A HYDROLOGICAL ANALYSIS OF THE PARADISE POND WATERSHED

PREPARED FOR

CITY OF RENO

PREPARED BY

SUMMIT ENGINEERING CORPORATION

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CONTENTS

FIGURES:

TABLES:

APPENDICES:

HYDROLOGICAL ANALYSIS OF THE PARADISE POND WATERSHED CITY OF RENO, WASHOE COUNTY, NEVADA

ABSTRACT

The purpose of this hydrological analysis of the Paradise Pond watershed is to provide the City of Reno Engineering Department with: (1) Background information on how the Paradise Pond watershed is arranged and functions with different storm durations; (2) a summary of the analysis methodology used in developing the hydrographs and attenuation of the peak discharges; (3) a comparison of the effects of different improvement conditions which were set forth by the City of Reno Engineering Department; and (4) a summary of recommended improvements that will alleviate major flood damage in the Paradise Pond watershed. These recommended improvements were placed in order of priorities for construction improvements with pertaining estimated construction costs.

THE BACKGROUND

The Paradise Pond watershed has been subjected to minor flooding in the recent years resulting in property damage, disruption of facilities, and threat to the well-being of the residents. As Reno grows further, development will encroach on the flooding of the major drainageways, increasing runoff and reducing the natural drainage channels. Continued development in the Paradise Pond watershed will intensify the many problems unless measures are taken to reduce the peak discharges and to collect the flood waters before they discharge into other watersheds.

The Paradise Pond watershed is located in the northeastern portion of Reno, Washoe County, Nevada. The watershed borders Sparks and Sun Valley to the east, and Panther Valley to the north. The watershed covers 5.3 square miles (3400 acres) in Sections 23 through 27, 34 through 36, of Township 20 North, Range 19 East; Sections 1 and 2 of Township 19 North, Range 19 East; Sections 30 and 31 of Township 20 North, Range 20 East; Section 6 of Township 19 North, Range 20 East, M.D.B. & M. (Reference Figure 1 for an outline of the watershed's boundary).

The Paradise Pond watershed measures 3.9 miles in length and 1.9 miles in width with the highest ridge within the watershed standing at an elevation of 5,460 feet. The Paradise Pond has a water surface elevation of approximately 4,438 feet.

A HYDROLOGICAL ANALYSIS OF THE

PARADISE POND WATERSHED

City of Reno, Washoe County, Nevada

Prepared for

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ENGINEERING DEPARTMENT

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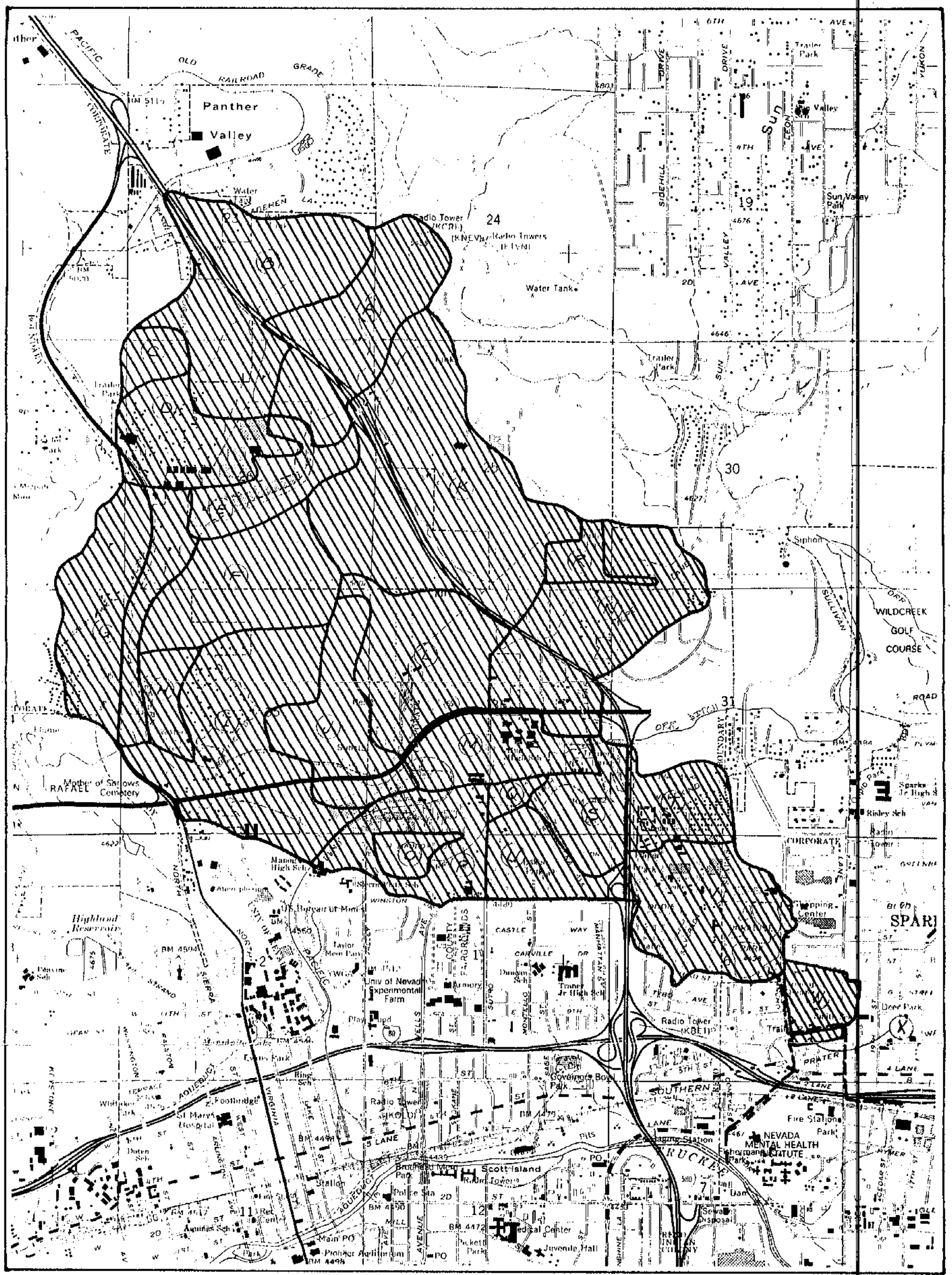


