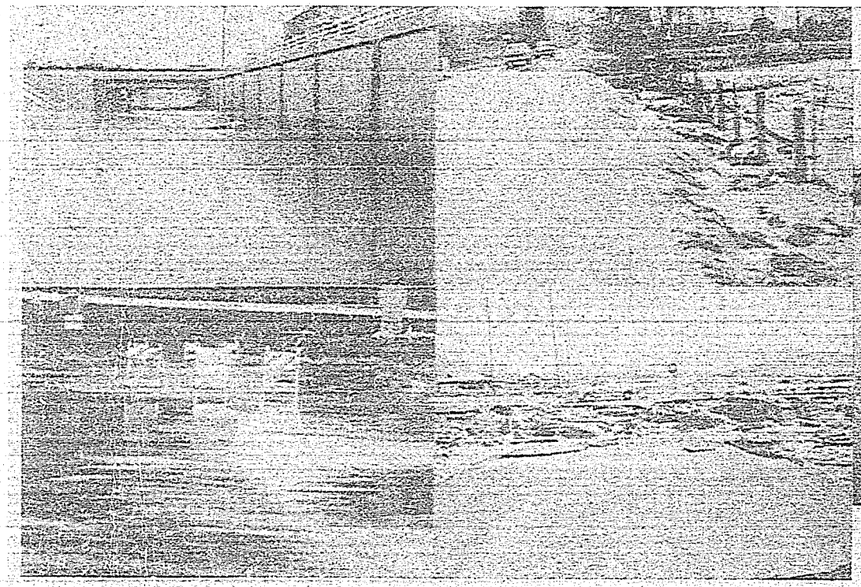
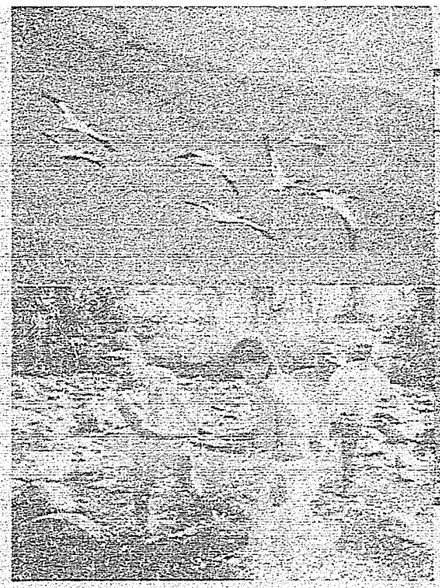
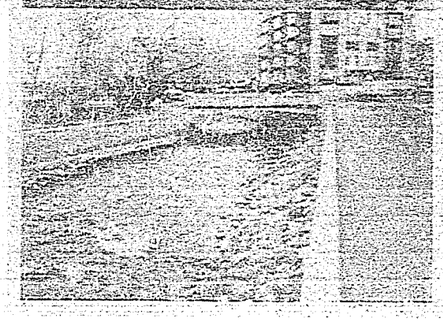
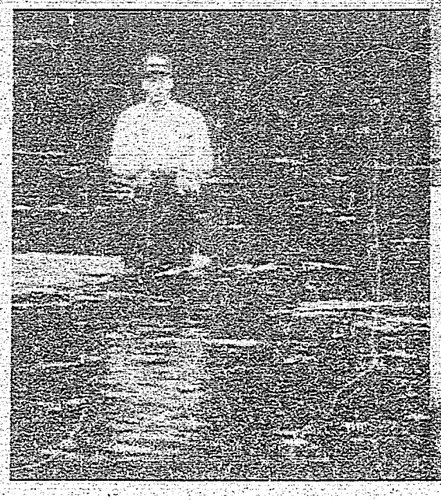
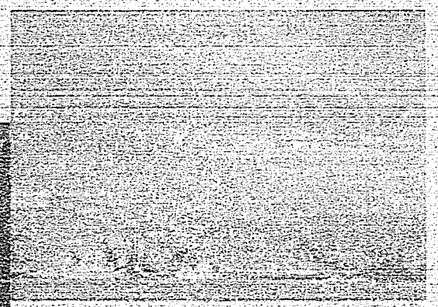
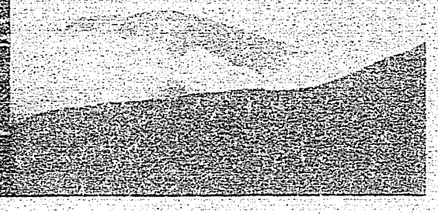
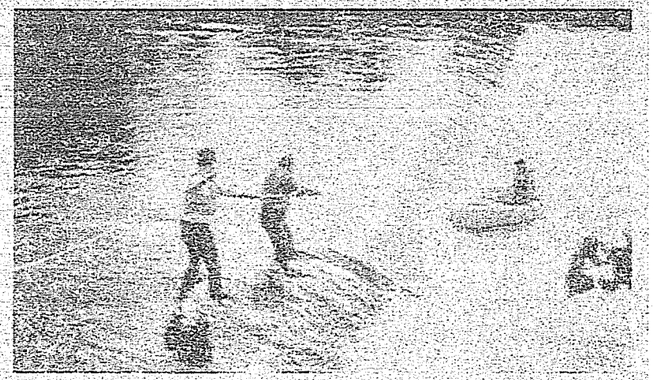
2368-00058

Washoe County Flood Control Master Plan Concept Level Report - Volume I





Prepared By Kennedy/Jenks/Chilton

in association with

Kato & Warren, Inc. and FCS Group, Inc.

K/J/C 897043.01

January 1991

WASHOE COUNTY FLOOD CONTROL MASTER PLAN
CONCEPT LEVEL REPORT - VOLUME I

PREPARED FOR:

WASHOE COUNTY, NEVADA
CITY OF RENO, NEVADA
CITY OF SPARKS, NEVADA

PREPARED BY:

KENNEDY/JENKS/CHILTON

IN ASSOCIATION WITH:

KATO & WARREN, INC.
AND
FCS GROUP, INC.

K/J/C 897043.01
JANUARY 1991
REVISED APRIL 1991

COVER PHOTOS

Kennedy/Jenks/Chilton would like to thank the following organizations and individuals for providing the photographs used on the report cover:

- City of Sparks Department of Public Works, David Roundtree
- Reno Gazette-Journal
- Washoe County Dept. of Comprehensive Planning, Leonard Crowe
- Washoe County Sheriff's Hasty Team, Corinne A. Dwyer

The Washoe County Flood Control Master Plan, Concept Level Report was prepared under contract with Washoe County and coordinated through the Interlocal Agreement between Washoe County and the Cities of Reno and Sparks, dated April 1989. This project was supported by the Flood Control Technical Advisory Committee (TAC).

The TAC members who participated in this project include:

- Floyd E. Vice, P.E.,
  Director of Public Works, Washoe County - Chairman (retired)
- Steve Varela, P.E.,
  City Engineer, City of Reno, - Vice Chairman
- David R. Roundtree, P.E., P.L.S.,
  Director of Public Works, City of Sparks
- Greg Evangelatos, AICP,
  Planning Director, City of Sparks
- Laura Tuttle,
  City of Reno Planning Department
- Robert N. Young,
  Director, Washoe County Department of Comprehensive Planning (retired)
- Douglas W. Hopkins, P.E., P.L.S.,
  County Engineer, Washoe County

Kennedy/Jenks/Chilton acknowledges the assistance of the many individuals who provided assistance in this project.

City of Reno Planning Department
City of Reno Engineering Department
City of Sparks Engineering Department
City of Sparks Planning Department
Washoe County Department of Public Works
Washoe County Department of Comprehensive Planning
Washoe Council of Governments

Volume I
TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND PURPOSE

INTRODUCTION

Flooding within areas of the cities of Reno and Sparks and Washoe County has been a recurring problem for many years. Our most recent experience with flood damage occurred in July of 1990 during a strong localized thunderstorm in the Lemmon Valley area. Prior to that event, the floods of 1986 focused community attention on the problem of flood control and storm drainage. In 1983, debris flows on Ophir Creek caused extensive property damage and loss of life. Major flooding events in the Truckee drainage have occurred periodically in recent history with significant occurrences in 1907, 1928, 1937, 1950, 1955, and 1963.

In addition to historical concerns about flood damage and disruption to transportation and commerce, today we are faced with two additional constraints in the evaluation of feasible solutions to the problem. Water quality along with the related issues of wetlands creation/preservation and environmentally appropriate channel treatment, have collectively become a significant issue in the evaluation of what facilities are required to convey and possibly treat storm water and low flow drainage to the Truckee River. As a second constraint, extensive development has created competition between the siting of flood control facilities and the commercial uses of land. Many opportunities for solving regional flood control problems will be lost to currently planned development efforts.

Recently the U.S. Army Corps of Engineers (USCOE) initiated pre-engineering design activities for preparation of the General Design Memorandum for the Truckee Meadows Project. This project is intended to reduce flooding problems along the main channel of the Truckee River. This project will generate a requirement for funding of the local share of the project cost and may have a significant impact on the location and cost of regional flood control facilities.

Recognizing the seriousness of the various problems associated with flood control and the need for coordinating regional facilities planning with the Truckee Meadows Project (USCOE); Washoe County, in cooperation with the cities of Reno and Sparks, retained Kennedy/Jenks/Chilton to develop a concept level flood control master plan and an approach for the organization and funding required to implement the Truckee Meadows Project and the recommendations resulting from the regional planning effort.

The scope of the planning study and report, in accordance with the contract, includes:

- The preparation of a conceptual level flood control master plan for Washoe County to provide an estimate of the overall program cost and to establish the general level of long term capital needed early in the planning process.

- The development of a recommended institutional structure and funding plan to implement the master plan including the following tasks:

  Organizational requirements. Determine the functions and responsibilities necessary for the effective implementation of the master plan and develop a consensus on the organizational approach to be used.

  Funding alternatives. Based on the evaluation of local funding requirements to implement the Truckee Meadows Project (USCOE), regional flood control facilities, local drainage facilities, operations and maintenance needs, and water quality maintenance and treatment facilities (NPDES); recommend a funding approach and any required legislative actions needed to implement the funding approach recommendation.

STATEMENT OF POLICY AND GOALS

It is stated in NRS 543.020 that the policy of the State of Nevada, along with Washoe County and the cities of Reno and Sparks, is (by inference) "to cooperate with the United States and its departments and agencies,...., in preventing loss of life and property, disruption of commerce, interruption of transportation and communication and waste of water resulting from floods, and in furthering the conservation, development, utilization and disposal of water."

In addition to this general statement regarding public safety, prevention of economic loss or disruption, and resource conservation, it is the objective of the Regional Flood Control Master Plan to develop a method for planning, funding, construction, and maintenance of flood control improvements in Washoe County.

It is also the objective of this plan to use the identified projects to enhance the community environment to the maximum extent feasible and to create opportunities for the multiple use of floodways including recreation, non vehicular transportation, and environmental preservation.

To implement the above statement of policy, the three local agencies intend to develop a flood control master plan that will provide:

- A financial and institutional approach to meeting local obligations resulting from the Truckee Meadows Project (USCOE).

- Estimation of peak flows in master plan study areas throughout Washoe County for existing and future conditions.

- Development of alternative plans describing flood control facilities, and selection of a recommended plan.

- Estimation of capital, operation and maintenance costs for the flood control alternatives and the recommended plan.

- Development of the organizational requirements needed to successfully implement a cost effective, regional flood control program.

- Development of design standards to assure consistency in the construction and operation of flood control facilities in Washoe County.

- Further development of a Flood Warning System to serve the developed areas in Washoe County.

The Concept Level Flood Control Master Plan is the first step in the process of achieving these regional goals. This first phase study effort provides both an institutional framework for proceeding and a conceptual definition of the facilities and activities necessary to successfully implement the regional plan.

The preparation of a prioritized capital improvement program and other detailed elements of the final Flood Control Master Plan will be completed in the next phase of the project.

CHAPTER 2

FINDINGS AND CONCLUSIONS

FINDINGS AND CONCLUSIONS

Based on the scope of work completed, the following significant findings and conclusions have been reached:

- The majority of regional flood control and drainage facilities evaluated were inadequate to pass the estimated 100 year flood. Program costs for all Washoe County regional facilities needed to convey the 100 year storm, based on future development conditions, are estimated to be on the order of Two Hundred Sixty Nine Million Dollars ($269,000,000).

- Many of the existing drainage and flood conveyance facilities are in need of improvement in order to protect property and assure public safety.

- The timely incorporation of a flood control facilities master plan in current land use planning efforts will have a significant impact on both the cost and technical feasibility of the recommended approach. As an example, current land use decisions in the University Farms and South Truckee Meadows area will have significant impact on the nature of the recommended facilities and both their effectiveness and cost.

- A combination of storm drainage utility charges and development impact fees forms a feasible basis for funding the anticipated program costs. Activities funded under the program will include the construction, operation and maintenance of regional flood control facilities, the provision of the local cost share requirements for the Truckee Meadows Project (USCOE), the construction, operation and maintenance of local drainage systems and general administration of the overall program elements.

- Implementation of a Regional Flood Control Master Plan is the best, if not only, means to meet increasing demands from the public for improvements to and the preservation of the Truckee River corridor and other environmentally sensitive water courses in the Truckee Meadows.

- The stated goal of the Concept Level Flood Control Master Plan to maximize the use of nonstructural solutions to flooding and to build multiple use facilities wherever feasible will contribute to the community goals of providing increased opportunities for recreation, improving the local environment and improving water quality in the Truckee River.

CHAPTER 3

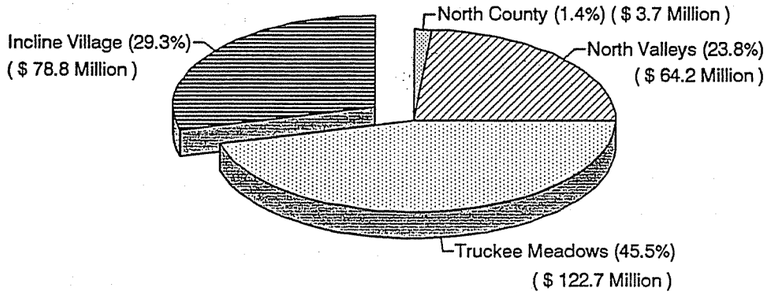
RECOMMENDED PROGRAM AND COST SUMMARY

The Concept Level Flood Control Master Plan provided planning estimates for regional facilities to convey the 100 year flood. These facilities assume future development conditions as described in the current draft of the area master plans for development. These planning estimates identified capital program needs for all of Washoe County totalling Two Hundred Sixty Nine Million Dollars ($269,000,000). A breakdown of the capital improvement program (CIP) elements by geographic location is provided in Figure 1 below.

Figure 1

Concept Level Flood Control Master Plan
CIP Program Costs by Area

*CIP Program Total Budget = $269 Million



* Does not include USCOE Truckee Meadows Project or Local Drainage Improvements

Details of the planning estimate values are presented in Table 1 at the end of this section. In this table, program costs are presented by drainage basin and summarize the detailed facilities presented in Chapter 4.

It should be understood that these estimates are based on structural solutions to conveying and or detaining flood flows for the identified drainages. Neither Kennedy/Jenks/Chilton nor the Technical Advisory Committee are recommending an overall approach of structural improvements. The estimates are intended only to define high range estimates for the implementation of the Flood Control Master Plan capital improvement program and will be revised to reflect the actual recommended facilities in the next phase of the project.

The organizational approach for implementing the flood control master plan, which will be selected during current deliberations on regional governance structure, may have an impact on program costs and responsibilities. For a more complete discussion of the organizational approaches considered in this planning effort and a description of the consensus recommendation of the technical advisory committee, see Volume II.

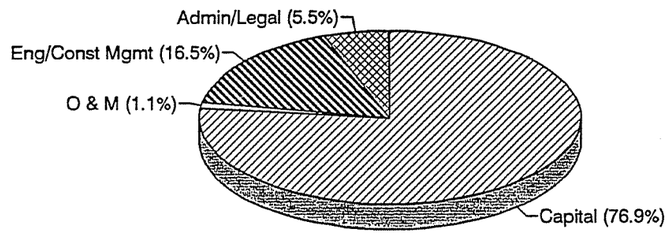
To better understand the scope of program activities contemplated in the concept level plan and their potential cost to area residents, the following utility rate example for residents of the Truckee Meadows has been developed.

CAPITAL IMPROVEMENTS

The concept level flood control and storm drainage master plan has identified capital improvement needs for the Truckee Meadows of One Hundred Twenty Two Million, Seven Hundred Thousand Dollars ($122,700,000). The majority of the regional flood control facilities that benefit the Cities of Reno and Sparks are located in Washoe County as indicated in Table 1. A breakdown of costs associated with this program element are shown in Figure 2 below. These costs are in addition to the proposed Corps of Engineers sponsored Truckee Meadows Flood Control project which is currently estimated to have a local cost share requirement of Forty Million Dollars ($40,000,000).

Figure 2

Concept Level Flood Control Master Plan
CIP Program Costs
*Truckee Meadows Breakdown
For Regional Facilities
Total CIP Budget = $ 122.7 Million



* Does not include USCOE Truckee Meadows Project or Local Drainage Improvements

The concept level plan did not evaluate in detail the capital improvements required to provide for local drainage improvements in Reno, Sparks, or the surrounding County area. However, these needs are currently estimated to total Fifty Million Dollars ($50,000,000) based on discussions with agency public works staff, (not including local drainage facilities now required of new development). Much of the local drainage improvement needs are within the Cities of Reno and Sparks.

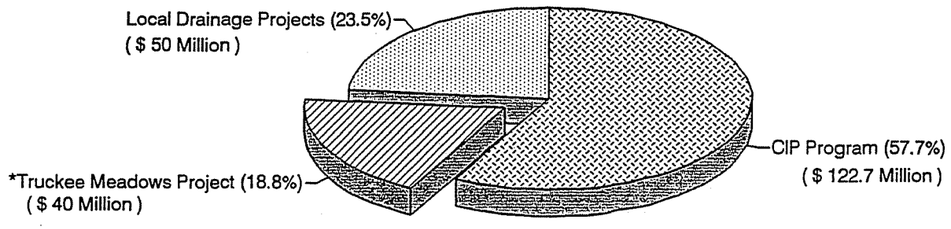
Based on these figures, the long term capital program needs of the Truckee Meadows are estimated to be approximately Two Hundred Twelve Million, seven Hundred Thousand Dollars ($212,700,000). Not all of these improvements are needed immediately. Probably less than one-half of this amount would be needed within the next ten years. Capital program totals for the Truckee Meadows are summarized below in Figure 3.

Figure 3

Concept Level Flood Control Master Plan
Program Costs for Truckee Meadows

Breakdown by Cost Category

Total Program Budget = $ 212.7 Million



* Based on current estimates of local cost share - USCOE project.

System Maintenance

Current expenditures for storm drainage maintenance by the three entities is somewhat difficult to identify since much of this work is undertaken in conjunction with street or sewer maintenance and costed against those funds. It is estimated from the agency budgets that approximately One Million Two Hundred Thousand Dollars ($1,200,000) is spent annually by all three agencies, primarily on local drainage system maintenance.

Considering the increasing need to address water quality and the condition of the major drains such as Steamboat Creek and the North Truckee Drain, it is recommended that expenditures for maintenance and water quality enhancement should be increased to approximately Three Million Dollars ($3,000,000) annually with One Million Five Hundred Thousand Dollars ($1,500,000) being ascribed to local facility maintenance and One Million Five Hundred Thousand Dollars ($1,500,000) ascribed to regional facility maintenance.

System Management

The regulation of storm drainage is becoming an increasing requirement for governments at all levels. This is certainly true in the Reno-Sparks area where concerns for localized flooding and Truckee River water quality are becoming major issues.

The three local agencies spend some monies on drainage system management at this time, but most of these expenditures are adjuncts of land development review or public works engineering functions. Based on proposed regional functions for managing flood control and storm drainage, a regional budget of $1.5 million annually is recommended.

Summary

Combining the need for funding management, maintenance and capital improvements produces a total increased funding need as shown below:

Activity	Estimated Annual Expenditures (Millions) Regional	Local
Management	1.5	0.3
Maintenance	1.5	1.5
Capital Improvements	9.0[1]	2.8[2]
TOTALS:	12.0	4.6

[1] Based on Eighty Two Million Dollars ($82,000,000) in short term capital funded by revenue bonds at 20 years, 7.5% interest, 1.2 coverage (50% of the Truckee Meadows CIP plus the Truckee Meadows Projce total).

[2] Based on local capital expenditures of Twenty Five Million Dollars ($25,000,000) funded by revenue bonds (50% of CIP total).

METHOD OF FUNDING

A review of existing legislative authority has led to the recommendation that the primary source of funding for flood control and storm drainage be utility service charges levied against all property served by the drainage systems of the three agencies.

Regardless of whether or not a regional flood control agency or Washoe County assumes responsibility for flood control and storm drainage, the impact of service charges would be similar. An estimate of the cost impacts resulting from implementation of the program can be made based on data developed by the Washoe County Planning Department.

Assuming an equivalent residential unit (ERU) approach to billing for service, the following total billable units can be identified.

	Equivalents
Dwelling Units	70,000
Commercial	100,000
Vacant and Other	40,000
Total Billable Units	210,000 *

*Estimated from County Geographical Information System (GIS) database.

