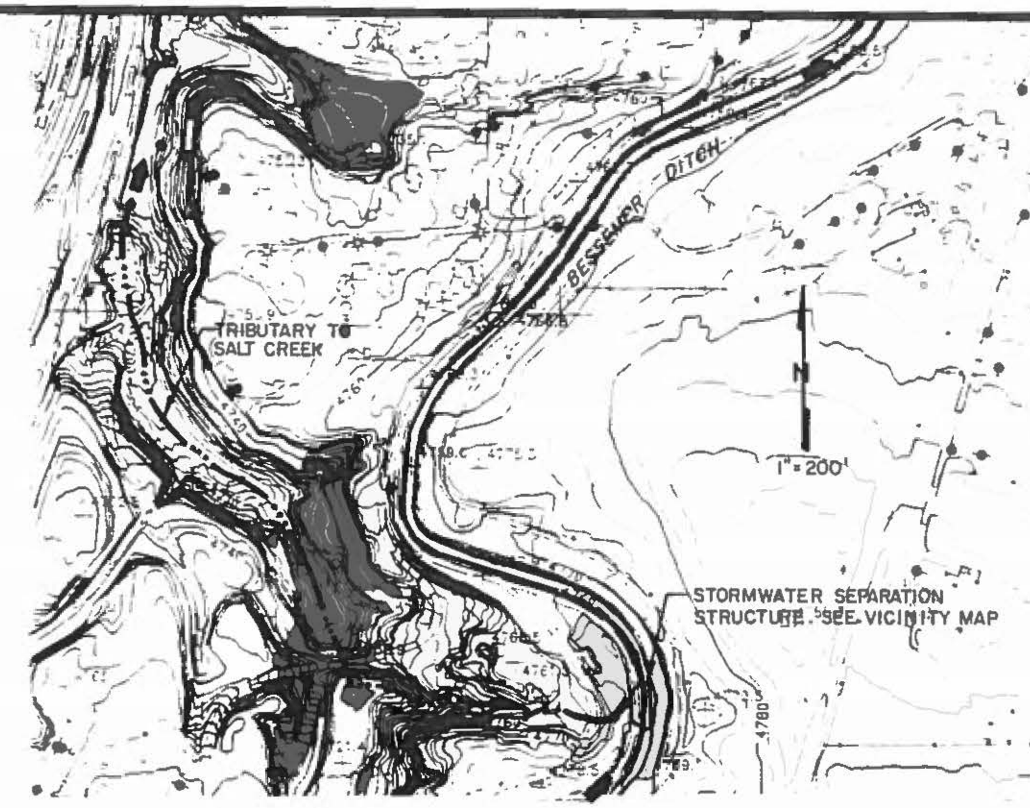
DETAIL SHT

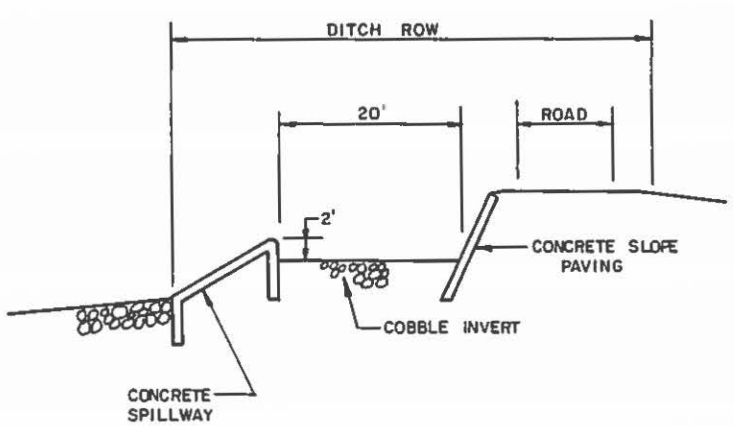


BESSEMER DITCH SEPARATION STRUCTURE
nts

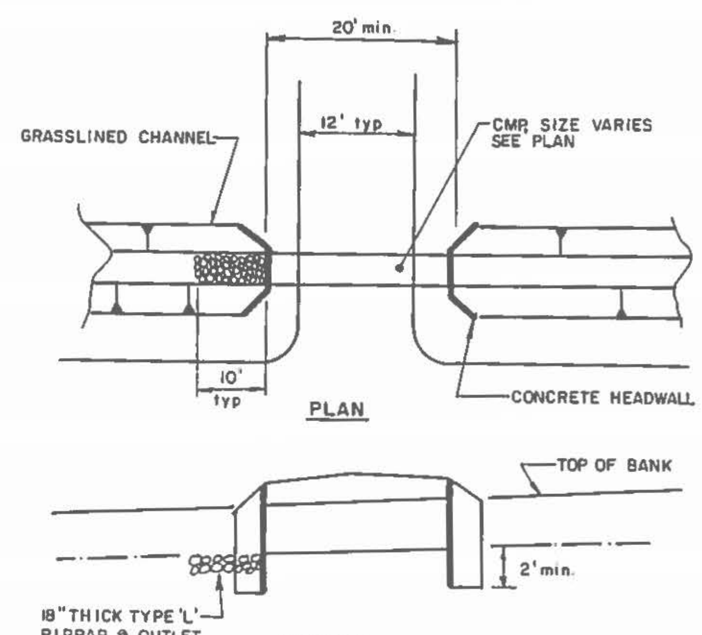


STORMWATER SEPARATION STRUCTURE VICINITY MAP





SECTION A-A



TYPICAL DRIVEWAY CULVERT

THIS DRAWING IS FOR OUTFALL PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY PUEBLO COUNTY PROVIDED THAT THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY, STABILITY AND DOES NOT COMPROMISE HYDROLOGIC RESPONSE DOWNSTREAM. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE COUNTY. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES.

Kiowa Engineering Corporation
419 West Bijou Street
Colorado Springs, Colorado
80905-1308
(719) 630-7342

ST. CHARLES MESA
DRAINAGE BASIN PLANNING STUDY
PUEBLO COUNTY, COLORADO

PRELIMINARY DESIGN PLANS

Project No.: 94.01.01
Date: 3/94
Design:
Drawn:
Check:
Revisions:

30
DETAIL SHT

SELECTED OUTFALL SYSTEMS

Hydrologic Sub-basin Map

St. Charles Mesa Outfall Systems Planning Study

Kiowa Engineering Corporation

Project No.	91/12/32
Date:	
Design:	
Drawn:	
Check:	
Revisions:	

EXHIBIT I