PARADISE POND WATERSHED
BOUNDARY WITH SUBAREAS

- Figure 1 -

will produce runoff hydrographs of similar shapes, and (2) that the hydrologic system described by the unit hydrograph is a linear system. These assumptions imply that by knowing the ordinates for a unit hydrograph, (a storm which produces one inch of runoff), a hydrograph for a storm which produces two inches can be determined by multiplying all the known ordinates by two. The definition of the unit hydrograph, is a hydrograph representing one unit (one inch) of direct runoff from a rainfall excess of some unit duration and specific area distribution. (13:7) The SCS has developed a typical unit hydrograph for the Reno area for use with a 3-, 6-, and 24-hour duration storm. This SCS unit hydrograph also pertains to a rainfall that falls over the entire watershed. An aerial reduction is used to adjust the rainfall quantity for the probability of the storm inundating the entire watershed. The Paradise Pond watershed, due to its size, has a high probability that a storm will cover the entire basin; therefore, an aerial reduction to the rainfall was not used.

To be able to attenuate the flows from one subarea to and through another subarea, a flood routing process was performed with the hydrographs. The Muskingum routing method was used for channel routing and the Modified Puls routing method was used for the storage or detention routing. These flood routing procedures define a process of tracing, by calculation, the course and character of a flood wave as it progresses through a channel reach or storage pond. This attenuation of the flood wave actually produces a longer and lower flood wave as it moves downstream. (13:1)

The SCS method requires four calculated items to analyze each subarea: (1) The total surface area of the Subarea; (2) the weighted curve number of the Subarea; (3) the lag time derived from the channel lengths velocity; and (4) the precipitation.

The Subarea areas were calculated from a 1" = 400' scale orthographic map having a topographic interval of five or ten feet by using a digital planimeter and a digitizer. (Reference Appendix "1" for the orthographic maps). Additional topographic maps were required for the Paradise Pond including the surrounding area and the Evans detention basin.

The weighted curve number value is an average value of a series of curve numbers over the entire Subarea. Each curve number value depends on four considerations:

1. Soil Type - Soils are classified according to their hydrologic behavior. The four classes in the SCS analyses are A, B, C, and D. Class A is the most pervious soil, and Class D is the least pervious soil.

2. Vegetative Type - Vegetation type affects runoff rates. SCS has grouped this variable by different description such as "forests," "grass," etc.

3. Cover - Cover is influenced by the extent of protective cover on the subarea. Cover is usually defined as the percent of surface area covered by vegetation (i.e., "good," "fair," or "poor."