With this number of billable units, the monthly service charge would be:

Annual Expenditure Level ($ Millions)	Monthly Charge/ERU
Regional Programs	
12.0	$ 4.76
Local Programs	
4.6	$ 1.83
TOTAL:	$ 6.59

Drainage service charges in this range are common throughout the country. In many areas, charges are approaching $10.00 and more per month for the average single family home (ERU).

The service charge levels indicated could be reduced even lower through the use of local assessment districts, new development construction and impact fees. The effect of using these additional funding techniques could be to lower service charges by 10 to 15 percent. Even without this reduction, the estimate service charge rates indicate that funding of the needed flood control and storm drainage program for the area is feasible.

Again, it should be understood that neither Kennedy/Jenks/Chilton nor the Technical Advisory Committee are recommending an overall approach of structural improvements. The estimates are intended only to define high range estimates for the implementation of the Flood Control Master Plan capital improvement program and will be revised to reflect the actual recommended facilities in the next phase of the project.

TABLE 1

SUMMARY OF CAPITAL IMPROVEMENT COSTS
COST (in Thousands of Dollars)

AREA*	WASHOE	RENO	SPARKS	TOTAL
LT01	43315	0	0	43315
NV01	31655	3565	0	35220
PV01	490	0	0	490
PV02	3755	0	0	3755
SS03	4295	0	0	4295
SS05	2835	0	0	2835
TM01	5060	0	0	5060
TM03	75	0	0	75
TM04	295	2600	0	2895
TM05	0	1290	0	1290
TM07	250	0	0	250
TM08	1105	0	0	1105
TM09	695	0	0	695
TM12	535	0	0	535
TM17	2280	0	0	2280
TM22	70	1040	0	1110
TM24	5430	275	0	5705
TM25	4955	0	0	4955
TM27	12220	0	0	12220
TM28	3310	0	0	3310
TM29	5225	0	0	5225
TM31	585	0	230	815
VE03	375	0	0	375
VE06	815	0	0	815
WV01	7330	0	0	7330
NORTH CO	2015	0	0	2015
WMSP VAL	50	0	0	50
TOTAL	139020	8770	230	148020

SUMMARY OF OTHER COSTS
COST (in Thousands of Dollars)

TYPE	WASHOE	RENO	SPARKS	TOTAL
CAPITAL	139020	8770	230	148020
CONTINGENCIES (40%)**	55608	3508	92	59208
O&M (CI) (2%)**	2780	175	5	2960
ENG/CONST (30%)**	41706	2631	69	44406
ADMIN/LEGAL (10%)**	13902	877	23	14802
TOTALS	253016	15961	419	269396

* See Table 3 (page 6) and Figure 4 (page 7) for area definitions.

** Percentage of Capital Cost

$174,102,000 excluding LT01 (includes improv)

CHAPTER 4
PROJECT APPROACH AND RECOMMENDED FACILITIES

INTRODUCTION

This chapter presents the land use planning information and other assumptions used in the development of flood control alternatives for the concept level flood control master plan. Also discussed are hydrology and water quality considerations. Finally this chapter presents the facilities identified for the purpose of estimating the costs of the capital improvement program. These facilities are shown on Figures A-1 through D-7 with descriptions and costs of the identified facilities.

LAND USE AND GROWTH

The northern portion of Washoe County is sparsely populated with only a small percentage of the lands under private ownership. Only the southern one third to one fourth of the County has experienced significant growth in the last 30 years. Therefore, the southern portion of the County has received the most focused attention with regards to land use planning and is the area receiving the greatest attention in the Concept Level Flood Control Master Plan. The northern portion of the County was evaluated for flood control needs as well, and some flood control improvements and study needs for this portion of the county were identified for inclusion in the Master Plan.

Washoe County's Department of Comprehensive Planning has developed a series of maps over the years that identify current and projected development within the southern portion of the County. During each planning cycle, maps are developed which attempt to project development patterns based upon current trends. These projections are typically for the 5 and 20 year planning horizons. In 1987, the Department of Comprehensive Planning prepared projected land use maps for the years 1992 and 2007. The 2007 land use map has been included as Figure 4. This map was used to estimate the extent and type of future development that is likely to occur in southern Washoe County. This information was used to assess the potential impacts on existing drainage systems that could be caused by future development and assess capital improvement needs for flood control in these areas.

The 2007 land use map identifies development in 15 land use categories which encompass density ranges for rural, suburban, urban, commercial, industrial and public facilities. These land use types are summarized below with an estimate of the dwelling unit densities represented by the residential land use categories.

TABLE 2
LAND USE CATEGORIES
USED BY WASHOE COUNTY DEPARTMENT OF COMPREHENSIVE PLANNING
(SEE FIGURE 4)

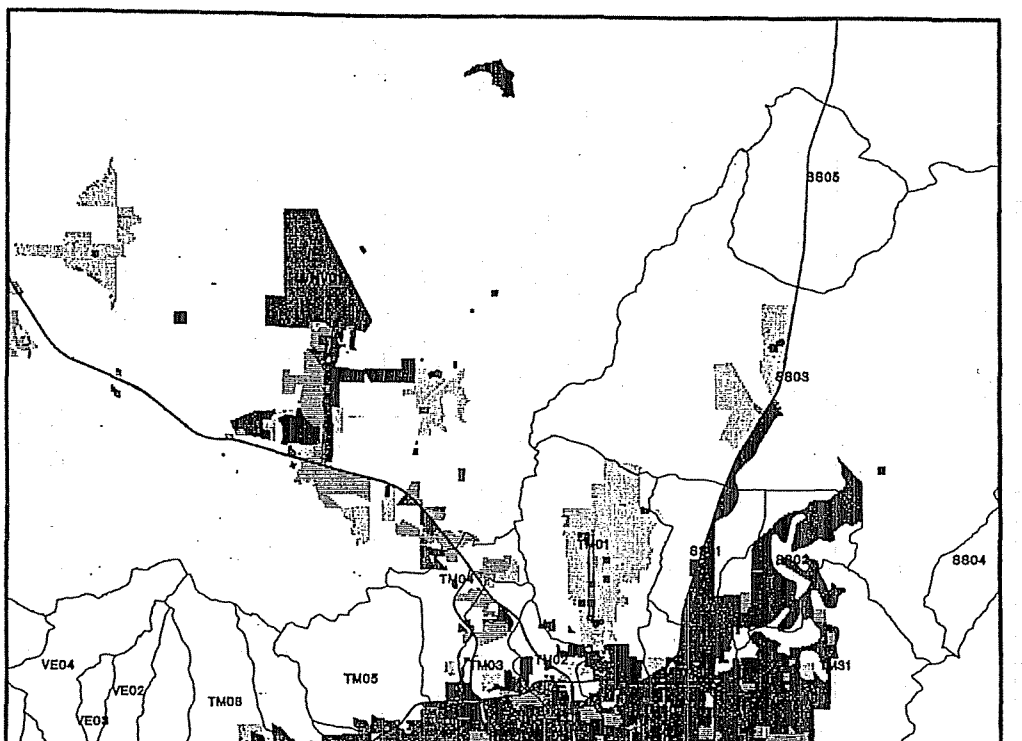
Category	Dwelling Unit Density
Rural	< 1 Unit / 1 Acre
Suburban	< 3 Units / 1 Acre
Urban	≥ 3 Units / 1 Acre
Commercial	N/A
Industrial	N/A
Public & Semi-public Facility	N/A
Parks & Recreation	N/A

Figure 4 shows the hydrographic basins (watersheds) used by Washoe County in the land use planning process. These basins are identified by the small number near the center of each basin. Washoe County identified the basins in order to develop land use data summaries by basin. This data was used in the institutional and financial alternatives analysis for this project.

Table 3 identifies the common watershed or major stream names for each of the basins shown.

TABLE 3
HYDROBASINS IDENTIFIED ON FIGURE 4

Basin #	Name
LT01	Incline Village and Lake Tahoe Basin
NV01	North Valleys (Stead, Lemmon Valley and Cold Springs)
PV01	Steamboat Valley
PV02	Galena Creek and Pleasant Valley
PV03	Browns Creek
SS01-02	Lower Spanish Springs Valley
SS03	Spanish Springs Valley
SS05	Northern Spanish Springs Valley (Boneyard Flat)
TM01	Sun Valley
TM02-03	Northeast Reno (Manogue and Hug High Schools)
TM04	Block N Watershed (Evans Creek & Univ. of Nevada)
TM05-07	Northwest Reno
TM08-09	Mogul Area
TM11	Hunter Creek
TM12	Alum Creek
TM13-23	Central Truckee Meadows
TM24	Evans Creek
TM25	Dry Creek
TM26	Steamboat Creek & Double Diamond/Bella Vista Ranches
TM27	Virginia Foothills
TM28	Thomas Creek
TM29	Whites Creek
TM30-32	City of Sparks
VE01-15	Verdi Area
WV01	Washoe Valley



SOUTHERN WASHOE COUNTY

2007 GENERALIZED LAND USE

- URBAN
- SUBURBAN
- RURAL
- COMMERCIAL
- INDUSTRIAL
- PUBLIC & SEMI-PUBLIC FACILITY
- PARKS & RECREATION

NOTE: THE SCALE AND CONFIGURATION OF ALL INFORMATION SHOWN HEREON ARE APPROXIMATE ONLY AND ARE NOT INTENDED AS A GUIDE FOR DESIGN OR SURVEY WORK. REPRODUCTION IS NOT PERMITTED WITHOUT PRIOR WRITTEN PERMISSION FROM THE WASHOE COUNTY DEPARTMENT OF COMPREHENSIVE PLANNING.

0 8000 16000

SCALE IN FEET

SOURCE: WASHOE COUNTY DEPARTMENT OF COMPREHENSIVE PLANNING

DATE: JULY 1990

WASHOE COUNTY DEPARTMENT OF COMPREHENSIVE PLANNING

POST OFFICE BOX 11130
RENO, NEVADA 89520
(702) 328-3600

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

2007 GENERALIZED LAND USE & HYDROBASINS

K/J/C 897043.01

April 1991

Figure 4

Hydrology

The existing drainage facilities were evaluated for their adequacy to convey the 100-year discharge. This was accomplished by estimating the discharge at each element location and comparing that discharge to the capacity of that element. The discharge estimates were made using a regional analysis to develop only approximate discharge values. Additional information on the methods used to develop the discharge and system capacity estimates, is contained in Volume II of this report.

Water Quality Considerations

Purpose

Pollutant loads from urban stormwater runoff have become a major cause of degradation of receiving water quality in many parts of the United States. Control of the quality of stormwater discharges to the Truckee River is important for maintenance of its high quality waters and protection of regional water supplies. The Washoe County 208 Water Quality Management Plan, adopted by Reno, Sparks and Washoe County in 1978, identified urban stormwater runoff as the second highest priority pollution source to the Truckee River (1). With the completion of the upgrade and expansion of the Reno-Sparks Wastewater Treatment Plant, control of urban runoff has now taken first priority.

Federal regulations, requiring permitting of stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) and development and implementation of stormwater management programs, were promulgated at the end of 1990. In anticipation of these requirements, Washoe County, with the Cities of Reno and Sparks and the Nevada Department of Transportation as co-permittees, requested and received an NPDES permit to discharge stormwater to the Truckee River and its tributaries. The permittees are required to "formalize a stormwater management program that effectively reduces the amount of pollutants entering receiving waters to the maximum extent practicable" (2).

As part of the Concept Level Flood Control Master Plan, the communities have a responsibility to address water quality issues as well as an opportunity to combine water quality controls with both structural and nonstructural flood controls in a cost-effective manner. The purposes of the Water Quality Element of the Concept Level Flood Control Master Plan will be to identify the major water quality issues associated with flood waters, define the communities' responsibility for stormwater quality controls and incorporate water quality control into the various flood control measures that are recommended in the Master Plan. The capital cost estimates presented in the Concept Level Master Plan do not directly address water quality requirements but the contingency item in the estimates is intended to include these requirements.

Relationship To Other Programs

It is expected that the Water Quality Element of the Master Plan will identify and evaluate many of the same best management practices (BMPs) and stormwater quality control measures that are evaluated as part of the development of a stormwater management program for the NPDES permit. Coordination between County staff involved with the Master Plan and County and City staff developing the Stormwater Management Program will benefit both programs.

The Master Plan will focus on BMPs and stormwater quality measures that relate to the control of flood waters. The NPDES Stormwater Management Program will include these measures but will also need to address: control of non-stormwater discharges, such as industrial discharges, spills and illegal connections; industrial compliance and inspection; enforcement of ordinances; and implementation of monitoring programs. These additional activities may not be relevant to the Master Plan; however, if the County has responsibility for these activities in areas outside the Cities of Reno and Sparks, it may make sense to incorporate them in the Master Plan for scheduling and budgeting purposes.

Public information and education is another area where coordination of efforts will benefit both the Master Plan and the NPDES Stormwater Management Program. This is described in more detail below.

Major Water Quality Issues

Typical water quality characteristics of stormwater that can have detrimental impacts on receiving water quality include: suspended solids and sediment; biochemical and chemical oxygen demand; nutrients such as phosphorus and nitrogen; trace metals, especially lead, cadmium, copper and zinc; oil and grease; bacteria; chlorides; and sometimes toxic chemicals. Many of the potential pollutants tend to be in a particulate form and or are attached to and carried by sediments.

The 1983 Washoe County Urban Stormwater Management Program report (3) presented estimates of pollutant loads from urban stormwater runoff, agricultural runoff and the Reno-Sparks Wastewater Treatment Plant to the Truckee River. The primary constituents of concern were suspended solids, chemical oxygen demand (COD), phosphorus, nitrogen and lead. At that time, urban runoff was estimated to contribute 29 percent of the suspended sediment, 23 percent of the COD, 3 percent of the nutrients, and 100 percent of the lead in annual loads to the Truckee River from man-influenced sources above Vista. The report predicted that in the future, following improvements to the treatment plant and urbanization of agricultural lands, urban runoff would contribute 73 percent of the suspended solids, 63 percent of the COD, 28 percent of the nutrients, and 100 percent of the lead.

Based on these findings, it appears that the control of suspended solids discharges to the river should be a high priority of water quality controls associated with the Master Plan. Reductions in suspended solids loadings would also achieve significant reductions in the adsorbed fractions of other pollutants, especially trace metals.

Type Of Water Quality Controls

Structural Controls. Many of the structural facilities proposed in the Master Plan for controlling flood flows, such as detention basins and channels, can also be designed to control water quality, particularly sediment loads. Detention

basins located in upstream areas of the watersheds can be effective for removing sediments generated by erosion of steep mountain areas. Conceptual design of these basins have already incorporated sediment basins for removal of sediments from high flows. Detention basins located in low-lying areas of the watersheds can be designed to allow sufficient detention time for settling of suspended solids during small storm events. Removal of solids and other pollutants can be enhanced by adding vegetation. A permanent pool added to the detention facilities, may be suitable for use as infiltration basins, which would reduce the volume of stormwater discharged to downstream channels as well as reduce pollutant loads.

Flood control channel designs should be considered which reduce flow velocities and allow settling of solids during small storm events. Possible channel treatments for this purpose include maintaining a natural channel bottom with vegetation and creating channel grade controls. Vegetated channels will also be more aesthetically pleasing and acceptable to the community, as well as providing natural habitat. However, channel widths may need to be increased to maintain sufficient capacity for peak flows. It may not be feasible to control velocities in channels situated on the steeper fringes of the county.

For larger, infrequent storm events, the purpose of control measures in channels should be to minimize the creation of sediment loads. Channel designs should include protective measures such as rip rap, concrete or fabric mats to prevent erosion during high flows.

The control structures described above will need continual maintenance to remove sediment and debris and to harvest vegetation. The level of maintenance required for effective water quality control will likely be greater than that usually performed for flood control purposes only.

Other types of structural controls, such as infiltration trenches, dry wells, water quality inlets, grassed swales, filter strips and porous pavement may be considered by the County as part of the NPDES Stormwater Management Program. However, they are typically more effective for controlling runoff from small areas and would not be appropriate for incorporation into regional facilities. They also do not perform well in cases where runoff contains large amounts of sediment. Diversion of dry weather or "first flush" flows to treatment facilities is another effective measure for reducing pollutant loads to receiving waters and should be considered as part of either the Stormwater Management Program or the Master Plan. This type of structure does not appear to be compatible with any of the structures proposed for flood control purposes.

Nonstructural Controls. The types of nonstructural controls that should be included in the Master Plan include: 1) ordinances that control erosion and transport of sediments from construction sites and newly developed areas and 2) public education. Other nonstructural BMPs, such as street sweeping, catch basin cleaning and control of illegal discharges and emergency spills may be addressed in the Stormwater Management Program.

Regulation of development will be an important means of controlling stormwater runoff quality as well as quantity. Regulations related to water quality include erosion controls during construction and provision of onsite detention facilities. Heavy rains and flood flows in construction areas and developments that have not been revegetated can generate large sediment loads to nearby channels. In addition, increased peak flows from developed areas can cause channel erosion downstream. Regulations and ordinances will need to be reviewed, revised and developed in conjunction with other public entities, and the responsibilities for enforcement will need to be defined.

Public education and information programs developed as part of the Master Plan will need to focus on water quality issues and the role of the individuals in controlling pollution at the source. The public should be educated on the sources of pollution as well as the impacts on the environment. Alternatives for illegal dumping of automotive fluids and hazardous household chemicals will need to be discussed and made available and convenient. The public information program will also be needed to build support for the costs of providing water quality controls. It would be beneficial for the public information program to be combined with the program being developed as part of the Stormwater Management Plan, as many of the same issues will be addressed.

RECOMMENDED FACILITIES

Utilizing the 100-year discharge estimates and the results of the drainage system inventory, regional watercourses within the plan area were evaluated for flood control needs. The flood control facilities identified are structural solutions to flood control which may not prove to be the optimal solution. The final flood control master plan will evaluate various structural and nonstructural solutions and present the recommended optimal solutions. This plan presents the structural solution which should also represent the upper cost limit for each stream or region.

Types of Facilities

The type of flood control facilities evaluated include:

- Detention Basins. Detention basins were utilized where opportunities for construction of conveyance systems downstream are limited because of existing development or where detention at that location would likely result in a system wide benefit (i.e. Dry Creek detention facility could benefit Boynton Slough and Steamboat Creek and possibly the Truckee River).

- Debris Basins. Debris basins were sited on streams which were identified as having a potential for producing significant amounts of sediment and debris with the 100-year discharge. These basins were needed to assure that downstream conveyance facilities were not obstructed by sediment and debris.

- Channels. Channels were used to many locations to either convey the 100-year discharge to a logical point of conclusion or to capture flow and convey flow for discharge into a detention basin. Two basic channel types were used for cost estimation purposes; earthen channels with rock rip-rap erosion protection and concrete lined channels. With the final master plan, vegetative, natural and other

types of linings will be explored where appropriate. In some cases, linear parks could be appropriate with wide shallow flows to reduce velocity, decrease peak flows and reduce erosion potential as well as provide a recreational benefit.

- Culverts and Bridges. Culverts and bridges were utilized at each road crossing that crosses a channel which is identified for improvement, where overtopping of the roadway compounds the flooding hazard for adjoining properties or where all-weather access is needed.

Nonstructural Flood Control Measures

The cost for nonstructural flood control measures is generally not included except where specific flood hazard studies are listed in the cost estimates. Nonstructural measures would generally be implemented by property owners and developers and would not be included directly into the capital improvement program. Nonstructural measures would include the following:

- Identification of floodplains. Floodplain mapping can be used to prevent new construction within the floodplain and assist in identification of the hazards for existing improvements. The current flood maps published by FEMA do not include floodplains for all significant watercourses in the plan area. Many large streams are not currently mapped or are mapped only with approximate methods. Approximate flood zones do not provide information on depth of flow or other data needed to establish a finished floor elevation or evaluate the impact a development might have when it encroaches upon the floodplain. Floodplain information is used regularly by land owners as well as the public agency that regulates uses of the floodplain.

- Floodwalls and Levees. Although floodwalls and levees are structural improvements, they are often classified as nonstructural flood control improvements when they are only localized improvements intended to protect a single structure or property and do not alter the watercourse itself. This type of improvement would be the responsibility of the property owner with guidance provided by the community's building and engineering officials.

- Flood Insurance. In many cases, flood control measures may not be cost effective. In such cases insurance against flood damages may be more practical. Reno, Sparks and Washoe County are all participating in the National Flood Insurance Program. Therefore flood insurance is available through the Federal Insurance Administration (FIA) to every property owner within these communities. Insurance is available regardless of whether or not the property lies in a 100-year flood zone, provided the improvement was constructed before the flood hazard was identified. If the structure was built after the flood hazard was identified the property owner must first demonstrate that the local floodplain management ordinance was complied with during construction of the building. Flood insurance is available from FIA for both structural damage and certain contents, up to a certain limit which varies with the type of improvement (residential or commercial).

- Floodproofing. The term floodproofing encompasses several types of flood damage protection measures for a single building. The type of floodproofing method employed would depend upon the type and depth of flooding that would be expected. Examples would include; watertight doors/walls (dry floodproofing), relocating damage prone contents to an upper floor or high enough to prevent damage to that item (wet floodproofing), raising the entire structure on piers or piles, or relocating the entire structure to a portion of the property that is not floodprone.

Organization of Data

For the purpose of evaluating flood control needs and organizing the inventory data, the entire County was subdivided into 37 major drainage provinces or basins. These basins are shown on Figures 5 and 6. The basin numbers identified in Table 3 are for individual watersheds within drainage provinces 28 through 36. Basins 1 through 23 comprise the northern portion of the County.

Each of the major basins were evaluated for flood control needs to protect existing improvements and for protection of transportation corridors. Each of the basins were categorized according to study level which will be described below. Additional description of each basin is also contained in Volume II of this report.

Study Level Designations

Each basin was evaluated with respect to: Percentage of private land, presence of public and private improvements subject to flood damage, presence of roads and highways subject to significant damage which could result in access difficulties for area residents, and potential for future development that might compound existing flooding problems or create a greater need for flood control. Each basin was identified to be in one of three categories numbered from one to three.

- Level 1. Most detailed level of analysis and facilities planning. Seven of the 37 drainage provinces were identified for Level 1 analysis. A level 1 area is an area with a significant amount of existing development and/or projected future development. These areas need regional flood control improvements to satisfy existing deficiencies and also have need for mitigation of the impacts from future development. These areas warrant the most detailed level of analysis in the Final Concept Level Flood Control Master Plan. These provinces include; Cold Springs, Lemmon and Spanish Springs Valleys, the Truckee Meadows and the Lake Tahoe and Washoe Lake areas.

- Level 2. A level 2 area contains major transportation routes which traverse the area and smaller communities or sparsely populated areas. The roadways may not provide all weather access for the

populations served by these transportation facilities. Existing development may have minor drainage deficiencies or sparsely populated areas subject to flooding, but these deficiencies may not be cost effectively resolved with regional flood control facilities. Some limited flood control improvements may be warranted where the improvements will result in significant damage potential reduction or improved public safety. Flood hazard studies may be warranted in many of these areas to identify flooding hazards and provide the communities with floodplain management tools for use in regulating future development. Drainage provinces were included in this category.

- Level 3. A level 3 area contains only sparse improvements and transportation facilities which only serve a small number of people. Damage to these facilities should not isolate the majority of users since other exit and entrance routes are available. Regional flood control facilities would not be cost effective in Level 3 areas. No hydrologic analysis or flood control facilities planning is to be conducted at this time. Many of these areas will need to be re-evaluated in the future with the preparation of Concept Level Flood Control Master Plan updates. 23 of the 37 drainage provinces were included in this category.

Figure 7 is an index of the more detailed maps of the Truckee Meadows and other Level 1 areas which have been identified as being in need of regional flood control facilities. Figures A-1 through D-7 identify the concept level facilities plan schematic. These facilities are the basis for the capital improvement costs presented in Table 1.

MATCH LINE SEE FIGURE 6 PG. 13

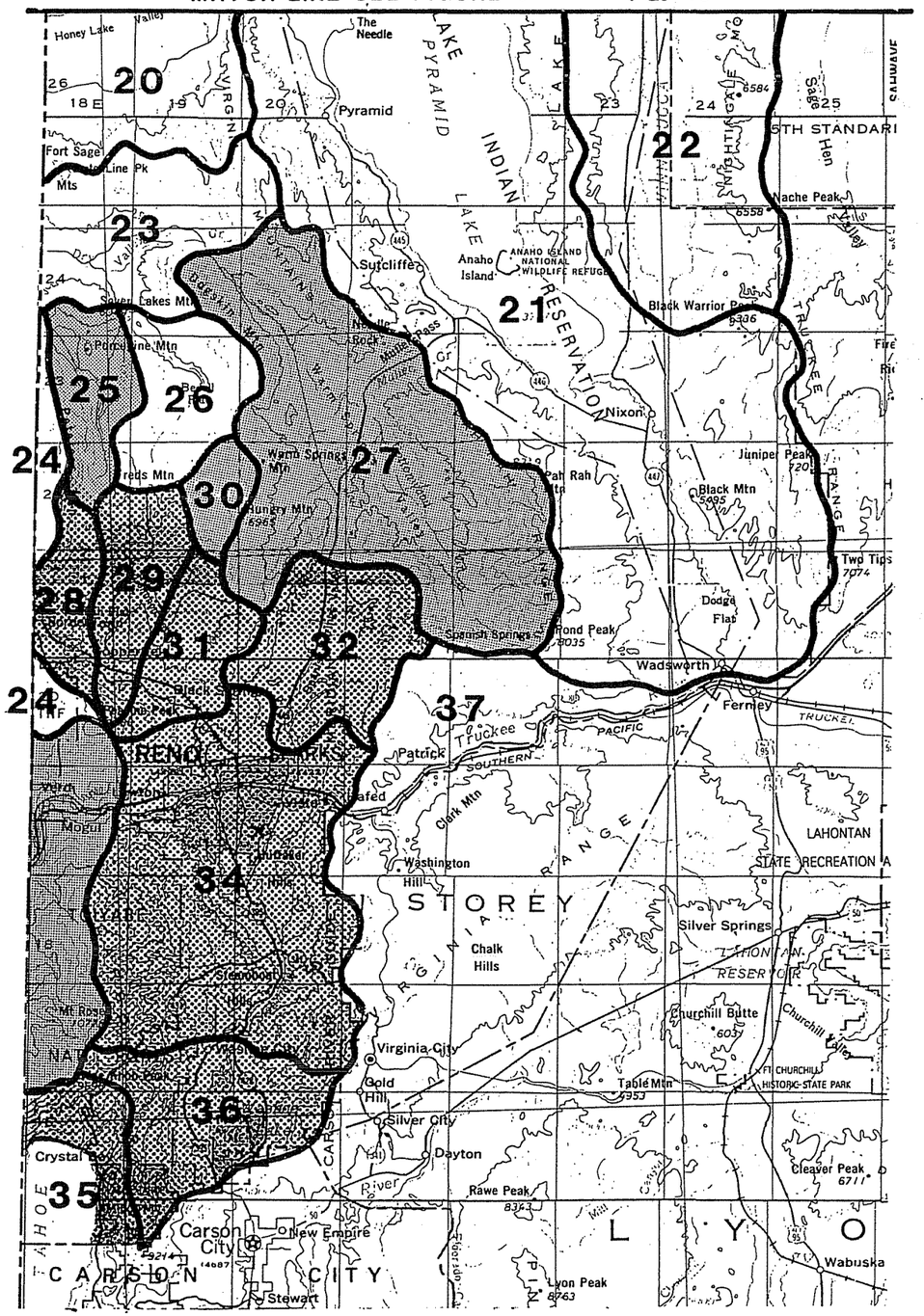


FIGURE 6 LEFT

FIGURE 6 RIGHT

FIGURE 5

WASHOE COUNTY, NEVADA

Index Map

LEGEND

COUNTY BOUNDARY

BASIN BOUNDARY

BASIN NUMBER 18

STUDY LEVEL 1

STUDY LEVEL 2

STUDY LEVEL 3

CULVERT OR BRIDGE

N

0 10 20

SCALE IN MILES

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY

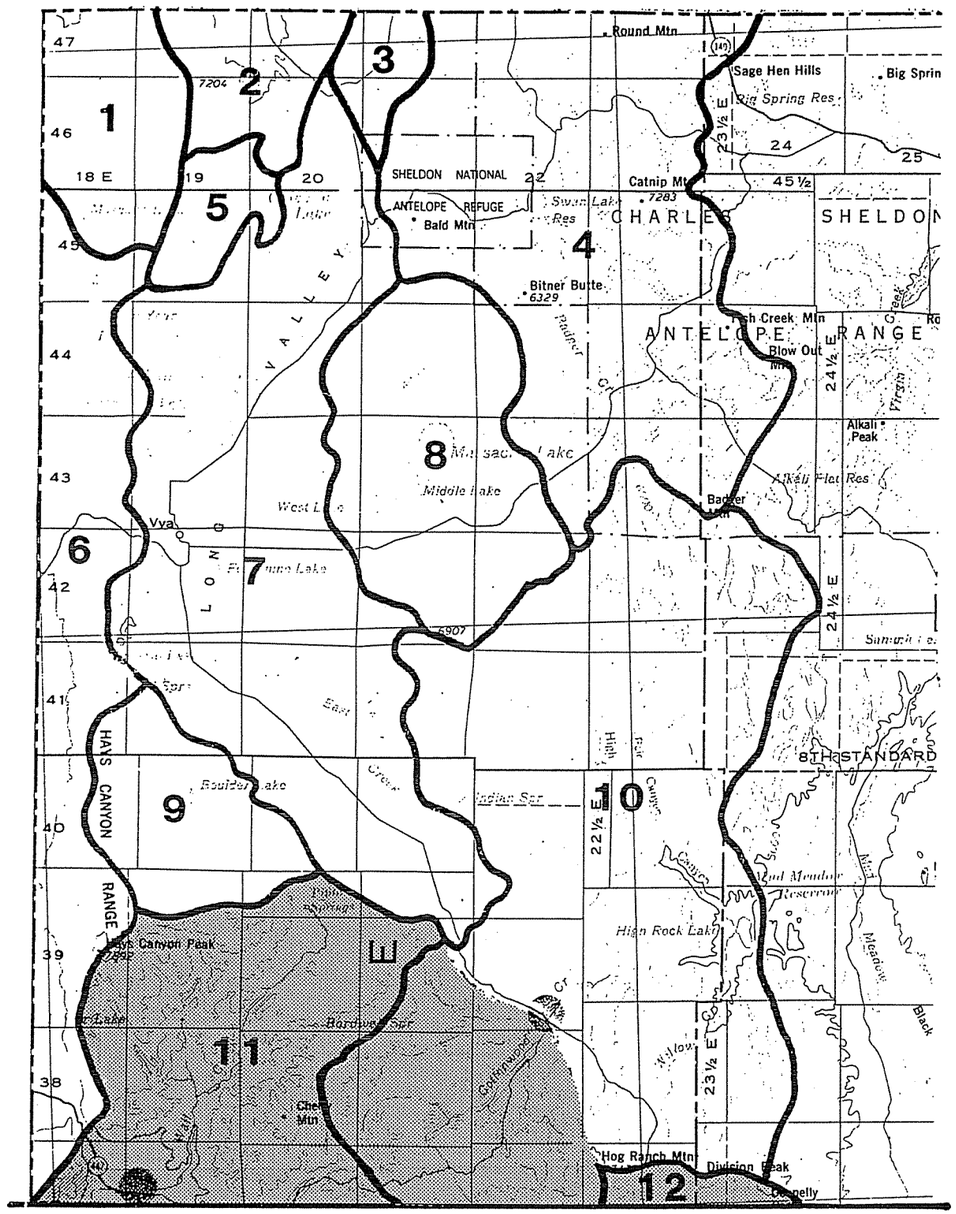
CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

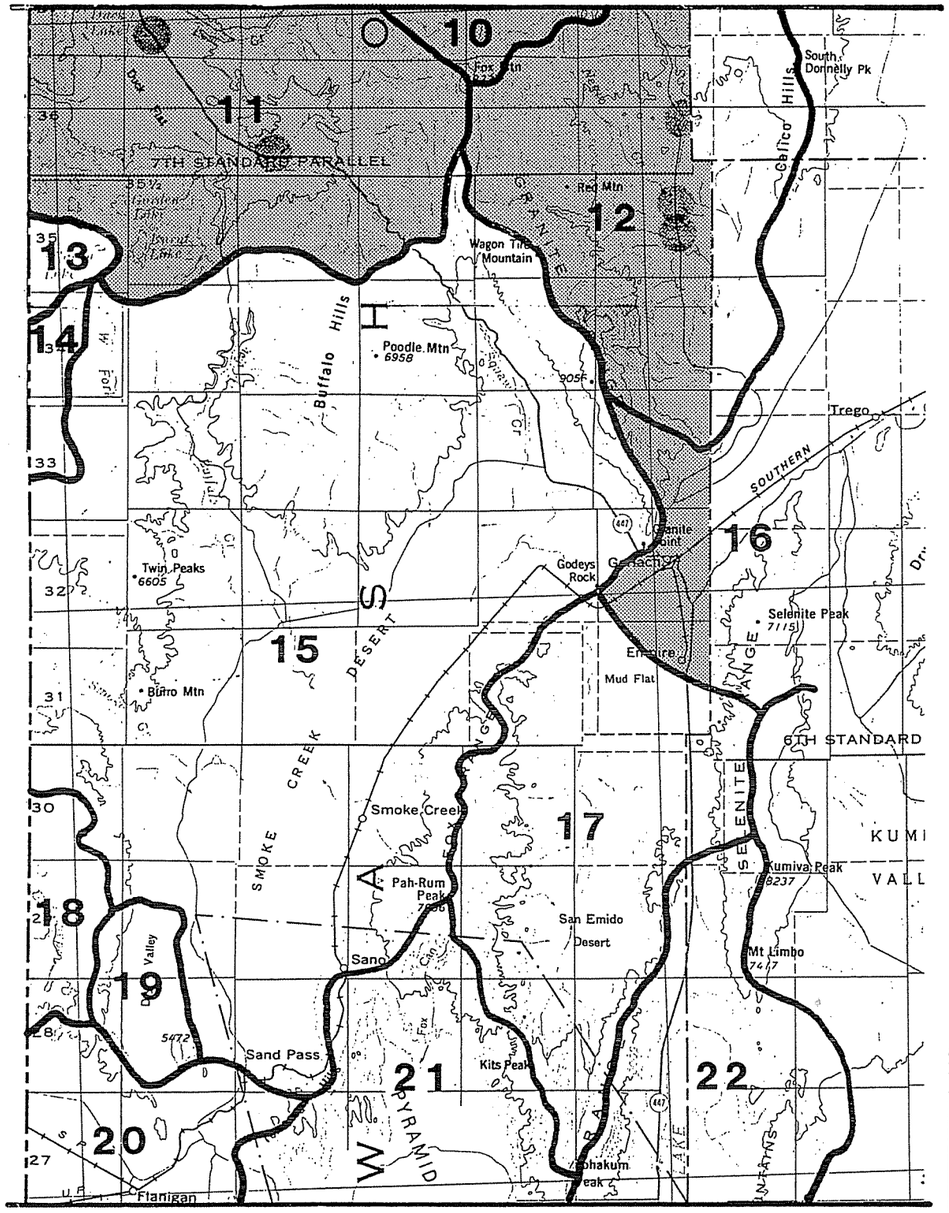
April 1991

Figure 5

MATCH LINE SEE BELOW



MATCH LINE SEE ABOVE



MATCH LINE SEE FIGURE 5 PG. 12

LEGEND

COUNTY BOUNDARY

BASIN BOUNDARY

BASIN NUMBER 18

STUDY LEVEL 1

STUDY LEVEL 2

STUDY LEVEL 3

CULVERT OR BRIDGE

N

0 10 20

SCALE IN MILES

Kennedy/Jenks/Chilton

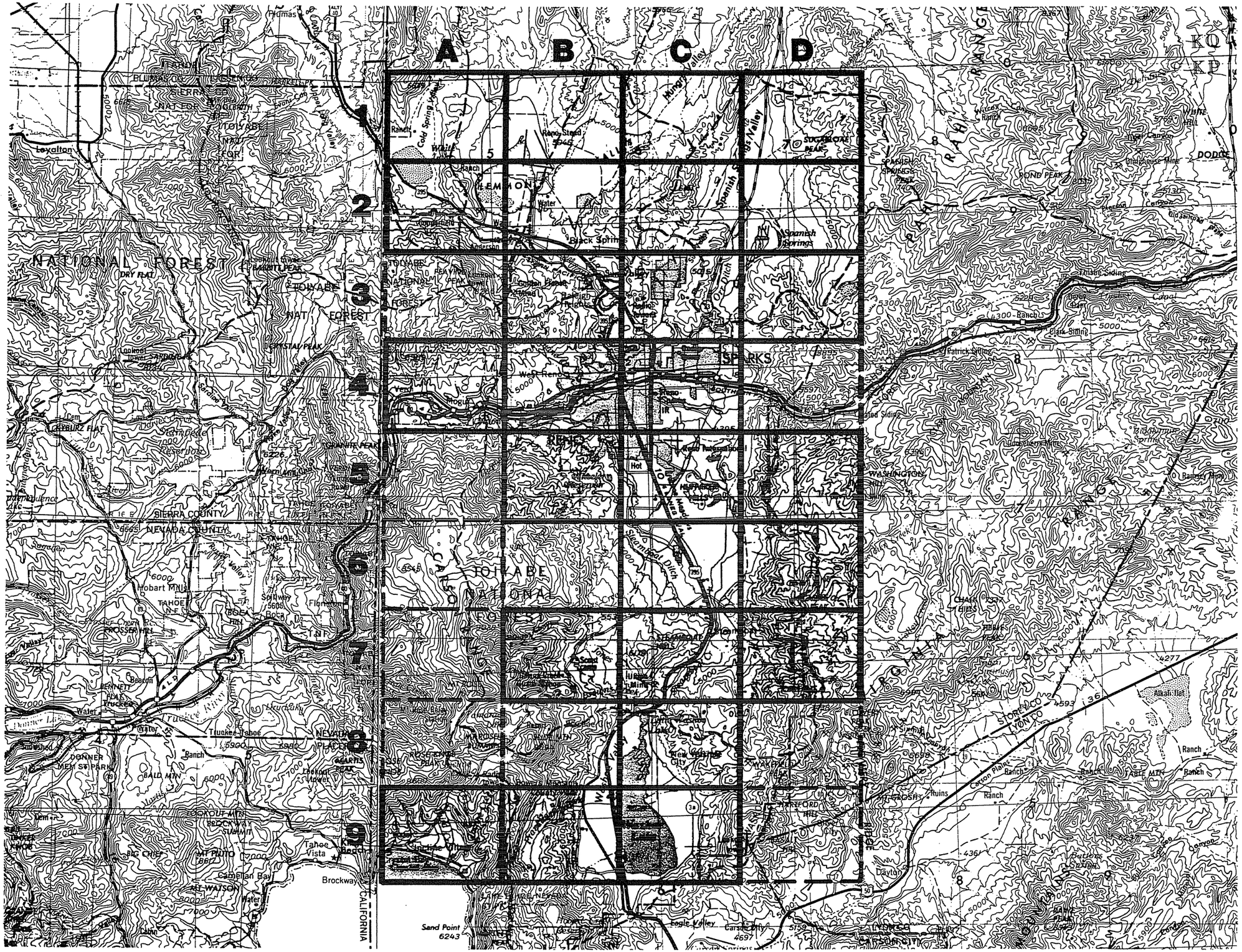
Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure 6



N

0 20000 40000

SCALE

LEGEND

- MAP BORDERS
- COUNTY/STATE LINE
- MAJOR DRAINAGE BASIN BOUNDARY
- MAPS INCLUDED IN THIS REPORT

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT INDEX MAP

K/J/C 897043.01

April 1991

Figure 7

Introduction (Figure A-1)

Figure A-1 shows the northern portion of the Cold Springs Valley area. A large playa known as White Lake, lies in the south central portion of Cold Springs Valley. The majority of the existing development rural and suburban land use. Much of the existing development, such as Border Town, is located on the northern and eastern sides of White Lake.

Principal Flooding Problems

Flooding within the area on Figure A-1, occurs around the edge of White Lake and from the drainages entering the lake from the north. White Lake is a playa or closed basin lake which means there is no natural outlet for the lake and it only contains water during wet years. All of the runoff volume entering the lake must leave the lake by evaporation or infiltration.

Due to the fact that the lake only contains water during wet years, development has occurred along the fringes of the lake where the danger of flooding is not apparent. Extreme flooding associated with the playa could potentially cause damage to Reno Park Boulevard and adjoining properties. Flooding associated with the playa could also last for an extended period of time (days or weeks) which would aggravate flooding damages.

The approximate extent of 100-year flooding associated with White Lake is shown on the current FEMA Flood Insurance Rate Maps. For the purposes of this study, the extent of flooding associated with White Lake was re-evaluated by comparative analysis using data from a recent study of Silver Lake and Lemmon Valley playas. The approximate extent of flooding resulting from that analysis is shown on Figure A-1 and A-2. A more detailed 100-year lake level and associated floodplain needs to be estimated for White Lake for regulatory and information purposes.

Flooding associated with the primary tributaries to the playa could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Future low density residential development in this portion of the Cold Springs Valley will not significantly increase downstream peak discharges but could increase runoff volumes to White Lake. Medium and high density residential and industrial/commercial development, especially when natural drainages are channelized, will cause an increase in both downstream peaks and volumes. An increase in runoff volume to White Lake could aggravate flooding damages for existing improvements near the lake. Procedures should be developed to require future developments to mitigate the impacts caused by development. Retention of increases in runoff volumes may be necessary in order to prevent increases in peak lake levels.

Non-Structural Flood Control Measures

Structural flood control measures to control flooding on the fringes of White Lake, would be difficult and expensive. Construction of levees to prevent flooding of the areas around the lake would also result in impoundment of the flow attempting to enter the lake. Due to the high cost of levees and the pumps required to evacuate the water impounded behind the levees, non-structural flood control measures were explored.