4. Soil Moisture - Soil moisture is expressed by antecedent precipitation (AMC).

The effects of soil moisture on storm runoff are dealt with through the index of five-day antecedent rainfall, dependent upon the time of year. AMC is classified as I, II, or III. AMC II is taken as the reference status and CN's are adjusted up or down in accordance with categories and the design conditions. The origin of the CN/AMC relationship is not known, nor is its derivation documented. As a matter of practical usage, most calculations for peak flow are done with AMC II.

All considerations must be considered together when making the selection for CN. CN may vary from values of 0 (a completely pervious watershed with no possible run-off) to 100 (a completely impervious watershed with runoff equalling rainfall).

The Subarea curve numbers were based upon field inspections and estimated average total percentage of standing vegetative cover. The soil type used in determining each specific curve number was taken from the SCS Soil Survey of Washoe County, Nevada, South Part.

The subarea lag time was calculated two ways: the hydrograph method and the modified curve number method. The hydrograph method reflected a greater change in lag time between the improved and unimproved channel sections. Therefore, the hydrograph method was used in determining the lag times for the subareas. The hydrograph method splits up the hydraulic length of the Subarea into segments of slopes and land uses. Each segment has a velocity determined for its condition which is divided into the segment's length to find the time of concentration. All the time of concentrations are added and divided by 5/3 to get the Subarea lag time. The subarea lag time is used to estimate the delay in time from initial precipitation to actual runoff at some reference point. It is important that the input lag variable correctly describes the field conditions. Field conditions which affect channel efficiency are soil materials in banks and bottoms, the stability or lack of for the channel, vegetation, debris, and sinuosity. These characteristics need to be evaluated and

TABLE 1

THE SUBAREA ANALYSIS DATA

SUBAREA	AREA (S.M.)	WEIGHTED CURVE NUMBER	LAG TIME IN HOURS
A	0.340	84	0.25
B	0.436	84	0.45
C	0.068	81	0.07
D	0.237	89	0.17
E	0.163	91	0.62
F	0.325	85	0.07
G	0.342	84	0.98
H	0.079	82	0.06
I	0.433	86	0.34
J	0.248	87	0.13
K	0.714	83	0.48
L	0.280	88	0.22
M	0.160	91	0.195
N	0.388	90	0.09
O	0.068	89	0.05
P	0.223	88	0.47
Q	0.031	89	0.08
R	0.060	92	0.08
S	0.121	86	0.11
T	0.159	88	0.28
U	0.265	87	0.32
V	0.195	65	0.26

Total area = 5.335 square miles
= 3414.4 acres

appropriate adjustments need to be made to the calculated lag variable.

The precipitation values for the Paradise Pond watershed were available from three different sources: (1) The City of Reno Rainfall Curves developed by Kennedy Engineers in 1957; (2) The City of Reno Rainfall Curves developed by Winzler and Kelly Engineers in 1984; and (3) The National Oceanic and Atmospheric Administration (NOAA) Precipitation-Duration-Frequency Atlas II Isopluvials for Nevada, dated 1973. (Reference Table 2 for comparison of precipitation values). The precipitation values developed by Winzler and Kelly Engineers were used for this analysis because they reflect the most recent rainfall data from the Reno area. The additional isopleth maps were not used for the Paradise Pond study because the majority of the watershed elevation is very near to the Reno rainfall gate station elevation and the low rainfall figure acts as a small aerial reduction factor.

There were also several discrepancies found in the Winzler and Kelly Isopleth maps. The most significant of these being:

1. The standard deviation of the rainfall ratios between the Reno Cannon Airport gauge and the unofficial gauges.

2. The plotting of the isopleth lines did not adequately reflect the ratios at the unofficial rain gauges.

Also, for these reasons, a correction factor based on the isopleth maps was not used. (Reference Table 1 for the Subarea analysis information.)

The channel routing process and the reservoir routing process were calculated by using the Muskingum method and the Modified Puls method, respectively. The Muskingum method requires a storage constant (k), and an inflow, outflow constant (x) for each channel reach. The Modified Puls method requires the storage-discharge curve data for each reservoir (detention pond).

COMPARISON OF THE SIX STORM DRAIN IMPROVEMENT CONDITIONS

The City of Reno Engineering Department requested that a hydrological analysis be presented for various storm drain improvement conditions.