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures. Flood walls and levees around structures, are not always an effective solution in areas subject to flooding for an extended period of time, as is the case for the properties subject to flooding from White Lake, because of seepage under the walls or levees from saturated soils.

A 100-year lake level and associated floodplain needs to be estimated for White Lake for regulatory and information purposes.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the two primary tributaries to White Lake. These improvements consist of channel improvements and culverts at the roadway crossings. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure A-1). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	U/S OF COLD SPRINGS DR	CHANNEL	WASHOE	230
2	COLD SPRINGS DRIVE	CULVERT	WASHOE	165
3	COLD SPR DR - PINON AVE	CHANNEL	WASHOE	160
4	PINON AVENUE	CULVERT	WASHOE	225
5	PINON AVE - MESQUITE	CHANNEL	WASHOE	215
6	MESQUITE AVENUE	CULVERT	WASHOE	320
7	MESQUITE - RENO PARK BL	CHANNEL	WASHOE	550
8	RENO PARK BOULEVARD	CULVERT	WASHOE	155
9	MUDSPRNGS - COLD SPR DR	CHANNEL	WASHOE	860
10	COLD SPRINGS DR	CULVERT	WASHOE	165
11	COLD SPR DR - RENO PK BL	CHANNEL	WASHOE	390
12	RENO PARK BOULEVARD	CULVERT	WASHOE	205

	TOTAL CAPITAL IMPROVEMENT COSTS:	$3,640,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,456,000
	OPERATION & MAINTENANCE (2%)	$ 72,800
	ENGINEERING & CONST MGMT (30%)	$1,092,000
	ADMINISTRATION & LEGAL (10%)	$ 364,000
	TOTAL COSTS:	$6,624,800

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

MATCH LINE SEE FIGURE B-1

APPROX. EXTENT OF 100-YEAR FLOODING ASSOCIATED WITH WHITE LAKE

LIMIT OF EXISTING FEMA ZONE A

MATCH LINE SEE FIGURE A-2

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure A-1

Introduction (Figure A-2)

Figure A-2 shows the southern portion of the Cold Springs Valley and the western portion of Silver Lake. Existing development in this area consists primarily of rural development. A large lake known as White Lake, lies in the south central portion of Cold Springs Valley and in the northwest corner of the figure. Silver Lake lies on the eastern edge of the figure and Highway 395 traverses the figure from the northwest to southeast corners.

Principal Flooding Problems

Flooding within the area on Figure A-2, occurs around the edges of White and Silver Lakes and from the drainages entering the lakes. Both lakes are playas or closed basin lakes which means there is no natural outlet for these lakes and they only contain water during wet years. All of the runoff volume entering the lakes must leave the lakes by evaporation or infiltration.

Due to the fact that the lakes only contain water during some wet years, development has occurred along the fringes of the lake where the danger of flooding is not apparent. Extreme lake levels could potentially cause damage to improvements that have encroached too closely to the lakes such as; Highway 395 at White Lake, Red Rock Road at Silver Lake, and adjoining properties. Flooding associated with the playas could also last for an extended period of time (days or weeks) which would aggravate flooding damages.

In February 1986, Silver Lake rose to the point where it was inundating private property. The estimated 100-year lake level in Silver Lake is approximately five feet higher than the lake level experienced in February 1986. This estimated lake level and extent of 100-year flooding are shown on the current FEMA Flood Insurance Rate Maps and on Figure A-2. The 100-year lake level for White Lake was estimated from comparative analysis using data from a recent study of Silver Lake and Lemmon Valley playas. The lake level resulting from this comparative analysis is also shown on Figure A-2.

Flooding associated with the primary tributaries to the playa could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many residential and commercial properties. Flooding of low lying areas just south of Highway 395 at White Lake could also occur from floodwaters accumulating at the culvert inlets.

Effects of Future Development

Future low density residential development in this portion of the Cold Springs Valley and Silver Lake watershed will not significantly increase downstream peak discharges but could increase runoff volumes. Medium and high density residential and industrial/commercial development, especially when natural drainages are channelized, will cause an increase in both downstream peaks and volumes. An increase in runoff volume to White and Silver Lakes could aggravate flooding damages for existing improvements near these lakes. Procedures should be developed to require future developments to mitigate the impacts caused by development. Retention of increases in runoff volumes may be necessary in order to prevent increases in peak lake levels.

Non-Structural Flood Control Measures

Structural flood control measures to control flooding on the fringes of White and Silver Lakes, would be difficult and expensive. Construction of levees to prevent flooding of the areas around the lake would also result in impoundment of the flow attempting to enter the lake. Due to the high cost of levees and the pumps required to evacuate the water impounded behind the levees, non-structural flood control measures were explored.

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures. Flood walls and levees around structures, are not always an effective solution in areas subject to flooding for an extended period of time, as is the case for the properties subject to flooding from Silver and White Lakes, because of seepage under the walls or levees from saturated soils.

A more defensible 100-year lake level and associated floodplain also needs to be estimated for White Lake for regulatory and information purposes.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the primary tributary entering at the southwest corner of Silver Lake. These improvements are culvert replacements at Red Rock Road, Highway 395 and Moya Boulevard. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure A-2). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	RED ROCK ROAD	CULVERT	WASHOE	365
2	MOYA BOULEVARD	CULVERT	RENO	365
3	US 395	CULVERT	WASHOE	700

	TOTAL CAPITAL IMPROVEMENT COSTS:	$1,430,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 572,000
	OPERATION & MAINTENANCE (2%)	$ 28,600
	ENGINEERING & CONST MGMT (30%)	$ 429,000
	ADMINISTRATION & LEGAL (10%)	$ 143,000
	FLOOD HAZARD STUDY	$ 20,000
	TOTAL COSTS:	$2,622,600

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE A-1

White Lake

LIMIT OF EXISTING FEMA ZONE A

APPROX. EXTENT OF 100-YEAR FLOODING ASSOCIATED WITH WHITE LAKE

APPROX. EXTENT OF 100-YEAR FLOODING ASSOCIATED WITH SILVER LAKE

Silver Lake

ANTELOPE HILLS

SANTA FE RD

PLATA MESA

WESTERN

PACIFIC

JEEP TRAIL

WASHOE CO

TOIYABE NATIONAL FOREST

Prospects

Dry Lake Summit

Granite Peak

Copperfield

Anderson

Red Metal Mine

BM 5208

BM 5320

BM 5373

395

N

0 2000 4000

SCALE: 1"=2000'

MATCH LINE SEE FIGURE B-2

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure A-2

Introduction (Figure A-4)

Figure A-4 includes the communities of Verdi and Mogul. Existing development in this area consists primarily of rural development in the Verdi area and some newer suburban density units in the Mogul area.

Principal Flooding Problems

Flooding within the area on Figure A-4, occurs in the floodplain of the Truckee River and from the drainages entering the river from the north and south. During the 1986 flooding event, Dog Creek damaged properties in the vicinity of Bridge Street due to both flooding and migration of the Dog Creek channel.

Effects of Future Development

There has been significant development activity near the Truckee River in the Verdi and Mogul areas. These newer developments consist of rural and suburban density residential units. The upper portions of the watersheds that contribute to the Truckee River in this area, have slopes which would be too steep to allow development of significant magnitude. The areas which are conducive to development are the lower portions of the watershed. Development in the lower portions of the watershed generally has less impact on the peak discharges from these tributary streams.

Future development in this area may have a slight impact on peak discharges entering the Truckee River, but would have a minimal impact on the peak discharges within the developed areas. The impacts on the Truckee River peak discharges caused by future development in this area, would be minor.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with the watercourses that enter the Truckee River in this area. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the primary tributaries entering the Truckee River from the north. These improvements consist of channel and bridge improvements on Dog Creek, channel improvements in the eastern Verdi area and two detention basins in the two largest watersheds in the Mogul area.

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure A-4). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	DOG VALLEY CK U/S BDG ST	CHANNEL	WASHOE	400
2	DOG VALLEY CK @ BRIDGE ST	BRIDGE	WASHOE	215
3	DOG VALLEY CK D/S BRIDGE ST	CHANNEL	WASHOE	200
4	N FLAT WASH U/S OLD 40	CHANNEL	WASHOE	210
5	N FLAT WASH D/S OLD 40	CHANNEL	WASHOE	165
6	MOGUL WASH W	DET BASIN	WASHOE	695
7	MOGUL WASH E	DET BASIN	WASHOE	1105

	TOTAL CAPITAL IMPROVEMENT COSTS:	$2,990,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,196,000
	OPERATION & MAINTENANCE (2%)	$ 59,800
	ENGINEERING & CONST MGMT (30%)	$ 897,000
	ADMINISTRATION & LEGAL (10%)	$ 299,000
	TOTAL COSTS:	$5,441,800

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

N

0 2000 4000

SCALE: 1"=2000'

MATCH LINE SEE FIGURE B-4

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure A-4

Introduction (Figure A-9)

Figure A-9 includes the community of Incline Village. Existing development in this area consists primarily of suburban development. Due to development restrictions resulting from environmental concerns in the Lake Tahoe region, future development will be limited.

Principal Flooding Problems

Flooding within Incline Village occurs primarily from thunderstorms in the steep watersheds surrounding Incline Village. One such storm occurred on the Second Creek drainage in August 1967. Extreme runoff events like the 1967 event carry significant amounts of sediment and debris which can block culverts and channels and aggravate flooding damages. Debris flows also present a significant public safety problem because of the high flow velocities and large amounts of material that can be mobilized by the flow. Boulders as large as seven feet in diameter were mobilized by the mud flow of August 1967. One such boulder was deposited on Silver Tip Drive just upstream of Tahoe Boulevard. Similar events also occurred on Third Creek in August 1965.

Effects of Future Development

As indicated above, the Incline Village area is not likely to experience significant future development activity because of the environmental concerns and development restrictions in the Lake Tahoe region. Therefore, existing peak discharges should not change significantly.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Flood Control System Elements and Cost Estimates

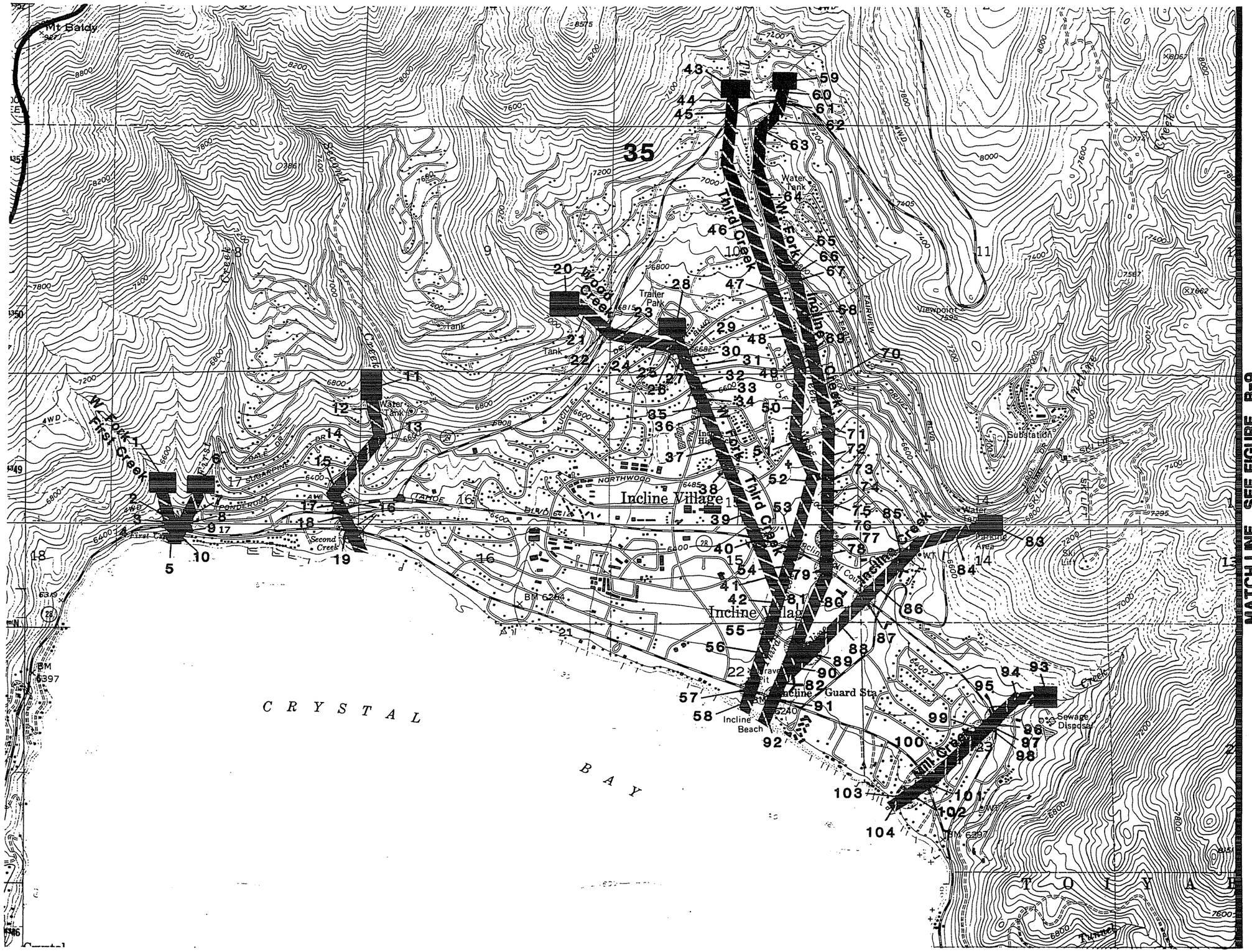
Structural flood control improvements have been identified for First Creek, Second Creek, Third Creek and it's tributaries, Incline Creek and Mill Creek. These improvements consist of debris basins to capture incoming debris and sediment from the offsite areas, channel improvements and culverts where the roadways cross these channels. Due to the environmental sensitivity of the area, the channels will need to be as natural as the design will allow. Rock and vegetative armoring will need to be used as much as possible. Regular maintenance will also be required to remove debris from channels and culverts. The debris basins will also require regular maintenance to assure continued effectiveness.

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure A-9). These improvements are identified by number and the preliminary cost for each of these components is as follows:

STREAM	IMPROVEMENT NUMBER	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
FIRST CREEK	1	DEBRIS BSN	WASHOE	860
		CULVERTS	WASHOE	235
		CHANNELS	WASHOE	260
W. FORK FIRST CREEK	6	DEBRIS BSN	WASHOE	860
		CULVERTS	WASHOE	235
		CHANNELS	WASHOE	260
SECOND CREEK	11	DEBRIS BSN	WASHOE	860
		CULVERTS	WASHOE	555
		CHANNELS	WASHOE	490
WOOD CREEK	20	DEBRIS BSN	WASHOE	865
		CULVERTS	WASHOE	735
		CHANNELS	WASHOE	840
W. FORK THIRD CREEK	28	DEBRIS BSN	WASHOE	865
		CULVERTS	WASHOE	2920
		CHANNELS	WASHOE	2695
THIRD CREEK	43	DEBRIS BSN	WASHOE	865
		CULVERTS	WASHOE	2650
		CHANNELS	WASHOE	5850
W. FORK INCLINE CREEK	59	DEBRIS BSN	WASHOE	860
		CULVERTS	WASHOE	2600
		CHANNELS	WASHOE	8375
INCLINE CREEK	83	DEBRIS BSN	WASHOE	865
		CULVERTS	WASHOE	1410
		CHANNELS	WASHOE	2970
MILL CREEK	93	DEBRIS BSN	WASHOE	860
		CULVERTS	WASHOE	995
		CHANNELS	WASHOE	1480

	TOTAL CAPITAL IMPROVEMENT COSTS:	$43,315,000
OTHER COSTS:	CONTINGENCIES (40%)	$17,326,000
	OPERATION & MAINTENANCE (2%)	$ 886,300
	ENGINEERING & CONST MGMT (30%)	$12,994,500
	ADMINISTRATION & LEGAL (10%)	$ 4,331,500
	TOTAL COSTS:	$78,833,300

Slightly higher unit costs were used in developing cost estimates for Incline Village due to higher construction costs in this area and environmental sensitivity factors. These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.



Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure A-9

Introduction (Figure B-1)

Figure B-1 includes the northern portion of Lemmon Valley and Reno-Stead Airport. Existing land use in this area is classified as rural and suburban.

Principal Flooding Problems

Flooding within the area on Figure B-1, occurs around the edge of the lake in Lemmon Valley and from the drainages entering the lake from the north and east. The lake in Lemmon Valley is a playa or closed basin lake which means there is no natural outlet for the lake and it only contains water in wet years. All of the runoff volume entering the lake must leave the lake by evaporation or infiltration.

Due to the fact that the lake only contains water during wet years, development has occurred along the fringes of the lake where the danger of flooding is not apparent. Extreme lake levels could potentially cause damage to improvements that have encroached too closely to the lake such as Lemmon Drive and many adjoining private properties. Flooding associated with the lake could also last for an extended period of time (days or weeks) which would aggravate flooding damages.

In February 1986, the lake rose to the point where it was inundating many private properties and caused a significant amount of damage to private property. The estimated 100-year lake level is approximately three feet higher than the maximum lake level experienced in February 1986. The estimated lake level and extent of 100-year flooding are shown on the current FEMA Flood Insurance Rate Maps and is also shown on Figure B-1.

Flooding associated with the primary tributaries to the playa could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Land use projections indicate additional suburban development within this area. Future residential development in this portion of Lemmon Valley could cause a slight increase in downstream peak discharges and an increase in runoff volumes to the playa. An increase in runoff volume to the playa could aggravate flooding damages for existing improvements near the lake. Procedures should be developed to require future developments to mitigate the impacts caused by development. Retention of increases in runoff volumes may be necessary in order to prevent increases in peak lake levels.

Non-Structural Flood Control Measures

Structural flood control measures to control flooding on the playa would be difficult and expensive. Construction of levees to prevent flooding of the areas around the lake would also result in impoundment of the flow attempting to enter the lake. Due to the high cost of levees and the pumps required to evacuate the water impounded behind the levees, non-structural flood control measures were explored.

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures. Use of flood walls and levees around structures is not always an effective solution in areas subject to flooding for an extended period of time, as is the case for the properties subject to flooding from the playa, due to the potential for seepage under the walls or levees from saturated soils.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the two primary tributaries to the playa. These improvements consist of channel improvements and culverts at the roadway crossings. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure B-1). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1-25	IDAHO DRIVE CHANNEL	CHANNEL	WASHOE	2855
1-25	IDAHO DRIVE CHANNEL	CULVERTS	WASHOE	2020
26	CHICKADEE DR CHANNEL	CHANNEL	WASHOE	2370
27	LEMMON VALLEY DR	CULVERT	WASHOE	415
28	CHICKADEE DR CHANNEL	CHANNEL	WASHOE	2880

	TOTAL CAPITAL IMPROVEMENT COSTS:	$10,540,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 4,216,000
	OPERATION & MAINTENANCE (2%)	$ 210,800
	ENGINEERING & CONST MGMT (30%)	$ 3,162,000
	ADMINISTRATION & LEGAL (10%)	$ 1,054,000
	TOTAL COSTS:	$19,182,000

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE A-1

MATCH LINE SEE FIGURE C-1

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

APPROX. EXTENT OF 100-YEAR FLOODING ASSOCIATED WITH LAKE

MATCH LINE SEE FIGURE B-2

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-1

Introduction (Figure B-2)

Figure B-2 includes the southern portion of Lemmon Valley, the community of Stead and Reno-Stead Airport. Existing land use in this area ranges from rural to industrial.

Principal Flooding Problems

Flooding within the area on Figure B-2, occurs around the edge of the playa in Lemmon Valley, Silver Lake and from the drainages entering the playas from the south and east. Silver Lake and the lake in Lemmon Valley are playas or closed basin lakes which means there is no natural outlet for these lakes and they contain water only in wet years. All of the runoff volume entering the lakes must leave the lakes by evaporation or infiltration.

Due to the fact that the lakes only contain water during wet years, development has occurred along the fringes of the lakes where the danger of flooding is not apparent. Extreme lake levels could potentially cause damage to Moya Boulevard, Lemmon Drive, the sewage treatment plant and adjoining properties. Flooding associated with the lake could also last for an extended period of time (days or weeks) which would aggravate flooding damages.

In February 1986, both lakes rose to the point where they were inundating many private properties and homes and caused a significant amount of damage to private and public property. The estimated 100-year lake level in Silver Lake and the playa in Lemmon Valley are approximately five and three feet higher, respectively, than the maximum lake levels experience in February 1986. The approximate extent of flooding is also shown on Figure B-1.

Flooding associated with the primary tributaries to the playa could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Land use projections indicate additional suburban development within this area. Future residential, commercial and industrial development in these portions of Lemmon Valley could cause increases in downstream peak discharges and significant increases in runoff volumes to the lakes. An increase in runoff volume to the lakes could aggravate flooding damages for existing improvements near the lakes. Procedures should be developed to require future developments to mitigate the impacts caused by development. Retention of increases in runoff volumes may be necessary in order to prevent increases in peak lake levels.