Six different storm drain improvement conditions were chosen for analysis. Each of these six conditions were analyzed with 12 different storms. These storms are the 5-year, 3-hour; 25-year, 3-hour; 50-year, 3-hour; 100-year, 3-hour; 5-year, 6 hour; 25-year, 6-hour; 50-year, 6-hour; 100-year,

TABLE 2

THE PRECIPITATION VALUES FOR RAINFALL

USED FOR THIS STUDY

24-Hour	Winzler & Kelly	NOAA Maps		Kennedy
100-Year	2.88"	2.75"	2.70"	2.76"
50-Year	2.62"	2.52"	2.50"	2.40"
25-Year	2.11"	2.14"	2.10"	2.11"
5-Year	1.39"	1.42"	1.50"	1.56"
6-Hour Duration				
100-Year	1.62"		1.70"	1.50"
50-Year	1.27"		1.50"	1.38"
25-Year	1.09"		1.35"	1.20"
5-Year	0.78"		0.95"	0.84"
3-Hour Duration				
100-Year	1.25"	1.20"	1.45"	1.32"
50-Year	1.04"	1.05"	1.28"	1.12"
25-Year	0.87"	0.90"	1.13"	0.99"
5-Year	0.60"	0.63"	0.79"	0.67"

6-hour; 5-year, 24-hour; 25-year, 24-hour; 50-year, 24-hour; and 100-year, 24-hour. For each of the four return frequencies used, the 24-hour duration storm yielded higher peak flows and larger volumes of storm runoff than either the 3-hour or 6-hour duration storms. For this reason, only the hydrographs for the 24-hour duration storms were plotted. The hydrographs for the 3- and 6-hour were computed and the peak flow rates tabulated with the 24-hur flow rates. The 24-hour duration storms simulate a slow-moving frontal storm traversing across the watershed. The 3- and 6-hour duration storms simulate either a short or a long thundershower. Each condition has an appendix with its corresponding hydrographs and data that has been compiled for each storm. A separate booklet has been prepared with the different appendixes. These tables and hydrographs show how the peak flows were added together as they travel down the drainage basin. One can also estimate how another condition may work within the watershed by using a similar set of hydrographs within the appendices, and combining or substracting flows or conditions as needed.

The following is a summary description of each of the six different storm drain improvement conditions. Each condition was modeled with the present condition of the watershed. The present condition of the watershed is the existing condition of the watershed with the addition of all the currently approved tentative maps overlaid throughout the watershed.

Condition No. 1

a. Construction of a dike along the southeastern corner of Paradise Pond to provide additional detention capacity.

b. Construction of a Paradise Pond outlet channel to the Truckee River.

Condition No. 2

a. Construction of a dike along the southeastern corner of the Paradise Pond to provide additional detention capacity.

b. Construction of a Paradise Pond outlet channel to the North Truckee Drain.

Condition No. 3

a. Construction of a dike along the southeastern corner of Paradise Pond to provide additional detention capacity.

b. Construction of a Paradise Pond outlet channel to the North Truckee Drain or the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drain system.

d. Construction of a storm drain channel to carry the runoff from the Clearacre area into Paradise Pond.

Condition No. 4

a. Construction of a dike along the southeastern corner of Paradise Pond to provide additional detention capacity.

b. Construction of a Paradise Pond outlet channel to the North Truckee Drain or the Truckee River.

c. Constuction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drain system.

d. Construction of a storm drain channel to carry the runoff from the Clearacre area into Paradise Pond.

e. Construction of a detention structure and pond in the area just west of the proposed Evans Avenue extension in place of the railroad acting detention.

Condition No. 5

a. Construction of a dike along the southeastern corner of Paradise Pond to provide additional detention capacity.

b. Construction of a Paradise Pond outlet channel to the North Truckee Drain or the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drain system.

d. Construction of a storm drain channel to carry the runoff from the Clearacre area into Paradise Pond.

The Paradise Pond with the surrounding park area became a City of Reno park on September 5, 1964. The pond, which originally was a gravel pit, was owned prior to the City of Reno, by the Teglia family, who operated a private fishing resort on the property. One of the reasons that the City of Reno purchased the Paradise Pond area for a park was to help alleviate the City's drainage problem in that area. The Reno councilmen also intended to have a storm drain system built from the Silverada area to the Truckee River.