Non-Structural Flood Control Measures

Structural flood control measures to control flooding on the playa would be difficult and expensive. Construction of levees to prevent flooding of the areas around the lake would also result in impoundment of the flow attempting to enter the lake. Due to the high cost of levees and the pumps required to evacuate the water impounded behind the levees, non-structural flood control measures were explored.

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures. Use of flood walls and levees around structures is not always an effective solution in areas subject to flooding for an extended period of time, as is the case for the properties subject to flooding from these playas, due to the potential for seepage under the walls or levees from saturated soils.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

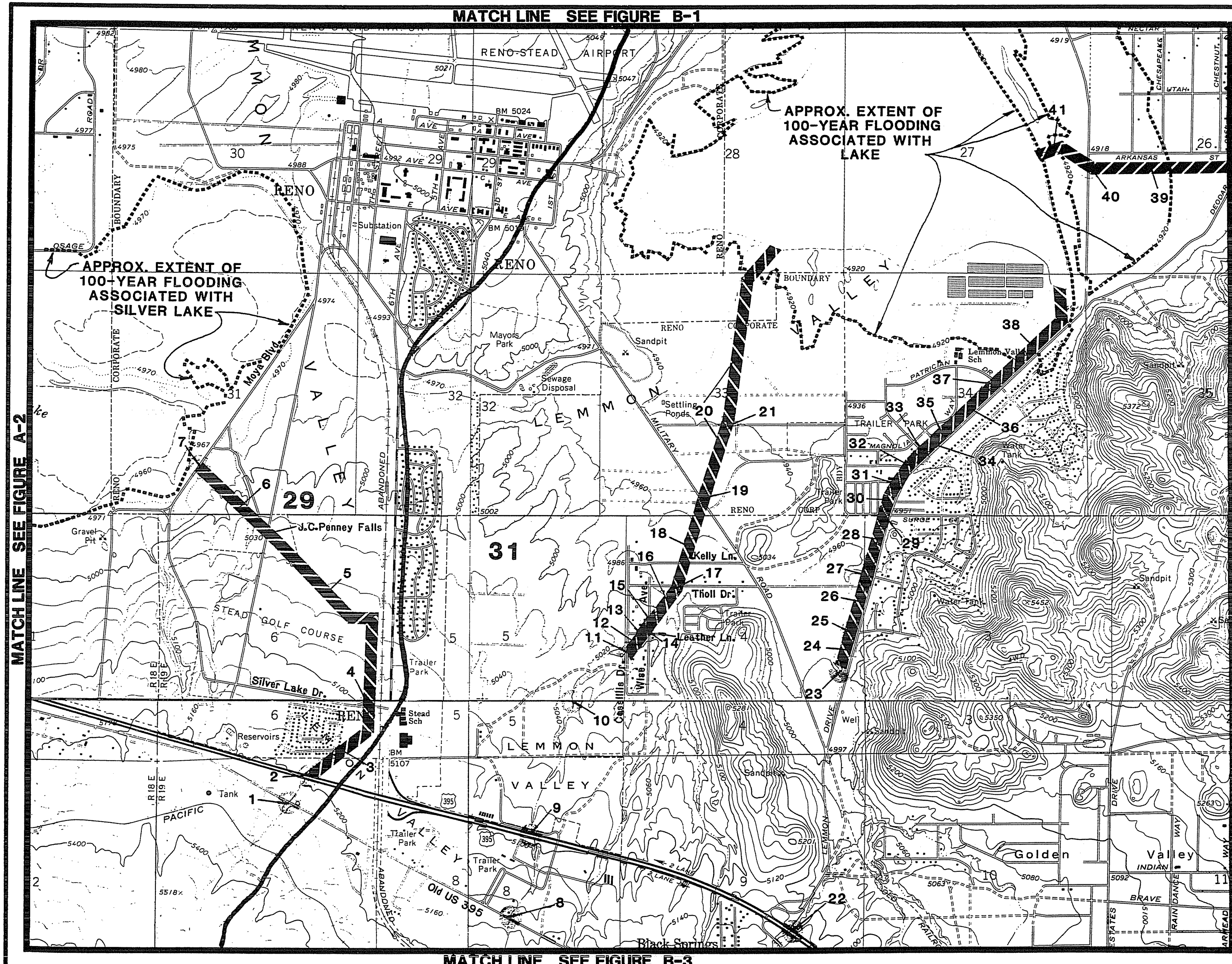
Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the two primary tributaries to the playa. These improvements consist of channel improvements and culverts at the roadway crossings. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure B-2). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	OLD 395	CULVERT	WASHOE	130
2	US 395	CULVERT	WASHOE	440
3-7	US 395 - SILVER LAKE	CULVERTS	RENO	540
3-7	US 395 - SILVER LAKE	CHANNEL	RENO	1370
8	OLD 395	CULVERT	WASHOE	85
9	US 395	CULVERT	WASHOE	385
10	SILVER LAKE DRIVE	CULVERT	WASHOE	70
11-19	CASSILIS DR TO MILITARY RD	CULVERTS	WASHOE	415
11-19	CASSILIS DR TO MILITARY RD	CHANNEL	WASHOE	885
20	MILITARY RD TO LAKE	CHANNEL	RENO	1200
21	UNNAMED ROAD	CULVERT	RENO	90
22	US 395	CULVERT	WASHOE	415
23-38	LEMMON VALLEY DRIVE	CULVERTS	WASHOE	2490
23-38	LEMMON VALLEY DRIVE	CHANNEL	WASHOE	5745
39	DEODAR - LEMMON VAL DR	CHANNEL	WASHOE	1015
40	LEMMON VALLEY DR	CULVERT	WASHOE	160
41	LEMMON VALLEY DR - LAKE	CHANNEL	WASHOE	420

	TOTAL CAPITAL IMPROVEMENT COSTS:	$15,855,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 6,342,000
	OPERATION & MAINTENANCE (2%)	$ 317,100
	ENGINEERING & CONST MGMT (30%)	$ 4,756,500
	ADMINISTRATION & LEGAL (10%)	$ 1,585,500
	TOTAL COSTS:	$28,856,100

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.



LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-2

Introduction (Figure B-3)

Figure B-3 includes the extreme southern portion of Lemmon Valley and the extreme northern portion of the Truckee Meadows area. Existing land use in this area ranges from rural to industrial.

Principal Flooding Problems

Flooding within the area on Figure B-3, occurs from the streams on the northern slope of Pevine Mountain. In February 1986, many of these streams had a significant amount of flow that caused damage to public and private property. Flooding occurred in Lemmon Valley along Lemmon Drive and near Military Road. The area in the southeast quadrant of this figure is the upper portion of the Evans Creek watershed which traverses the University of Nevada campus. In February 1986, Evans Creek caused a significant amount of damage to buildings and contents on the University Campus.

Flooding associated with these streams could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Future residential, commercial and industrial development in this area could cause increases in downstream peak discharges and runoff volumes to the lake in Lemmon Valley (Figure B-2). An increase in runoff volume to the lakes could aggravate flooding damages for existing improvements near the lake. Procedures should be developed to require future developments to mitigate the impacts caused by development. Retention of increases in runoff volumes may be necessary in order to prevent increases in peak lake levels.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

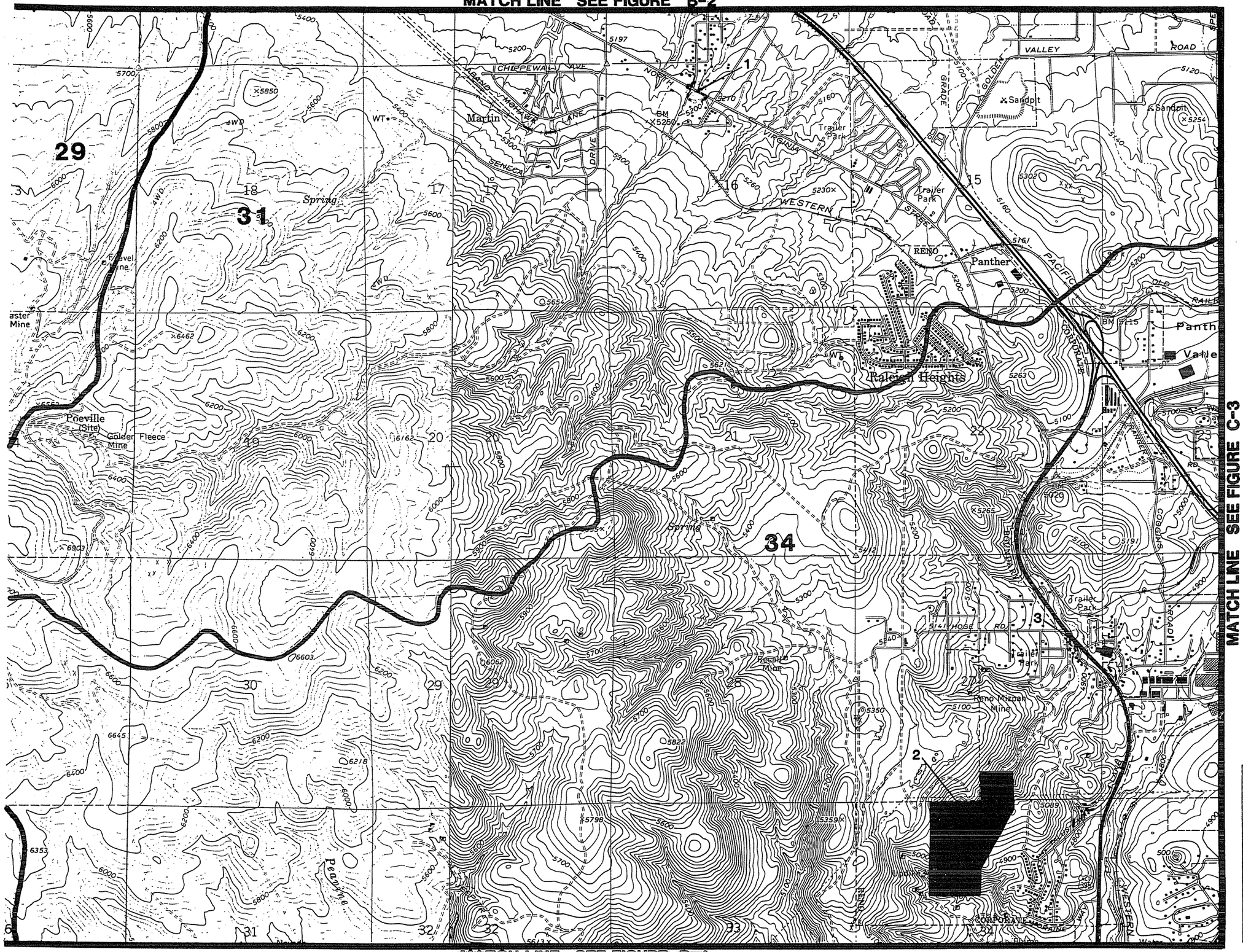
Only two structural flood control improvements have been identified for the concept level plan. These improvements consist of one culvert improvement and one detention facility. The detention facility is located in the Evans Creek watershed and would serve to reduce the peak discharges in Evans Creek. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure B-3). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	LEMMON VAL W @ OLD 395	CULVERT	WASHOE	110
2	BLOCK N WASH DAM SITE	DET BASIN	RENO	2600
3	OLD 395	CULVERT	WASHOE	295

	TOTAL CAPITAL IMPROVEMENT COSTS:	$3,005,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,202,000
	OPERATION & MAINTENANCE (2%)	$ 60,100
	ENGINEERING & CONST MGMT (30%)	$ 901,500
	ADMINISTRATION & LEGAL (10%)	$ 300,500
	TOTAL COSTS:	$5,469,100

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE B-2



MATCH LINE SEE FIGURE B-4

MATCH LINE SEE FIGURE C-3

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-3

Introduction (Figure B-4)

Figure B-4 includes the northwestern portion of the Truckee Meadows area. Existing land use in this area ranges from rural to industrial.

Principal Flooding Problems

Flooding within the area on Figure B-4, occurs from the streams on the southern face of Pevine Mountain and from the Truckee River. In February 1986, many of these streams had a significant amount of flow that caused damage to public and private property. Flooding occurred on Evans Creek (Block N watershed) in and around the University of Nevada Campus and the existing detention basins on the Peavine drainages filled to near capacity.

Three detention basins have been constructed in this area by the Soil Conservation Service. It is not clear from the existing data, if these detention basins have sufficient capacity of detain the 100-year peak discharge without having flow spill out of the basin through the emergency spillways. At two of these detention basin sites, development has encroached up to the spillways for these basins. At both of the sites, the spillways discharge into residential streets. Any significant flow leaving the basin through this spillway could cause significant damage to these residences.

Flooding associated with these streams could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Future residential, commercial and industrial development in this area could cause increases in downstream peak discharges. Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the Peavine drainages, Alum Creek and Rosewood Creek near Plumb Lane. These improvements consist of modifications to the existing detention basins to increase capacity, channel improvements on Alum Creek and Rosewood Creek, and one culvert improvement. These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	UPPER PEAVINE CREEK DAM	DET BSN	RENO	440
2	WEST WASH DAM	DET BSN	RENO	700
3	DANDINI WASH @ COMSTOCK	CULVERT	WASHOE	75
4	McQUEEN WASH @ WEST 4TH ST	CULVERT	WASHOE	250
5	ALUM CREEK U/S OF MAYBERRY	CHANNEL	WASHOE	495
6	ROSEWOOD CREEK US ARLINGTON	CHANNEL	RENO	215
7	McCARRAN BLVD	CULVERT	RENO	150

	TOTAL CAPITAL IMPROVEMENT COSTS:	$2,325,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 930,000
	OPERATION & MAINTENANCE (2%)	$ 46,500
	ENGINEERING & CONST MGMT (30%)	$ 697,500
	ADMINISTRATION & LEGAL (10%)	$ 232,500
	FLOOD HAZARD STUDY	$ 40,000
	TOTAL COSTS:	$4,271,500

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE B-3

MATCH LINE SEE FIGURE A-4

MATCH LINE SEE FIGURE C-4

MATCH LINE SEE FIGURE B-5

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-4

Introduction (Figure B-5)

Figure B-5 includes the southwestern portion of the Truckee Meadows area. Existing land use in this area ranges from rural to suburban.

Principal Flooding Problems

Flooding within the area on Figure B-5, occurs from the streams originating in the eastern slopes of the Carson Range. This figure includes portions of Hunter Creek, Alum Creek and Evans Creek. In February 1986, many of these streams had a significant amount of flow that caused damage to public and private property. Evans Creek overflowed its banks at several locations downstream of Lakeside Drive and caused damage to residences and flooded properties along Virginia Street.

Flooding associated with these streams could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Future land uses projected for this area shows additional residential development in the lower portions of these watersheds. Additional development could cause increases in downstream peak discharges and runoff volumes. Procedures should be developed to require future development to mitigate the downstream impacts caused by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

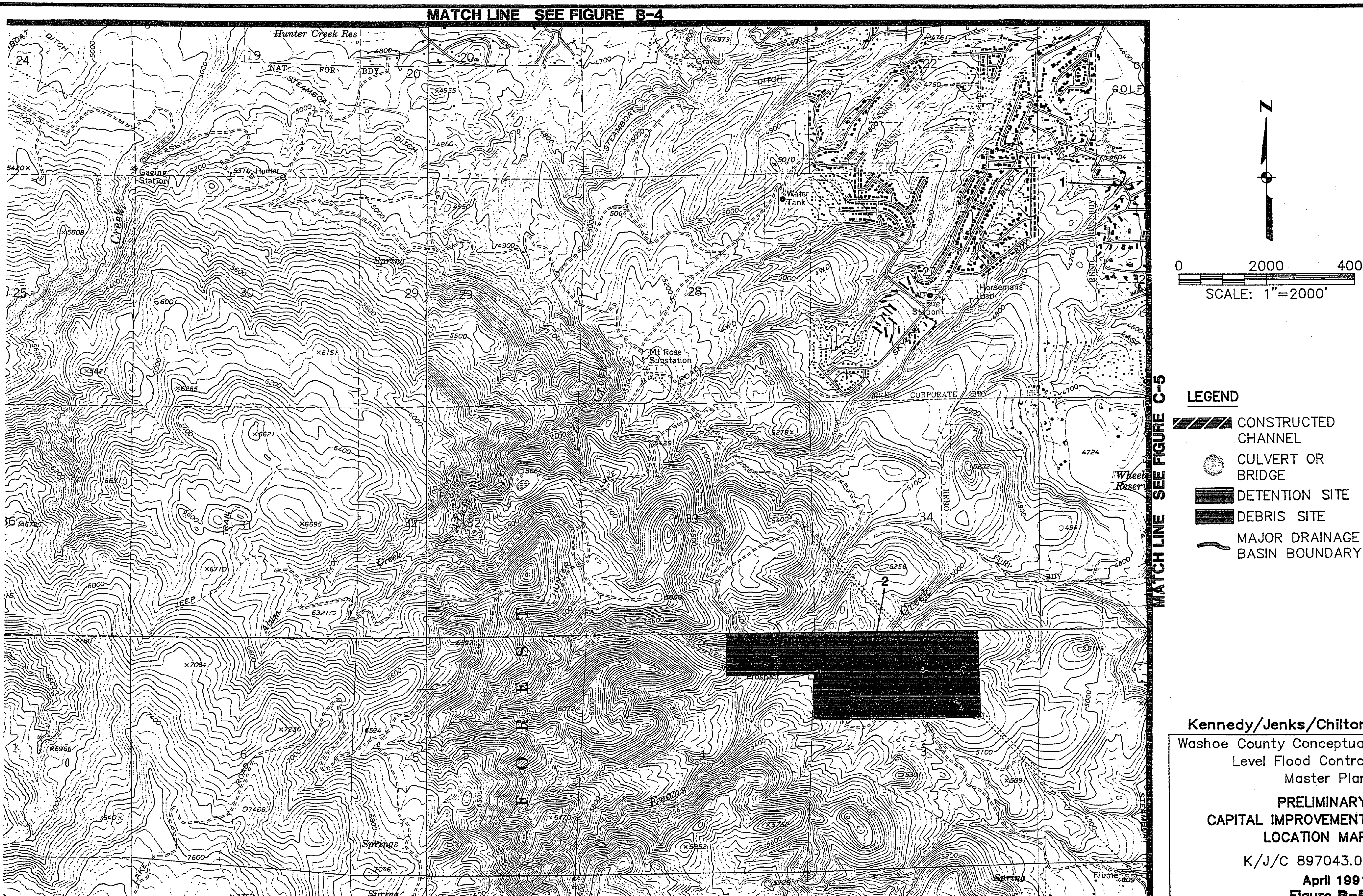
Structural Flood Control Measures and Cost Estimates

Only two structural flood control improvements have been identified for this area. These improvements consist of one culvert improvement on the Plumas/Moana drainage and a detention facility on Evans Creek. These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	PLUMAS/MOANA W PHEASANT	CULVERT	WASHOE	70
2	EVANS CREEK DAM SITE	DET BASIN	WASHOE	3260

	TOTAL CAPITAL IMPROVEMENT COSTS:	$3,330,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,332,000
	OPERATION & MAINTENANCE (2%)	$ 66,600
	ENGINEERING & CONST MGMT (30%)	$ 999,000
	ADMINISTRATION & LEGAL (10%)	$ 333,000
	TOTAL COSTS:	$6,060,600

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.



LEGEND

CONSTRUCTED CHANNEL

CULVERT OR BRIDGE

DETENTION SITE

DEBRIS SITE

MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-5

Introduction (Figure B-7)

Figure B-7 is the Galena Creek area at the extreme southwestern portion of the Truckee Meadows. Existing land use in this area is classified as rural.

Principal Flooding Problems

Flooding within the area on Figure B-7, occurs from the streams originating in the eastern slopes of the Carson Range. This figure includes portions of Galena Creek, Browns Creek, Jones Creek and Whites Creek. In August 1965, a severe thunderstorm resulted in the record flow on Galena Creek. This flooding event caused a significant amount of damage to public and private property in the Pleasant Valley area from both flood water and the sediment and debris the flow was transporting.