The climate in the Reno area varies considerably -- typical of the semi-arid southwest. Reno has an annual rainfall of approximately 7.5 inches and a mean annual temperature of 50 degrees F. The daily temperature swing usually exceeds 45 degrees from morning to evening. During the winter there are very few days that the temperature does not exceed freezing. More than half of the annual precipitation falls as mixed rain and snow, low intensity frontal type storms during the winter season, while the summer precipitation falls as brief, high intensity thunderstorms in the middle and late afternoons. Historically, the high intensity thunderstorms have not produced widespread flooding, whereas the low intensity frontal type storms have.

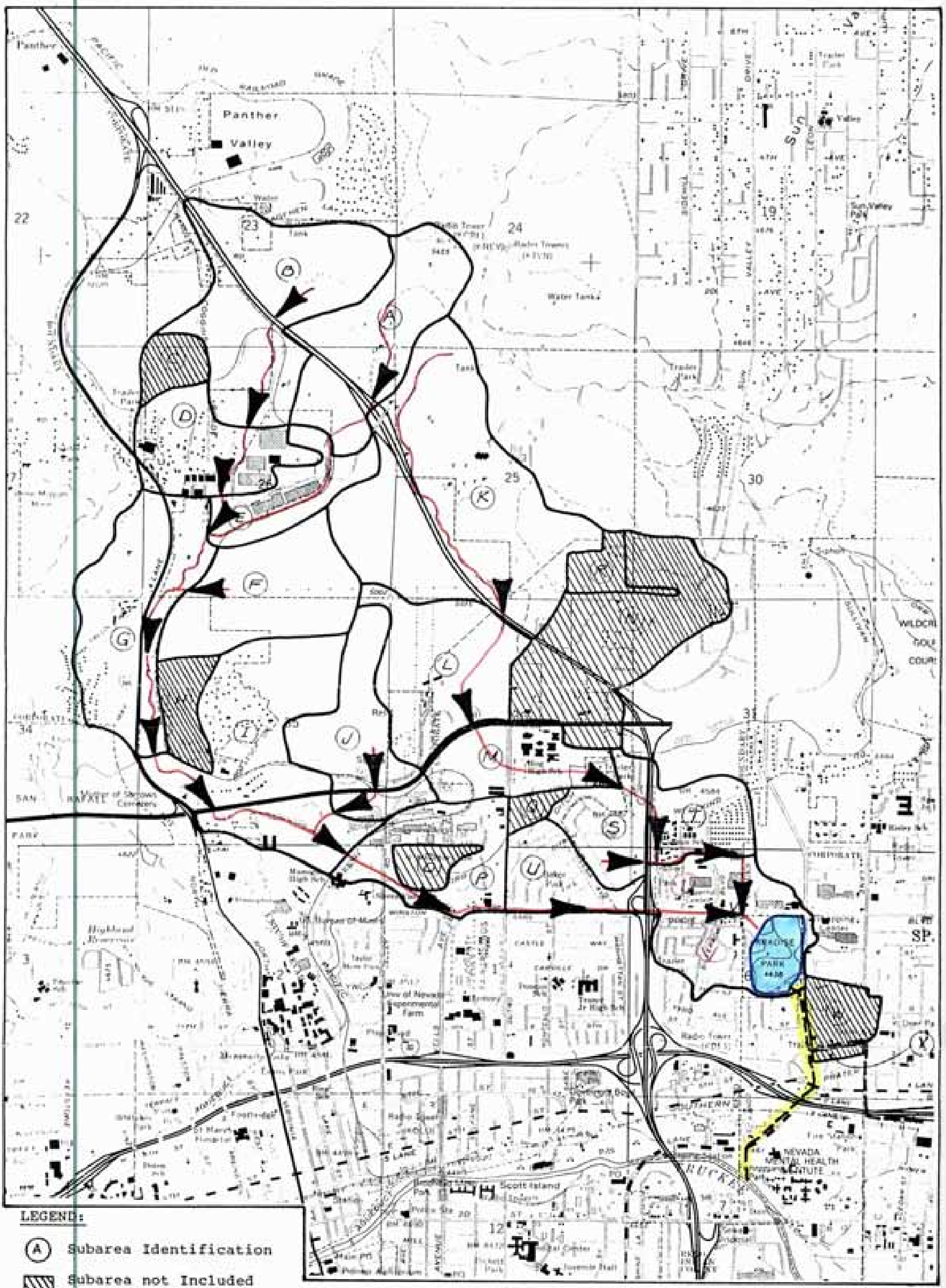
The majority of the different soil types within this watershed contain a high percentage of clay. Clayey soils are considered by the Soil Conservation Service as in Hydrologic Soil Group "D", which is soil that has a very low permeability to water and a high runoff rate.