Flooding associated with these streams could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Future land uses projected for this area show a considerable amount of additional residential development in the lower portions of these watersheds as well as additional tourist commercial and urban development in the central portion of the Galena Creek watershed. Additional development could cause increases in downstream peak discharges, runoff volumes and possibly increased sediment yield. Procedures should be developed to require future development to mitigate the downstream impacts caused by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

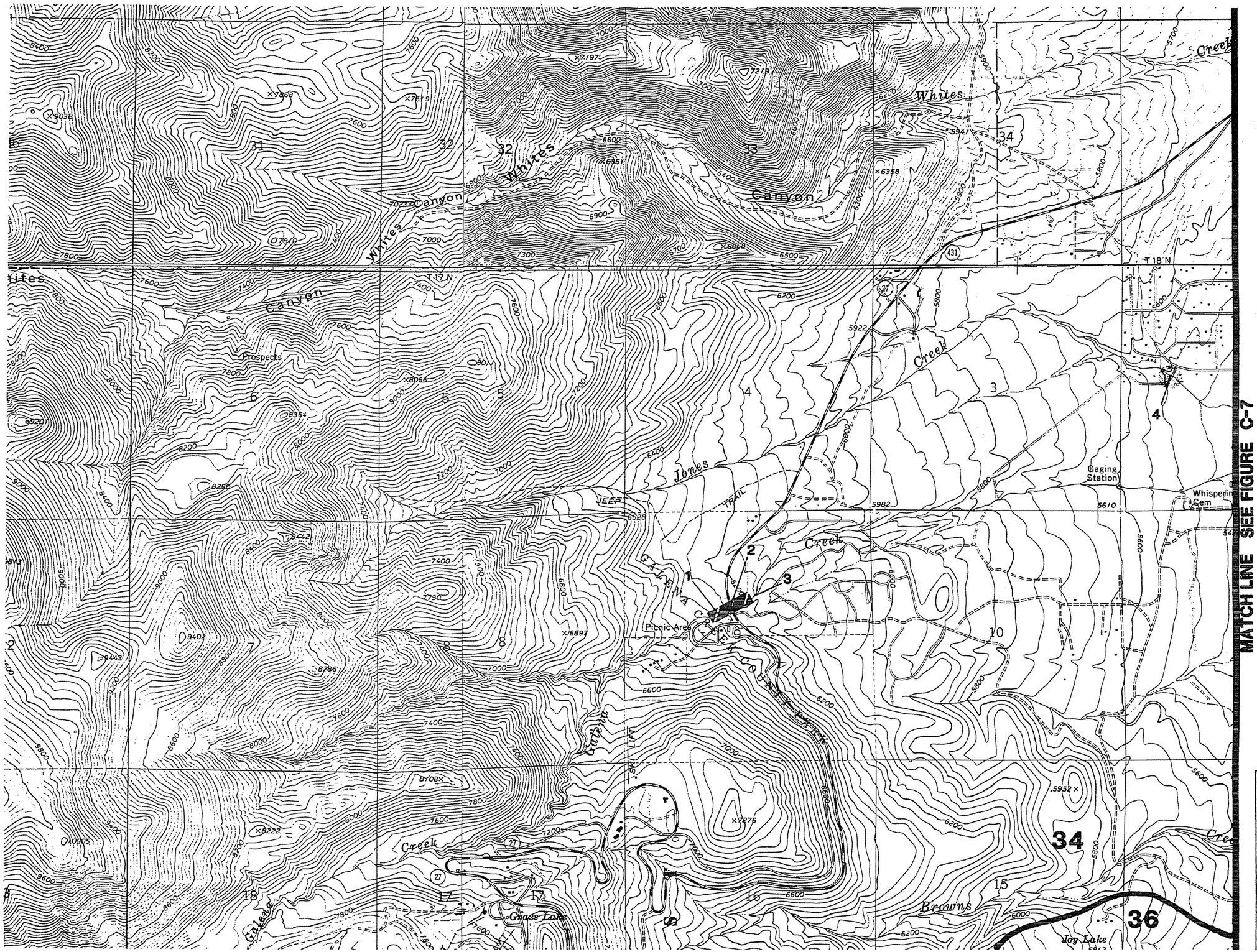
Structural Flood Control Measures and Cost Estimates

Four structural flood control improvements have been identified for this area. These improvements consist of culvert and channel improvements at Mt. Rose Highway and Mountain Meadow Lane. These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	GALENA CR U/S OF SR431	CHANNEL	WASHOE	110
2	GALENA CR @ SR431	CULVERT	WASHOE	310
3	GALENA CR D/S OF SR431	CHANNEL	WASHOE	110
4	JONES CR @ MT MEADOW LN	CULVERT	WASHOE	190

	TOTAL CAPITAL IMPROVEMENT COSTS:	$ 720,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 288,000
	OPERATION & MAINTENANCE (2%)	$ 14,400
	ENGINEERING & CONST MGMT (30%)	$ 216,000
	ADMINISTRATION & LEGAL (10%)	$ 72,000
	TOTAL COSTS:	$1,310,400

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.



Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-7

Introduction (Figure B-9)

Figure B-9 is the Franktown area in the western portion of Washoe Valley. Existing land use in this area is classified as rural.

Principal Flooding Problems

Flooding within the area on Figure B-9, occurs from the streams originating in the eastern slopes of the Carson Range. This figure includes portions of Franktown Creek and Musgrove Creek.

Flooding associated with these streams could occur from both large winter storms and summer thunderstorms. Due to the lack of adequate drainage facilities, extreme flooding events on these drainages would result in flooding of many private properties.

Effects of Future Development

Future land uses projected for this area show a considerable amount of additional residential development in the lower portions of these watersheds. Additional development could cause increases in downstream peak discharges and runoff volumes. Procedures should be developed to require future development to mitigate the downstream impacts caused by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area should be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

The structural flood control improvements have been identified for this area consist of culvert improvements at Old Highway 395 and Franktown Road. These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	FRANKTOWN CK FRANKTOWN RD	BRIDGE	WASHOE	600
2	MUSGROVE CK FRANKTOWN RD	CULVERT	WASHOE	170
3	MUSGROVE CR @ OLD US 395	CULVERT	WASHOE	270

	TOTAL CAPITAL IMPROVEMENT COSTS:	$1,040,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 416,000
	OPERATION & MAINTENANCE (2%)	$ 20,800
	ENGINEERING & CONST MGMT (30%)	$ 312,000
	ADMINISTRATION & LEGAL (10%)	$ 104,000
	TOTAL COSTS:	$1,892,800

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE A-9

MATCH LINE SEE FIGURE C-9

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure B-9

Introduction (Figure C-1)

Figure C-1 includes the eastern portion of Lemmon Valley and the southern portion of Hungry Valley. The developed areas within Lemmon Valley are classified as rural.

Principal Flooding Problems

The developed area within this portion of Lemmon Valley does not include a flood control system to convey flows from extreme events through the developed area. The runoff must pass through private property. This runoff also ultimately discharges into the playa in Lemmon Valley (see Figure B-1).

Effects of Future Development

Land use projections indicate additional suburban development within this area. Future residential development in this portion of Lemmon Valley could cause a slight increase in downstream peak discharges and an increase in runoff volumes to the playa. An increase in runoff volume to the playa could aggravate flooding damages for existing improvements near the lake. Procedures should be developed to require future development to mitigate the downstream impacts caused by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area could be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for one stream within this figure. These improvements consist of a channel and one culvert at Deodar Way. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-1). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	U/S DEODAR DRIVE	CHANNEL	WASHOE	1760
2	U/S DEODAR DRIVE	CHANNEL	WASHOE	625
3	DEODAR DRIVE	CULVERT	WASHOE	230

	TOTAL CAPITAL IMPROVEMENT COSTS:	$2,615,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,046,000
	OPERATION & MAINTENANCE (2%)	$ 52,300
	ENGINEERING & CONST MGMT (30%)	$ 784,500
	ADMINISTRATION & LEGAL (10%)	$ 261,500
	TOTAL COSTS:	$4,759,300

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE B-1

MATCH LINE SEE FIGURE D-1

MATCH LINE SEE FIGURE C-2

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-1

Introduction (Figure C-2)

Figure C-2 includes the west central portion of Spanish Springs Valley, the northern tip of Sun Valley and the east central portion of Lemmon Valley. The developed areas are classified as rural or suburban.

Principal Flooding Problems

The area shown in this figure is the upper end of several watersheds that contribute to locations which experience flooding problems. The majority of this area is currently undeveloped. The developed areas on the fringes for the figure would experience flooding from these relatively steep watersheds.

Effects of Future Development

Land use projections indicate additional suburban development within this area. Future residential development in these areas could cause increases in downstream peak discharges. Future development in the Lemmon Valley portion of figure could result in an increase in runoff volumes to the playa in Lemmon Valley. An increase in runoff volume to the playa could aggravate flooding damages for existing improvements near the lake.

Procedures should be developed to require future development to mitigate the downstream impacts caused by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area could be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for each of the three areas on the figure. For Lemmon Valley a debris basin site has been identified which would serve to capture sediment and debris in order to prevent the downstream channel improvements from becoming filled with sediment. Channel improvements have been identified adjacent to an existing development in Spanish Springs Valley to accept and convey flows through the developed area. This channel may also require debris and sediment control at the channel entrance. Channel improvements have also been identified for Sun Valley which are included on Figure C3-1. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-2). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	DEBRIS BASIN SITE	DEBR BAS	WASHOE	500
2	U/S OF DEODAR WAY	CHANNEL	WASHOE	410
3	DEODAR WAY	CULVERT	WASHOE	100
4	U/S ERIN DR	CHANNEL	WASHOE	220

	TOTAL CAPITAL IMPROVEMENT COSTS:	$1,230,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 492,000
	OPERATION & MAINTENANCE (2%)	$ 24,600
	ENGINEERING & CONST MGMT (30%)	$ 369,000
	ADMINISTRATION & LEGAL (10%)	$ 123,000
	TOTAL COSTS:	$2,238,600

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-1

MATCH LINE SEE FIGURE B-2

MATCH LINE SEE FIGURE D-2

MATCH LINE SEE FIGURE C-3

SEE C3-1

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-2

Introduction (Figure C-3)

Figure C-3 includes Sun Valley and portions of northeast Sparks and southwest Spanish Springs Valley. The developed areas are classified as suburban.

Principal Flooding Problems

Sun Valley is a large and mostly developed watershed which discharges into the City of Sparks without benefit of adequate drainage facilities to convey the flows from extreme events. During the February 1986 flooding event, a significant amount of flow discharged from Sun Valley into the City of Sparks. This flow resulted in flooding of McCarran Boulevard and many of the residential areas within Sparks. Due to the lack of adequate drainage facilities, the City of Sparks constructed a detention basin in 1987, just upstream of the Wild Creek Golf Course. This basin has sufficient capacity to detain flows from a short duration 100-year event but may not have sufficient capacity for a longer duration 100-year event.

Many of the drainage facilities within Sun Valley also do not have sufficient capacity to contain flows from extreme events.

Effects of Future Development

Land use projections indicate additional suburban development within this area. Future residential development in these areas could cause increases in downstream peak discharges and volumes. An increase in peak discharges and volumes could render the Sun Valley Detention Basin less effective.

Procedures should be developed to require future development to mitigate the downstream impacts caused by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The primary drainages in this area could be studied in detail to define the extent of flooding associated with these watercourses. This information would be useful for floodplain management and flood hazard identification.

Structural Flood Control Measures and Cost Estimates

Structural flood control improvements have been identified for the Sun Valley Area. These improvements include the conversion of an existing gravel pit to a retention basin. It is anticipated that this retention basin will significantly reduce the amount of runoff contributing to the existing Sun Valley detention facility. A series of channel improvements are also necessary to collect as much flow from surrounding areas as possible for delivery into the retention basin. Culvert replacements would also be necessary to upgrade the existing culverts at the locations where roadways cross the proposed channel system. Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-3). These improvements are identified by number and the preliminary cost for each of these components is as follows:

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	AMARAGOSA ST TO GRAVEL PIT	CHANNEL SYS	WASHOE	1040
2	5TH AVE - GRAVEL PIT	CHANNEL SYS	WASHOE	445
3	GRAVEL PIT	DET BASIN	WASHOE	1935
4	LEON DRIVE - 1ST AVE	CHANNEL	WASHOE	470
5	1ST AVENUE	CULVERT	WASHOE	155
6	1ST AVENUE - FRANKS LN	CHANNEL	WASHOE	280
7	FRANKS LANE	CULVERT	WASHOE	170
8	FRANKS LANE - RAMPION WAY	CHANNEL	WASHOE	280
9	RAMPION WAY	CULVERT	WASHOE	285

TOTAL CAPITAL IMPROVEMENT COSTS: $5,060,000

OTHER COSTS:	CONTINGENCIES (40%)	$2,024,000
	OPERATION & MAINTENANCE (2%)	$ 101,200
	ENGINEERING & CONST MGMT (30%)	$1,518,000
	ADMINISTRATION & LEGAL (10%)	$ 506,000
	TOTAL COSTS:	$9,209,200

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-2

MATCH LINE SEE FIGURE B-3

MATCH LINE SEE FIGURE D-3

MATCH LINE SEE FIGURE C-4

EXISTING SUN VALLEY DETENTION FACILITY

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-3

Introduction (Figure C-4)

Figure C-4 includes much of the Reno/Sparks metropolitan area. The Corps of Engineers' Truckee Meadows Project includes many proposed flood control improvements within this reach of the Truckee River.

Principal Flooding Problems

This portion of the plan area experiences flooding from a number of sources. The Truckee River traverses the center of the figure and is the source for most of the flooding experienced in this area. Flooding of this area was experienced most recently during the February 1986 flooding event.

Several tributary drainages enter the river within this figure from the north, northwest and southwest. Block N watershed (Evans Creek) enters this area through the University of Nevada at the northwest corner of the figure. The Manogue drainage also enters near this same location. At the north central portion of the figure, the drainage from Sun Valley enters the area. Although North Truckee drain lies to the east of the figure's edge, flooding associated with the North Truckee drain impacted the neighborhoods on the eastern edge of the figure during the 1986 floods. At the southwest corner, Rosewood Creek enters near Arlington Avenue and Plumb Lane and many other smaller or local drainages traverse the area.

The runoff is conveyed to the river through storm drains and some open channels which lack adequate capacity to contain a 100-year event and in some cases these systems lack capacity even for very frequent events. As a result, some residential areas are flooded relatively frequently.

Effects of Future Development

Although most of this area is fully developed, some additional commercial/industrial development is expected in the southeast quadrant of the figure. At the present time, much of the area north of the Truckee River conveys a substantial portion of the 100-year flow. Future development in the areas near the river could result in greater depths of flow in the Truckee River during extreme events due to decreased conveyance capability of the overbank areas. For this reason, FEMA has recently published a regulatory floodway for the Truckee River to prevent encroachment into these areas without appropriate mitigation of the impacts.

Future residential, commercial and industrial development in the other portions of the figure could cause increases in downstream peak discharges and runoff volumes. Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The Truckee River has been studied in detail to define the extent of flooding and definition of a regulatory floodway. Flooding within the urban areas is often difficult to define because of the very flat and subtle topography. Storm drainage master plans should be developed for the urban areas which would include topographic mapping, detailed inventory of storm drains, hydrologic analysis, development of local drainage improvement options and development of a local storm drainage master plan.

Structural Flood Control Measures and Cost Estimates

The Corps of Engineers' Truckee Meadows Project includes many improvements to the Truckee River in this area. The improvements proposed by the Corps of Engineers are not shown on this figure.

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-4). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below. Some of the structural flood control improvements that would relieve flooding in this area, are shown on adjoining figures. For example, the Sun Valley retention basin and flood control diversion in Spanish Springs would both reduce flooding within the area shown in this figure.

The flood control improvements within this area include detention sites on Rosewood Creek in the southwest corner of the figure and the Manogue drainage (which is currently in progress by the City of Reno) in the northwest corner. One culvert replacement is also identified on Arlington Avenue just south of Plumb Lane. These detention sites would serve to reduce the peak discharges downstream of the site and reduce the need for expensive reconstruction of drainage facilities in the urban area. The Rosewood Creek detention site is also ideally located for a multi-use detention and park site.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	SOCRATES DR & WPRR SITE	DET BASIN	RENO	(In Prog)
2	ROSEWOOD CREEK @ ARLINGTON	CULVERT	RENO	60
3	ROSEWOOD CREEK DAM SITE	DET BASIN	RENO	755
	TOTAL CAPITAL IMPROVEMENT COSTS:			$ 815,000
OTHER COSTS:	CONTINGENCIES (40%)			$ 326,000
	OPERATION & MAINTENANCE (2%)			$ 16,300
	ENGINEERING & CONST MGMT (30%)			$ 244,500
	ADMINISTRATION & LEGAL (10%)			$ 81,500
	TOTAL COSTS:			$1,483,300

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-3

MATCH LINE SEE FIGURE B-4

MATCH LINE SEE FIGURE C-5

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-4

Introduction (Figure C-5)

Figure C-5 includes southern Reno and the southern portion of Reno-Cannon International Airport. Although much of this area is currently developed, additional development is expected in the southern portion of the figure.

Principal Flooding Problems

This portion of the plan area experiences flooding from a number of sources. Evans, Dry and Thomas Creeks enter in the southwest corner and Steamboat Creek enters at the southeast corner. All four of these streams caused substantial amounts of flooding during the February 1986 flooding event. Evans Creek left it's banks in several places and flooded properties near Del Monte Lane and at Virginia Street. Dry Creek also overflowed Virginia Street resulting in flooding of commercial and residential properties. Steamboat Creek flooded several square miles of area and damaged residential areas near the Steamboat and Hidden Valley areas.

During extreme events, Thomas Creek splits into two primary flow paths. One of these paths proceeds north through the Virginia Street and I-580 interchange where it floods properties on both sides of Virginia Street. Since the Dry Creek and Evans Creek channels lack sufficient capacity to convey the 100-year discharge, these streams have relatively large floodplains and will also cause significant flooding due to ponding behind the I-580 embankment. Evans Creek, Dry Creek and a portion of Thomas Creek ultimately arrive in Boynton Slough which also lacks sufficient capacity to convey 100-year peak discharges. This portion of the City of Reno has some of the greatest potential for flooding damage.

Effects of Future Development

Future residential, commercial and industrial development will result in increases in downstream peak discharges and runoff volumes. Increases can be caused by both urbanization and also by channelization of the primary watercourse. In the case of streams such as Thomas, Dry and Evans Creek, channelization can cause a much greater impact on downstream peak discharges as compared to increases in impervious cover resulting from urbanization. Channelization results in less area available for natural storage of the floodwaters as they pass through the area. Confining the flow to a channel removes that storage potential and increases flow velocity. Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Steamboat Creek and Dry Creek have been studied in detail to define the extent of flooding and a regulatory floodway. Dry and Thomas Creeks are currently undergoing a re-study by FEMA to refine these floodplains. This re-study will also likely result in increased estimates of the 100-year discharge and expansion of the 100-year floodplain.

Flooding within the urban areas in the northwest portion of the figure, would be difficult to define because of the very flat and subtle topography. Storm drainage master plans should be developed for the urban areas which would include topographic mapping, detailed inventory of storm drains, hydrologic analysis, development of local drainage improvement options and development of local storm drainage master plans.

Structural Flood Control Measures and Cost Estimates

The Corps of Engineers' Truckee Meadows Project includes some proposed improvements along the Steamboat Creek within the northeast portion of the figure and may include a detention basin at Huffaker Hills on the eastern edge of the figure. The Steamboat Creek improvements proposed by the Corps of Engineers consist primarily of levees to protect the residential areas and are not shown on this figure.

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-5). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below. Some of the structural flood control improvements that would relieve flooding in this area, such as the Evans Creek and Thomas Creek detention basins, are shown on the adjoining figures.

The flood control improvements within this area include a detention site on Dry Creek and channel improvements on Evans Creek to convey the detained flows to I-580. Culvert improvements are also needed on Dry and Evans Creek to convey these flows through existing streets. The Dry Creek detention site is also ideally located for a multi-use detention and park site.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	CLASSIC RES PARKING LT	CULVERT	RENO	10
2	EVANS CK U/S OF LAKESIDE	CHANNEL	RENO	275
3	EVANS CK @ LAKESIDE	CULVERT	WASHOE	85
4	EVANS CK LKSIDE - DELMONTE	CHANNEL	WASHOE	610
5	EVANS CK DEL MONTE	CULVERT	WASHOE	75
6	EVANS CK DEL MONTE - I-580	CHANNEL	WASHOE	1400
7	N. FK DRY CREEK, FROST LANE	CULVERT	WASHOE	95
8	DRY CREEK LAKESIDE	CULVERT	WASHOE	195
9	DRY CREEK DERRINGER	CULVERT	WASHOE	175
10	DRY CREEK PANORAMA	CULVERT	WASHOE	155
11	DRY CREEK DAM SITE	DET BASIN	WASHOE	3605
		TOTAL CAPITAL IMPROVEMENT COSTS:		$6,680,000
OTHER COSTS:		CONTINGENCIES (40%)		$2,672,000
		OPERATION & MAINTENANCE (2%)		$ 133,600
		ENGINEERING & CONST MGMT (30%)		$2,004,000
		ADMINISTRATION & LEGAL (10%)		$ 668,000
		TOTAL COSTS:		$12,157,600

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-4

MATCH LINE SEE FIGURE B-5

MATCH LINE SEE FIGURE D-5

MATCH LINE SEE FIGURE C-6

Reno Municipal Tennis Center
Virginia Lake
RENO
Drive-in Theater
Trailer Pks
Trailer Parks
Air National Guard
Control Tower
Brookside Municipal Golf Course
CANNON INTERNATIONAL AIRPORT
BM X4403
Hubbard BM 4395
BM 4442
Moana Muni Pool
Tigh Park
Washoe Fish Rearing Station
Lakeridge Golf Course
Snowbridge Park
Trailer Park
BM 4412
Water Tank
BM 4396
Steamboat Creek
Boynton Slough
Short Springs
Rattlesnake Mtn
Huffaker Hills
Meadows
Audrey Harris Park
Flume
Panorama
Derringer Line
Frost Ln.
Huffaker Sch
Spillway Elev 4429
I-580
PEMBROKE DRIVE
HASH LANE
HUFFAKER LANE
LAKE LANE
MOANA LANE
PLUMAS ST
VIRGINIA ST
KIETZKE
LAKESIDE DRIVE
AQUEDUCT
CORP BDY
RENO
DITCH
Longley Creek

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

N

0 2000 4000

SCALE: 1"=2000'

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-5

Introduction (Figure C-6)

Figure C-6 includes much of the southwest Truckee Meadows and the southern portion of the City of Reno. Existing development in this area consists primarily of suburban development.

Principal Flooding Problems

This portion of the plan area experiences flooding from a number of sources. Whites, Thomas and Steamboat Creeks enter in the southwest and southern portions of the figure. Bailey Creek also enters Steamboat Creek at the southeast corner of the figure. All of these streams have very large natural floodplains. During extreme events, Thomas Creek splits into two primary flow paths. One of these paths proceeds north through the Virginia Street and I-580 interchange, the other proceeds east along Mays Lane at the northern edge of the figure. Whites Creek splits into several primary flow paths that distribute the flow across a mile and a half reach of Virginia Street. Steamboat Creek is well defined until it reaches Highway 341. Downstream of that point the flow becomes shallower and much wider as it proceeds north through this agricultural area.

Bailey Creek lacks a well defined channel between it's confluence with Steamboat Creek and where it emanates from Bailey Canyon. Due to the steepness of this stream and it's ability to transport significant amounts of sediment and debris, Bailey Creek represents a significant public safety hazard.

The future extension of I-580 will need to cross through this area and provide drainage structures for the conveyance of flows from Whites and Thomas Creeks. Due to the wide and shallow nature of this flow and the potential for significant impacts upstream of the highway embankment, it will be necessary to carefully plan for drainage in this segment of the highway.

Effects of Future Development

Additional rural, suburban and some urban and industrial development is expected in this area. Future residential, commercial and industrial development will result in increases in downstream peak discharges and runoff volumes. Increases can be caused by both urbanization and also by channelization of the primary watercourse. In the case of streams such as Thomas and Whites Creeks, channelization can cause a much greater impact on downstream peak discharges as compared to increases in impervious cover resulting from urbanization. Channelization results in less area available for natural storage of the floodwaters as they pass through the area. Confining the flow to a channel removes that storage potential and increases flow velocity. Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Thomas Creek has been mapped as an active alluvial fan on the current FEMA maps. Whites Creek and Steamboat Creek have only approximate floodplains identified. Thomas Creek is currently undergoing a re-study by FEMA to refine the floodplain near Virginia Street and may refined the upstream floodplain as well. This re-study will also likely result in increased estimates of the 100-year discharge and expansion of the 100-year floodplain.

Whites Creek should to be studied in detail to better define the 100-year floodplain.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-6). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The flood control improvements within this area include a detention site on both Whites and Thomas Creeks, channel improvements on Thomas and Bailey Creeks and culvert improvements on Dry, Thomas, Whites, Steamboat and Bailey Creeks to convey these flows through existing streets.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	DRY CREEK @ HOLCOMB	CULVERT	WASHOE	165
2	THOMAS CREEK DAM SITE	DET BASIN	WASHOE	3100
3	THOMAS CK DIXON LN - VIRG	CHANNEL	WASHOE	490
4	THOMAS CREEK SIERRA MANOR	CULVERT	WASHOE	75
5	THOMAS CREEK SOUTH VIRGINIA	CULVERT	WASHOE	210
6	WHITES CREEK DAM SITE	DET BASIN	WASHOE	4630
7	WHITES CREEK THUNDERBOLT	CULVERT	WASHOE	125
8	WHITES CREEK LA GUARDIA RD	CULVERT	WASHOE	125
9	WHITES CREEK ZOLEZZI	CULVERT	WASHOE	125
10	WHITES CREEK US 395	CULVERT	WASHOE	150
11	WHITES CREEK OLD VIRG RD	CULVERT	WASHOE	70
12	BAILEY CK KIEVETT - TOLL RD	CHANNEL	WASHOE	1700
13	BAILEY CK TOLL ROAD	CULVERT	WASHOE	125
14	BAILEY CK TOLL RD - STMBOAT	CHANNEL	WASHOE	480
15	STEAMBOAT CK SR 341	CULVERT	WASHOE	405

	TOTAL CAPITAL IMPROVEMENT COSTS:	$11,975,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 4,790,000
	OPERATION & MAINTENANCE (2%)	$ 239,500
	ENGINEERING & CONST MGMT (30%)	$ 3,592,500
	ADMINISTRATION & LEGAL (10%)	$ 1,197,500
	TOTAL COSTS:	$21,794,500

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-5

MATCH LINE SEE FIGURE C-7

MATCH LINE SEE FIGURE C-6

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-6

Introduction (Figure C-7)

Figure C-7 includes much of the Steamboat and Pleasant Valley areas. Existing development in this area consists primarily of suburban development.

Principal Flooding Problems

This portion of the plan area experiences flooding from Steamboat, Galena and Browns Creeks. Galena Creek has experienced two major events in the last 35 years. Both events were the result of intense summer thunderstorms. In July of 1956 Galena Creek produced a discharge of approximately 4730 cfs. Again in 1965 Galena Creek experience another event which was estimated to be 3670 cfs. The 1965 event caused a significant amount of damage in the Pleasant Valley area. Both Browns and Galena Creek pass through Pleasant Valley on their way to Steamboat Creek. Along Steamboat Creek, residential areas have encroached upon the Steamboat Creek channel. Some of these properties are subject to damage from flooding and undermining of structures from lateral migration of the Steamboat Creek channel.

Effects of Future Development

Additional suburban and urban development is expected in the Galena Creek watershed. Future development will result in increases in downstream peak discharges and runoff volumes. Increases can be caused by both urbanization and also by channelization of the primary watercourse. Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

The portion of Galena Creek within Pleasant Valley has been mapped as an active alluvial fan on the current FEMA maps. The upper portion of Galena Creek has only approximate floodplains identified. This portion of the Steamboat Creek floodplain has been mapped in detail by FEMA.

Due to the increased development in the Galena Creek watershed, the portion of Galena Creek upstream of Pleasant Valley should be studied to develop floodplain mapping. This information would be useful for flood hazard identification and regulatory information.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-7). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The flood control improvements within this area include a detention site on Galena Creek. The channel improvements to convey Browns Creek into the Galena Creek detention facility would serve to reduce the discharges from Browns Creek as well. This improvement would be optional since there are few improvements on Browns Creek that would be significantly impacted by flood flows. There are some downstream improvements on Steamboat Creek that might receive an additional benefit from a reduction in peak flows from Browns Creek. This diversion will need to be evaluated for cost effectiveness in the final plan. Other improvements in this area consist of culvert improvements on Steamboat and Galena Creeks to convey these flows through the existing streets.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	JONES CK CALLAHAN RANCH RD	CULVERT	WASHOE	220
2	GALENA CK CALLAHAN RANCH RD	CULVERT	WASHOE	310
3	GALENA CK GALENA NARROWS	DET BASIN	WASHOE	2505
4	STEAMBOAT CK BLACK WILLOW	CULVERT	WASHOE	115
5	STEAMBOAT CK CONESTOGA	CULVERT	WASHOE	115
6	STEAMBOAT CK LARAMIE	CULVERT	WASHOE	115
7	STEAMBOAT CK CONCHO	CULVERT	WASHOE	145
8	STEAMBOAT CK TOWNE	CULVERT	WASHOE	230

	TOTAL CAPITAL IMPROVEMENT COSTS:	$3,755,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,502,000
	OPERATION & MAINTENANCE (2%)	$ 75,100
	ENGINEERING & CONST MGMT (30%)	$1,126,500
	ADMINISTRATION & LEGAL (10%)	$ 375,500
	TOTAL COSTS:	$6,834,100

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-6

MATCH LINE SEE FIGURE B-7

MATCH LINE SEE FIGURE D-7

MATCH LINE SEE FIGURE C-8

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-7

Introduction (Figure C-8)

Figure C-8 includes northeastern Washoe Valley. Existing development in this area consists primarily of suburban development.

Principal Flooding Problems

This portion of the plan area experiences flooding from the drainages entering Washoe Lake from the western slopes of the Virginia Range. This area lacks sufficient drainage improvements to convey discharges from extreme events through the residential area.

This area experienced flooding twice in 1986. In February 1986, Jumbo Grade watershed produced a significant amount of flow that caused damage in the residential area. Again in August of 1986, a localized summer thunderstorm caused another flooding event on Jumbo Grade that resulted in property damage.

Effects of Future Development

Some additional rural and suburban development is expected in this area. Future development will result in minor increases in downstream peak discharges and runoff volumes. Since this development is occurring as construction of single family units, it would be difficult to develop procedures to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Only approximate flood zones have been identified by FEMA for Washoe Lake and the drainages entering the lake from the east. Washoe Lake and the largest drainages should be studied to better define the flooding hazards in these areas. This information would be useful for flood hazard identification and regulatory information.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-8). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The structural improvements consist of; a channel for the Jumbo Grade drainage with a debris basin at the upper end of the channel to capture sediment and debris, a channel for the unnamed drainage approximately one mile north of Jumbo Grade and culverts at each existing roadway crossing. Recent improvements have been made to the Jumbo Grade drainage system, but these improvements were not designed for 100-year discharge.

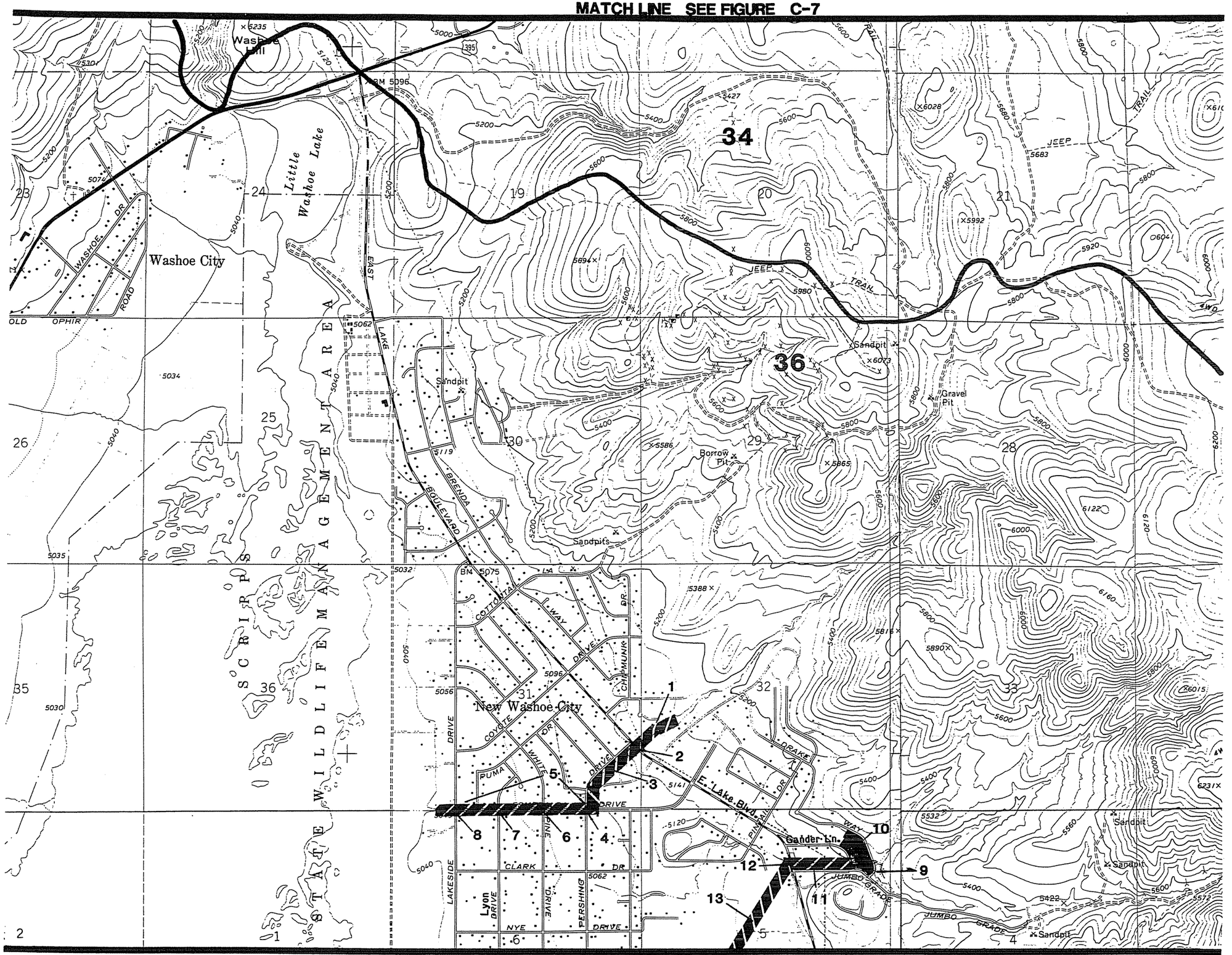
ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	ESMERALDA WASH U/S E. LAKE	CHANNEL	WASHOE	350
2	ESMERALDA WASH @ E. LAKE BLVD	CULVERT	WASHOE	70
3	ESMERALDA WASH E.LAKE - ESM	CHANNEL	WASHOE	470
4	ESMERALDA WASH @ PERSHING	CULVERT	WASHOE	210
5	ESM WASH PERSH - LAKESIDE	CHANNEL	WASHOE	595
6	ESMERALDA WASH @ WT PINE DR	CULVERT	WASHOE	110
7	ESMERALDA WASH @ LYON DRIVE	CULVERT	WASHOE	110
8	ESMERALDA WASH @ LAKESIDE DR	CULVERT	WASHOE	110
9	JUMBO GRADE @ DRAKE WAY	CULVERT	WASHOE	150
10	JUMBO GRADE @ PINTAIL DRIVE	BASIN	WASHOE	980
11	JUMBO GRADE GANDER - E.LAKE	CHANNEL	WASHOE	440
12	JUMBO GRADE @ EASTLAKE	CULVERT	WASHOE	95
13	JUMBO CK EASTLAKE - ORMSBY	CHANNEL	WASHOE	1950

TOTAL CAPITAL IMPROVEMENT COSTS: $5,640,000

OTHER COSTS:	CONTINGENCIES (40%)	$2,256,000
	OPERATION & MAINTENANCE (2%)	$ 112,800
	ENGINEERING & CONST MGMT (30%)	$1,692,000
	ADMINISTRATION & LEGAL (10%)	$ 564,000
	TOTAL COSTS:	$10,264,800

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-7



N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-8

MATCH LINE SEE FIGURE C-9

Introduction (Figure C-9)

Figure C-9 includes southeastern Washoe Valley. Existing development in this area consists primarily of suburban development. A large portion of this area is also encompassed by the Washoe Lake State Park.

Principal Flooding Problems

The portion of the plan area on the east side of the lake experiences flooding from the drainages entering Washoe Lake from the western slopes of the Virginia Range. This area lacks sufficient drainage improvements to convey discharges from extreme events through the residential area.

The portion of the area on the west side of the lake experiences flooding from drainages originating on the eastern slopes of the Carson Range and also from high lake levels on Washoe Lake. In February and March of 1986, the lake experienced record levels which resulted in flooding of properties on the west side of Highway 395. Had the levels been slightly higher, it would have also resulted in closure of Highway 395.

Effects of Future Development

Some additional rural and suburban development is expected in this area. Future development will result in minor increases in downstream peak discharges and runoff volumes. Since this development is occurring as construction of single family units, it would be difficult to develop procedures to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Structural flood control measures to control flooding on the fringes of Washoe Lake would be difficult and expensive. Construction of levees to prevent flooding of the areas around the lake would also result in impoundment of the flow attempting to enter the lake. Due to the high cost of levees and the pumps required to evacuate the water impounded behind the levees, non-structural flood control measures were explored.

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures. Flood walls and levees around structures, is not always an effective solution in areas subject to flooding for an extended period of time, as is the case for the properties subject to flooding from Washoe Lake because of seepage under the walls or levees from saturated soils.

Only approximate flood zones have been identified by FEMA for Washoe Lake and the drainages entering the lake from the east. Washoe Lake and the largest drainages should be studied to better define the flooding hazards in these areas. This information would be useful for flood hazard identification and regulatory information.

Structural Flood Control Measures and Cost Estimates

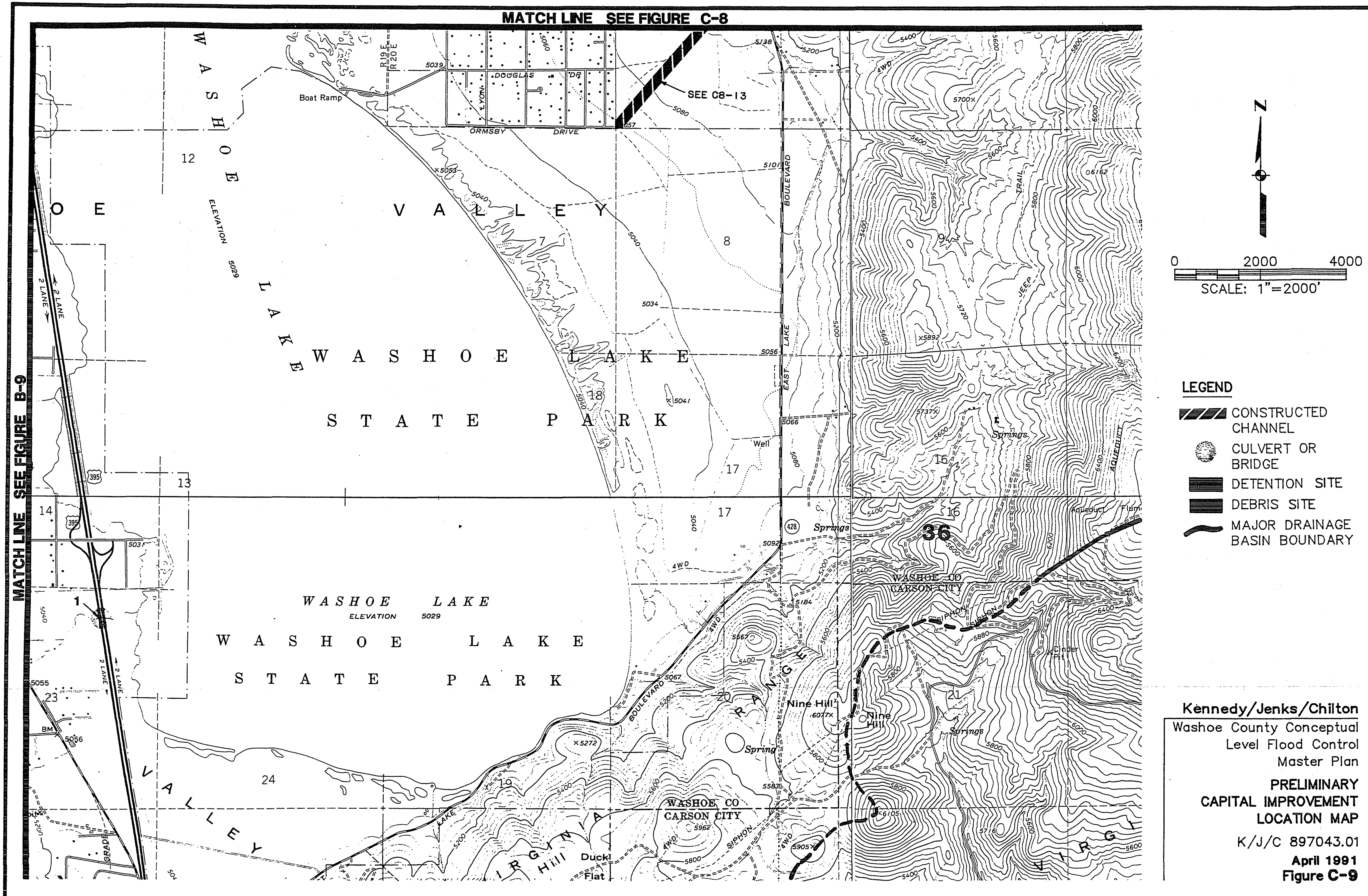
Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-9). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The channel improvement shown on the northern edge of the figure is included in the costs identified on Figure C-8 (structure number 13). Only one additional structure is identified on this figure, which is a culvert to convey the flow from Musgrove Creek through Highway 395. This culvert improvement was identified because of the significant backwater influence caused by this culvert. This backwater results in extended ponding behind the highway embankment within private property. Should this area be developed at some point in the future, culvert improvements may be necessary at this location.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	MUSGROVE CREEK @ US 395	CULVERT	WASHOE	650

	TOTAL CAPITAL IMPROVEMENT COSTS:	$ 650,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 260,000
	OPERATION & MAINTENANCE (2%)	$ 13,000
	ENGINEERING & CONST MGMT (30%)	$ 195,000
	ADMINISTRATION & LEGAL (10%)	$ 65,000
	TOTAL COSTS:	$1,183,000

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.



Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure C-9

Introduction (Figure D-1)

Figure D-1 includes northern Spanish Springs Valley. Existing development in this area consists primarily of only sparse rural development.

Principal Flooding Problems

The majority of this area is the watershed contributing to Boneyard Flat. Flooding occurs in this area from the drainages entering Boneyard Flat and from high lake levels in the flat. Boneyard Flat is a playa or closed basin lake which means there is no natural outlet for this lake and it contains water only in wet years. All of the runoff volume entering the lake must leave the lake by evaporation or infiltration. No improvements currently exist near the playa that could be threatened by high lake levels.