The Paradise Pond has had only two reports in which the pond actually overflowed its banks and caused flooding downstream. This happened a couple of years ago and this year with only a minor storm. This analysis will show how the present situation works and functions if the storm drain culverts were cleared and cleaned throughout the watershed.

THE METHODOLOGY

The Paradise Pond watershed was divided into three Natural Drainage Basins. Each Drainage Basin was then further divided into smaller subareas to analyze the different effects occuring within each Drainage Basin. (Reference Figure 1 for the location of the Subareas and Drainage Basins.) The Soil Conservation Service (SCS) method for analyzing urban hydrology was used to establish the hydrograph data for each subarea.

The SCS method of analyzing urban hydrology (TR-20), uses the "unit hydrograph concept." This concept uses two major assumptions: (1) For a given basin similar types of storms



DRAINAGE DIAGRAM FOR STORM DRAIN CONDITION NO. 1

- Figure 2 -

e. Construction of a detention structure and pond in the area just west of the proposed Evans Avenue extension in place of the railroad acting detention.

f. Construction of a detention structure and pond on the north side of I-580 at the northwest corner of the future Sutro Street overpass.

Condition No. 6

a. Construction of a dike along the southeastern corner of Paradise Pond to provide additional detention capacity.

b. Construction of a Paradise Pond outlet channel to the North Truckee Drain or the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drain system.

d. Construction of a storm drain channel to carry the runoff from the Clearacre area into Paradise Pond.

e. Construction of a detention structure and pond in the area just west of the proposed Evans Avenue extension in place of the railroad acting detention.

f. Construction of a detention structure and pond on the north side of I-580 at the northwest corner of the future Sutro Street overpass.

g. Construction of a detention structure and pond on the west side of I-580 at Fife Drive, between Oddie Boulevard and Wedekind Road.

In the following pages, each storm drain improvement condition will be detailed individually, showing construction details and development improvements and problems.

Condition No. 1 - Additional Pond Capacity and 60-Inch Diameter Outfall to Truckee River.

The storm drain improvement Condition No. 1 included the following improvements:

TABLE 3

THE DETENTION STORAGE OF THE PROPOSED PARADISE POND

Elevation	Acre Feet of Storage		Description
4438.3	0		Water Surface - Begin Storage
4439.0	16.59		0.7 ft. depth
4440.0	43.09		1.7 ft. depth
4441.0	72.29		2.7 ft. depth
4442.0	104.99		3.7 ft. depth
4443.0	139.69		4.7 ft. depth Begin spillway flow
4443.33	151.66		Spillway 0.33 ft. depth
4443.66	163.63		Spillway 0.66 ft. depth
4444.0	175.60		Spillway 1.00 ft. depth
4444.5	193.56	8.4×10^6 ft.^{3}	Spillway 1.50 ft. depth

a. Construction of a 5-foot high dike along the southeastern corner of Paradise Pond.

b. Construction of a 60-inch diameter pipe from the outlet of the improved Paradise Pond along El Rancho Drive, Kietzke Boulevard and Galetti Way to the Truckee River.

c. All existing storm drain improvements were cleared and cleaned.

These were the only improvements considered in the analysis of Condition No. 1.

The 5-foot high dike had a crest elevation of 4445.0 feet. A 30-foot wide spillway with a flow line elevation of 443.0 feet (2 feet below the crest of the dike) was designed into the dike to prevent water from flowing over the crest. The dike could not be made any higher without flooding existing nearby buildings and the 60-inch diameter pipe outfall was chosen because it was determined that this is the biggest size pipe that can be constructed under El Rancho Drive. The 60-inch pipe had an approximate capacity of 90.5 cfs. $S_f = 0.001$

The dike provided 4.7 vertical feet of storm water detention. Table 3 shows the detention capacity of the improved Paradise Pond. The dike was included in Condition No. 1 and all the other conditions because it greatly increased the efficiency of the outfall pipe. If the dike was not constructed, an additional 60-inch pipe outfall would be necessary to carry the same flow. The cost of constructing an additional 60-inch pipe outfall was found to be much greater than the cost of constructing the dike.

In the analysis of Condition No. 1, the runoff from subareas R, N, O, and Q flowed into the Orr Ditch; therefore, these areas did not flow into Paradise Pond. The runoff from subareas C and H percolated into the ground, thereby not contributing runoff to Paradise Pond. Runoff from subareas A, B, D, E, F, H, I, and J were routed into the 24-inch pipe under the railroad fill at Manogue High School. The railroad fill and the 24-inch pipe caused the low spot upstream of the railroad to act as a detention area. Any overflow of this railroad acting detention will flow down into the Evans Avenue area and away from Paradise Pond.

In the analysis of Condition No. 1, storm water did not flow over the spillway in the Paradise Pond dike. This was true for all 12 storms analyzed.

Reference Appendix "A" in the separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" for the hydrographs and the data compiled for Condition No. 1.

The major problems that surfaced in the analysis of Condition No. 1 were threefold:

1. The railroad acting detention at Manogue High School overflowed during the 40- and 100-year, 24-hour duration storms, causing as much as 16.5 cfs to travel through the existing Evans Avenue area.

2. The Clearacre area (subareas R and N) which flows into the Orr Ditch caused the Orr Ditch to overflow its banks.

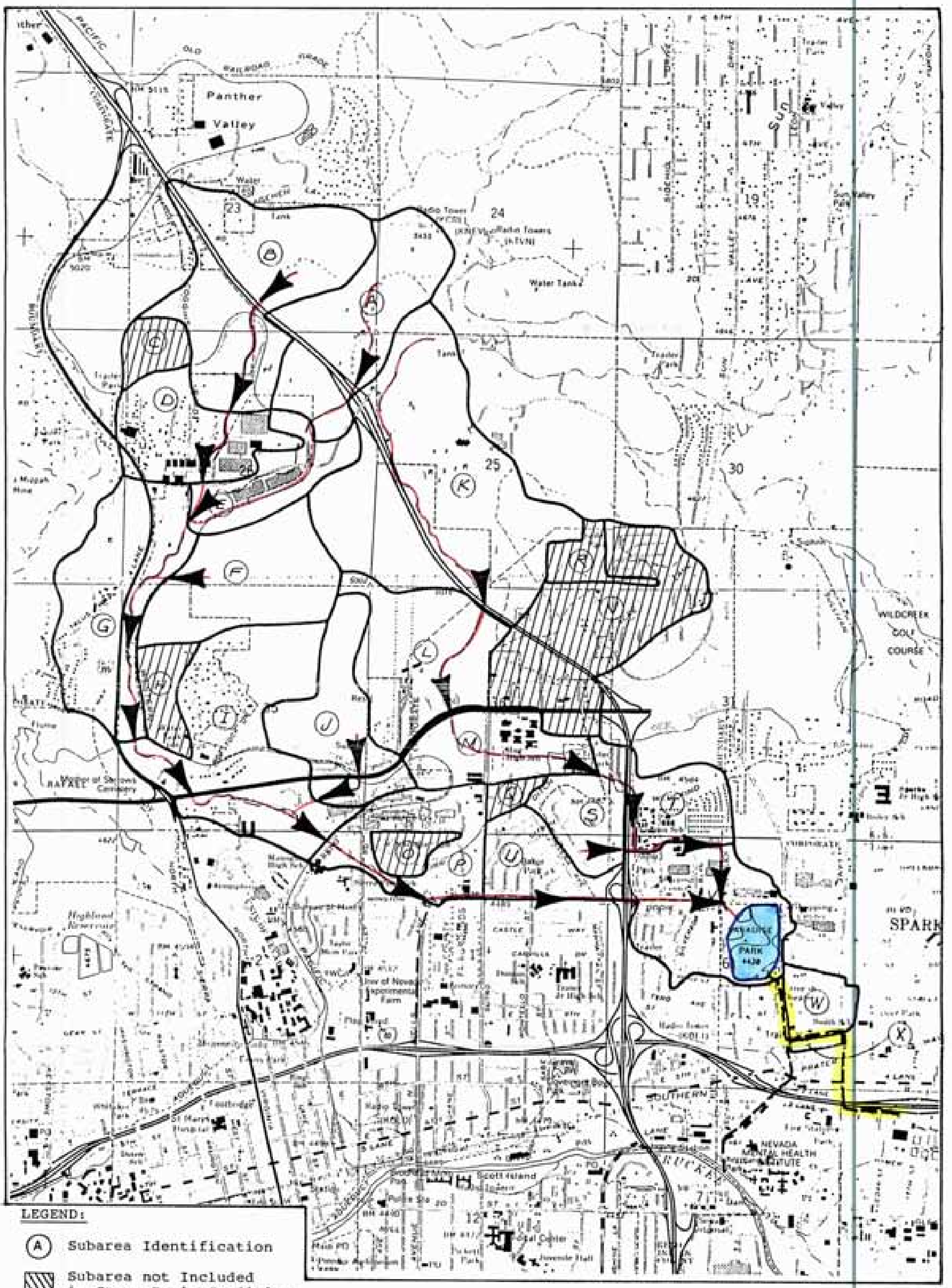
   The Orr Ditch has a capacity of approximately 60 cfs. The runoff from subareas R and N exceeded this during a 5-year, 24-hour storm; a 25-year, 6-hour storm, a 50-year, 3-hour storm; and any storm greater than these. From April 1 to October 1 the ditch flows full with irrigation water; therefore, any runoff directed into the ditch during that time caused it to overflow. From October 1 to February 15 the ditch flowed at less than full capacity. At this time the ditch handled some storm water runoff without overflowing. The exact amount depended on how much water was already flowing in the ditch. The only time the ditch was empty was from February 15 to April 1. It is only during this time that the ditch handled 60 cfs of storm water runoff without overflowing.