Effects of Future Development

Some additional high density rural is expected in this area. Future development will result in minor only increases in downstream peak discharges and runoff volumes. Since this development is occurring as construction of single family units, it would be difficult to develop procedures to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Shallow flooding zones have been identified by FEMA for the Griffith Canyon drainage on the southern edge of the figure. No flood zones have been identified for Boneyard Flat. The flat should be studied to better define the flooding hazards in these areas. This information would be useful for flood hazard identification and regulatory information.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure C-8). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The drainage improvement identified is a diversion channel intended to convey flows from Griffith Canyon into Boneyard Flat. At the upstream end of this channel, the natural channel from Griffith Canyon is unstable resulting in flows randomly producing flow in both the northern and southern directions. By forcing the flow to consistently go north into Boneyard Flat, approximately one third of the Spanish Springs watershed is diverted away from the valley. This would significantly reduce peak flows and runoff values in the urbanized areas in Spanish Springs and also to the northern limit of the City of Sparks. If the concentration of salts in the soils of the playa are low, this alternative may also be used to supplement groundwater recharge by capturing flood flows and injecting this water into the aquifer.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	GRIFFITH CAN CALLE LAPLATA	CULVERT	WASHOE	130
2	GRIFFITH CAN	CHANNEL	WASHOE	420
3	GRIFFITH CAN	CHANNEL	WASHOE	1310
4	GRIFFITH CAN @ SR445	CULVERT	WASHOE	225
5	SR445 - BONEYARD FLAT	CHANNEL	WASHOE	1300

	TOTAL CAPITAL IMPROVEMENT COSTS:	$3,385,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,354,000
	OPERATION & MAINTENANCE (2%)	$ 67,700
	ENGINEERING & CONST MGMT (30%)	$1,015,500
	ADMINISTRATION & LEGAL (10%)	$ 338,500
	TOTAL COSTS:	$6,160,700

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-1

MATCH LINE SEE FIGURE D-2

Boneyard Flat

Sugarloaf Peak

Gravel Pit

Sandpit

BM 1390.9

S.R. 445

TRAIL

JEEP

RANGE

ALLEY

RANGE

Current

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure D-1

Introduction (Figure D-2)

Figure D-2 includes east central Spanish Springs Valley. Existing development in this area consists primarily of rural and suburban development.

Principal Flooding Problems

The flooding event of February 1986 produced significant flows from the watersheds in Spanish Springs Valley. A record flow was observed at the northern limit of Sparks where the Spanish Springs watershed drains into the City. The flow in North Truckee Drain at the City limit was estimated to be 1500-1800 cfs. This flow caused considerable damage to residential properties on both sides of North Truckee Drain.

The northern portion of the Spanish Springs area contributes to the natural channel located just west of the existing development and arrives at Pyramid Highway (SR445) where a very small culvert presently exists at the intersection of Pyramid Highway and Spanish Springs Road. Due to the lack of adequate drainage facilities in this area and the relatively high discharge, a wide floodplain area exists through this area. This floodplain includes some residential and commercial properties.

Another smaller watershed arrives at Pyramid Highway from the west near the pistol range. The flow from this watershed has been diverted by the developer of the adjoining residential development. Due to the high sediment loads carried by extreme events and the sudden change in channel slope and direction, the constructed channel tends to plug with sediment resulting in the flood flows being forced across Pyramid Highway. During the flooding of February 1986, both of these locations experienced significant flooding.

A considerable amount of current development also exists north and east of Spanish Springs Road which receives drainage from several large watersheds north and east of the developed areas.

Effects of Future Development

Future development in the Spanish Springs area will result in increases in downstream peak discharges and runoff volumes. Increases can be caused by both urbanization and also by channelization of the primary watercourses. Channelization results in less area available for natural storage of the floodwaters as they pass through the area. Confining the flow to a channel removes that storage potential and increases flow velocity. Channelization of any of the primary watercourses in Spanish Springs will result in significant increases in downstream peak discharges. Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure D-2). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The structural improvements consist of channel and culvert improvements. The northern channel improvement is dependant upon the diversion of Griffith Canyon shown on Figure D-1. The channel which parallels Pyramid Highway is identified for replacement with a channel to convey this discharge easterly (as occurred prior to diversion). The northern channel segment is conveyed across the Orr Ditch to eliminate the present flooding apparently caused by the elevated bank of the Orr Ditch which diverts flood flows easterly into an existing residential area.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	WATER TANK ROAD - SR445	CHANNEL	WASHOE	2080
2	SR 445	CULVERT	WASHOE	115
3	ERIN DRIVE	CULVERT	WASHOE	80
4	ERIN DRIVE - DOLORES DRIVE	CHANNEL	WASHOE	240
5	DOLORES DRIVE	CULVERT	WASHOE	80
6	SR445	CULVERT	WASHOE	130
7	SR445 - ORR DITCH	CHANNEL	WASHOE	315
8	SPANISH SP RD - ORR DITCH	CHANNEL	WASHOE	485

	TOTAL CAPITAL IMPROVEMENT COSTS:	$3,525,000
OTHER COSTS:	CONTINGENCIES (40%)	$1,410,000
	OPERATION & MAINTENANCE (2%)	$ 70,500
	ENGINEERING & CONST MGMT (30%)	$1,057,500
	ADMINISTRATION & LEGAL (10%)	$ 352,500
	TOTAL COSTS:	$6,415,500

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE D-1

MATCH LINE SEE FIGURE C-2

MATCH LINE SEE FIGURE D-3

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure D-2

Introduction (Figure D-3)

Figure D-3 includes southeast Spanish Springs Valley and the northeast Sparks. Existing development in this area consists primarily of suburban development.

Principal Flooding Problems

The flooding event of February 1986 produced significant flows from the watersheds in Spanish Springs Valley. A record flow was observed at the northern limit of Sparks where the Spanish Springs watershed drains into the City. The flow in North Truckee Drain at the City limit was estimated to be 1500-1800 cfs. This flow caused considerable damage to residential properties on both sides of North Truckee Drain. As a result of the inadequate drainage facilities flooding damages, the City of Sparks constructed a detention facility in the Spanish Springs Valley to reduce the peak discharges impacting the City of Sparks. The location of this facility is shown in the northwest corner of this figure.

There are several significant watersheds in the foothills located on the eastern edge of the City of Sparks. These watersheds are steep and are comprised of very rocky soils which have a high runoff potential. An intense summer thunderstorm on these watersheds could result in substantial damage to these residential areas. One of the largest of these watersheds drains to Vista Boulevard and through a park near Whitehead School. This existing system is not adequate to convey 100-year discharges through this area, which would result in flooding of the school and adjoining residential areas.

Effects of Future Development

Future development in the Spanish Springs area will result in increases in downstream peak discharges and runoff volumes. Increases can be caused by both urbanization and also by channelization of the primary watercourses. Channelization results in less area available for natural storage of the floodwaters as they pass through the area. Confining the flow to a channel removes that storage potential and increases flow velocity. Channelization of any of the primary watercourses in Spanish Springs will result in significant increases in downstream peak discharges.

The foothills of northeast Sparks are expected to be developed in the near future. The proposed development plans call for relatively high density development in this part of Sparks. This development would result in increased peak flows and runoff volumes entering the City of Sparks where adequate drainage facilities do not presently exist.

Procedures should be developed to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure D-3). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The structural improvements consist of one detention facility in the watershed above the intersection of Vista Boulevard and Shadow Lane and channel improvements, including a culvert at Orr Ditch, to convey the detained discharge into the existing drainage system at Shadow Lane.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	DETENTION SITE	DET BASIN	WASHOE	585
2	VISTA BLVD - SHADOW LANE	CHANNEL	SPARKS	230

	TOTAL CAPITAL IMPROVEMENT COSTS:	$ 815,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 326,000
	OPERATION & MAINTENANCE (2%)	$ 16,300
	ENGINEERING & CONST MGMT (30%)	$ 244,500
	ADMINISTRATION & LEGAL (10%)	$ 81,500
	TOTAL COSTS:	$1,483,300

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE D-2

MATCH LINE SEE FIGURE C-3

EXISTING SPANISH SPRINGS DETENTION FACILITY

Borrow Pit

Well

32

34

Pit

Sandpit

Shadow Ln.

Shadow Mountain Park

Reed High Sch.

Vista Blvd.

SPANISH SPRINGS ROAD

SPANISH SPRINGS

JEEP TRAIL

PIPELINE

Spanish Springs Canyon

DRY LAKE

RANGE

1

2

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure D-3

Introduction (Figure D-5)

Figure D-5 includes the eastern Hidden Valley area. Existing development in this area consists primarily of rural and suburban development.

Principal Flooding Problems

The Hidden Valley area was constructed on an area typically classified as an alluvial fan, where the drainage from the foothills discharges onto the shallower sloping deposits along the mountain front. In such areas, there are often many small channels radiating from the mountain front, rather than a single well defined channel. The flooding hazard in such areas is often underestimated because the lack of defined channels gives the appearance of little historic flooding.

During the mid 1970's several summer thunderstorms produced significant flooding from watersheds east of Hidden Valley. Sediment laden flows caused damage to several homes and left sediment and debris in the streets. As a result, Washoe County constructed several diversion channels to direct runoff away from the developed areas or into an existing gravel pit which was converted into a detention basin. During an extreme event it is possible that these channels could be damaged by erosion or become plugged with sediment making them ineffective. Also, since the storage characteristics of this detention facility have not been analyzed, the adequacy of this detention facility for reducing the peak discharge from a 100-year event is not known.

Runoff from the foothills and developed areas is ultimately discharged into Steamboat Creek. Some of this drainage arrives at a gated culvert at the west end of Pebble Beach Drive. This culvert is gated to allow it to be closed when high flows are experienced in Steamboat Creek. However, when the gate is closed, stormwater collecting at the inlet also accumulates and results in flooding of this residential area.

Effects of Future Development

Future development in the Hidden Valley will be the result of construction of custom homes on existing lots. Since this development is occurring as construction of single family units, it would be difficult to require future development to mitigate the downstream impacts cause by the development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure D-5). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The structural improvements consist of two detention facilities to capture runoff and sediment and release the flow at a rate that the downstream facilities can handle.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	N HIDDEN VAL DET SITE	DET BASIN	WASHOE	1680
2	S HIDDEN VAL DET SITE	DET BASIN	WASHOE	600

	TOTAL CAPITAL IMPROVEMENT COSTS:	$2,280,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 912,000
	OPERATION & MAINTENANCE (2%)	$ 45,600
	ENGINEERING & CONST MGMT (30%)	$ 684,000
	ADMINISTRATION & LEGAL (10%)	$ 228,000
	TOTAL COSTS:	$4,149,600

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE C-5

1
Sand and Gravel Pit
2
Sandpit
Gravel Pit
Sand and Gravel Pit
Sand and
Prospect
Mines
Washington Hill Prospect
Hidden Valley
HIDDEN VALLEY DRIVE
WASHOE CO
STOREY CO
Long Valley
TRAIL
JEEP
MIRALOMA
RANGE

0 2000 4000
SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure D-5

MATCH LINE SEE FIGURE D-6

Introduction (Figure D-6)

Figure D-6 includes a portion of the Virginia Foothills area. Existing development in this area consists primarily of suburban development.

Principal Flooding Problems

The Virginia Foothills area was constructed on an area typically classified as an alluvial fan, where the drainage from the foothills discharges onto the shallower sloping deposits along the mountain front. In such areas, there are often many small channels radiating from the mountain front, rather than a single well defined channel. The flooding hazard in such areas is often underestimated because the lack of defined channels gives the appearance of little historic flooding.

In the past severe summer thunderstorms produced significant flooding from the watersheds east of the foothills development. Sediment laden flows caused damage to several homes and left sediment, large boulders and debris in the streets. As a result, Washoe County constructed a several diversion channels to direct runoff away from the developed areas. During an extreme event it is possible that this channel could be damaged by erosion or become plugged with sediment making it ineffective.

Effects of Future Development

Future development in the this area will likely be confined to the foothills areas and the areas near Mira Loma Road. Figure 4 shows additional rural development in these areas. Additional development could cause increases in downstream discharges, runoff volumes and possibly increased sediment yield or point discharge of sediment. Procedures should be developed to require future development to mitigate the downstream impacts caused by development.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Structural Flood Control Measures and Cost Estimates

Each of the structural flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure D-6). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The structural improvements consist of one debris basin to capture sediment and channel improvements to convey the clean water to a reasonable discharge point downstream.

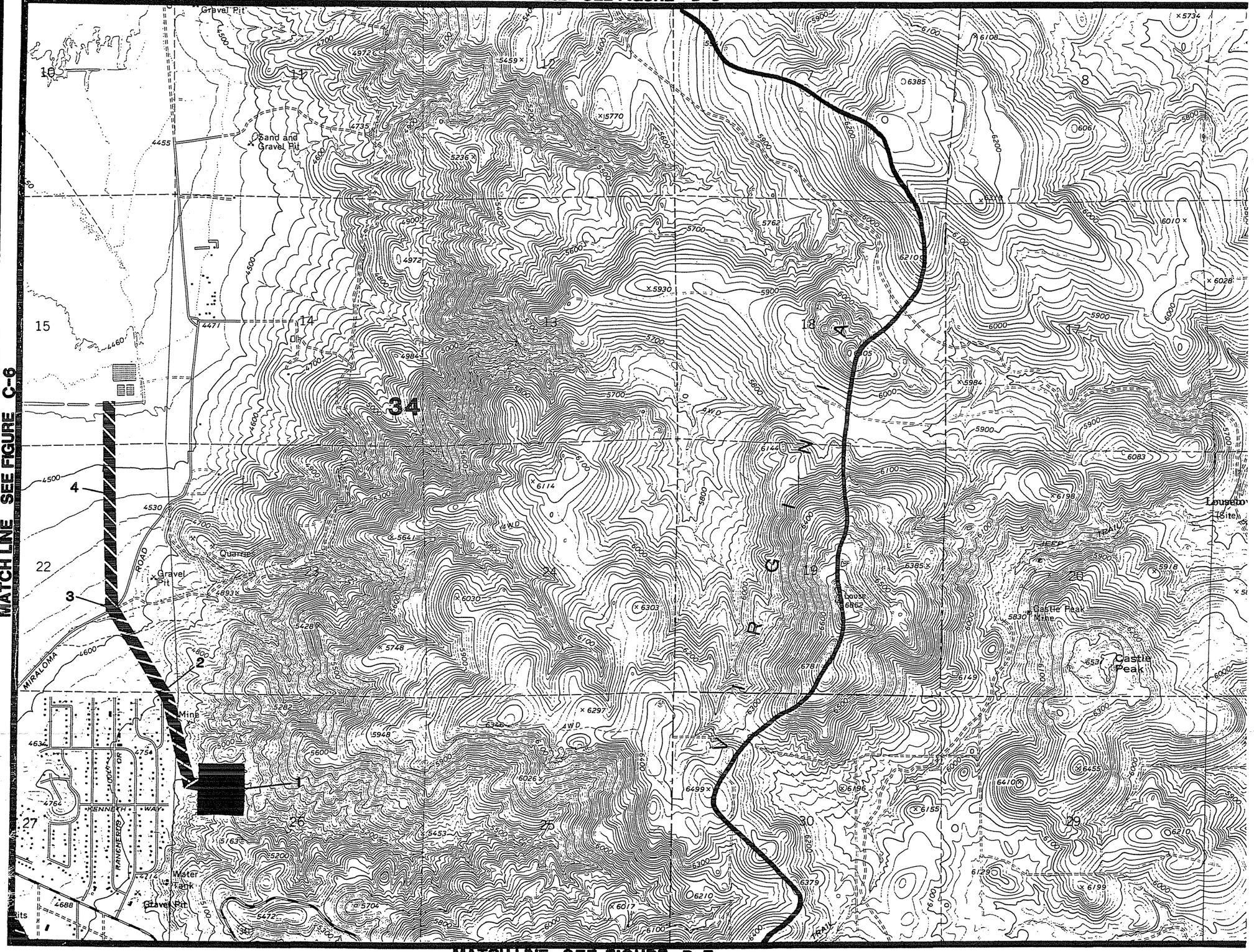
ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	VIRG FOOTHILLS DEBRIS SITE	DEBR BASIN	WASHOE	450
2	BASIN - MIRALOMA ROAD	CHANNEL	WASHOE	765
3	MIRA LOMA ROAD	CULVERT	WASHOE	70
4	MIRALOMA RD - TOE OF FAN	CHANNEL	WASHOE	805

	TOTAL CAPITAL IMPROVEMENT COSTS:	$2,090,000
OTHER COSTS:	CONTINGENCIES (40%)	$ 836,000
	OPERATION & MAINTENANCE (2%)	$ 41,800
	ENGINEERING & CONST MGMT (30%)	$ 627,000
	ADMINISTRATION & LEGAL (10%)	$ 209,000
	TOTAL COSTS:	$3,803,800

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE D-5

MATCH LINE SEE FIGURE C-6



MATCH LINE SEE FIGURE D-7

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure D-6

Introduction (Figure D-7)

Figure D-7 includes Bailey Canyon area. Existing development at the mouth of the canyon consists primarily of suburban development.

Principal Flooding Problems

Bailey Canyon is a very large and steep watershed. The soils within the watershed are also very rocky and have a high runoff potential. Flooding events from Bailey Canyon would produce high peak flows that could be laden with sediment and debris. The existing development has encroached on the mouth of the canyon and the natural drainage paths. Because of the high flow velocities, an extreme event on Bailey Canyon could pose a significant public safety problem and result in significant property damage.

There are a set of floodplain maps published by the Federal Emergency Management Agency for Bailey Canyon Creek. These maps are based upon an estimate of 100-year peak discharge that appears to be substantially underestimated. Therefore, the extent of the hazard identified, may also be substantially underestimated. Due to the number of homes located near Bailey Canyon Creek, many more residences may be flood prone than indicated by the current floodplain maps.

Effects of Future Development

Additional rural and suburban development is expected in this area. Such development would have only a minor impact on flows from Bailey Canyon.

Non-Structural Flood Control Measures

Non-structural flood control measures could consist of floodplain mapping and regulation of construction within the 100-year floodplain, purchase of flood insurance, floodproofing of individual structures and elevation or relocation of affected structures.

Structural Flood Control Measures and Cost Estimates

Each of the structural-flood control improvements identified with the concept level master plan, are shown on the adjoining page (Figure D-6). These improvements are identified by number and the preliminary cost for each of these components are identified in the table below.

The structural improvements consist of a detention basin on the main branch of Bailey Creek to capture sediment and runoff from Bailey Canyon and release the flow into a constructed channel downstream of the basin which will convey the detained discharge to Steamboat Creek. Other structural improvements consist of channel and culvert improvements on the Geiger branch of Bailey Creek to convey runoff through the developed areas and discharge into the main branch of Bailey Creek.

ELEMENT	LOCATION	IMPROVEMENT TYPE	JURISD	COST (THOUSANDS)
1	BAILEY CREEK DAM SITE	DET BASIN	WASHOE	5360
2	BAILEY CK DAM - TOLL RD	CHANNEL	WASHOE	280
3	BAILEY CREEK TOLL ROAD	CULVERT	WASHOE	20
4	BAILEY CK TOLL RD - T HILL	CHANNEL	WASHOE	340
5	BAILEY CREEK PVT DRIVEWAY	CULVERT	WASHOE	20
6	BAILEY CREEK TEMPLE HILL	CULVERT	WASHOE	20
7	BAILEY CK T HILL - KIVETT	CHANNEL	WASHOE	365
8	GEIGER FK BLY CK SR 341	CULVERT	WASHOE	50
9	GEIGER FK SR 341 - PINION	CHANNEL	WASHOE	390
10	GEIGER FK BLY CK PINION DR	CULVERT	WASHOE	50
11	GEIGER FK PINION - KIVETT	CHANNEL	WASHOE	95
12	GEIGER FK BLY CK KIVETT LN	CULVERT	WASHOE	50
13	GEIGER FK KIVETT - BAILEY	CHANNEL	WASHOE	150

	TOTAL CAPITAL IMPROVEMENT COSTS:	$7,190,000
OTHER COSTS:	CONTINGENCIES (40%)	$2,876,000
	OPERATION & MAINTENANCE (2%)	$ 143,800
	ENGINEERING & CONST MGMT (30%)	$2,157,000
	ADMINISTRATION & LEGAL (10%)	$ 719,000
	TOTAL COSTS:	$13,085,800

These cost estimates are approximate costs developed for the purpose of estimating the total funding requirements for the master plan. Actual costs may differ from the values shown.

MATCH LINE SEE FIGURE D-6

MATCH LINE SEE FIGURE C-7

SEE C6-12

N

0 2000 4000

SCALE: 1"=2000'

LEGEND

- CONSTRUCTED CHANNEL
- CULVERT OR BRIDGE
- DETENTION SITE
- DEBRIS SITE
- MAJOR DRAINAGE BASIN BOUNDARY

Kennedy/Jenks/Chilton

Washoe County Conceptual Level Flood Control Master Plan

PRELIMINARY CAPITAL IMPROVEMENT LOCATION MAP

K/J/C 897043.01

April 1991

Figure D-7