3. Subarea S and subarea T had standing flood waters during a 5-year, 24-hour storm; a 5-year, 6-hour storm; a 25-year, 3-hour storm or any storm greater than these.

   The Clearacre area overflowed the Orr Ditch and spilled out into subarea S; however, flooding was mainly caused by the channeling of storm water runoff from subareas K, L, and M into subarea S. There were no structures within subarea S or subarea T that are able to carry this runoff. (Reference Appendix "1" for the existing improvements within subareas S and T). Therefore, the water ran overland, some draining into subarea T through the I-580 and Wedekind Street overpass, and the remainder draining down to the low point at Clearacre Lane and Fife Drive. The runoff water stood there until the pipes downstream had capacity to carry this additional load, approximately 1600 minutes (27 hours) from the beginning of the storm.

Condition No. 2 - Additional Pond Capacity and Pond Outfall to North Truckee Drain

The storm drain improvement Condition No. 2 included the following improvements:



DRAINAGE DIAGRAM FOR STORM DRAIN CONDITION NO. 2

- FIGURE 3 -

a. Construction of a 5-foot high dike along the southeastern corner of Paradise Pond.

b. Construction of an improved Paradise Pond outfall to the existing North Truckee Drain.

c. All the existing storm drain improvements were cleared and cleaned.

These were the only improvements considered in the analysis of Condition No. 2.

The 5-foot high dike was the same as the one used in Condition No. 1.

The improved Paradise Pond outfall to the existing North Truckee Drain required replacement of two lengths of pipe. The existing 12-inch diameter pipe from the outlet of Paradise Pond to "D" Street (approximately 1625 linear feet) was replaced with a 30-inch pipe. The existing 24-inch and 30-inch diameter pipe from Prater Way to "A" Street (approximately 955 linear feet) was replaced with a 42-inch pipe. The improved outfall to the North Truckee Drain was analyzed because of its relatively low construction price.

In the analysis of Condition No. 2, all the runoff from all the subareas was routed the same way it was in Condition No. 1. Reference Appendix "B" in the separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" for the hydrographs and the data compiled for Condition No. 2.

The major problems that surfaced in the analysis of Condition No. 2 were twofold:

1. All the problems presented within Condition No. 1 still applied; the railroad acting detention at Manogue overflowed, the Orr Ditch was overloaded, and subareas S and T were flooded.

2. The analysis showed that storm water flowed over the 30-foot spillway built into the 5-foot high dike along the southeastern corner of Paradise Pond. This occurred during three different storms. During a 25-year 24-hour storm, the peak spillway overflow was 2.09 cfs. The 50-year 24-hour storm peak spillway overlow was 26.56 cfs. 48.34 cfs was the peak spillway overflow during a 100-year, 24-hour storm. These overflows traveled down El Rancho Drive ponding at its many low points; then, the overflow continued eastwardly down "D" Street into Sparks, following the natural slope of the land.

Condition 3 - Additional Pond Capacity, Improved Pond Outfall, Split Box, and Clearacre Area Addition

The storm drain improvement Condition No. 3 included the following improvements:

a. Construction of a 5-foot high dike along the southeastern corner of Paradise Pond.

b. Construction of an improved Paradise Pond outfall. This was either to the North Truckee Drain or a pipe directly to the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drainage system.

d. Construction of a channel from Orr Ditch to Paradise Pond to carry the storm water runoff from the Clearacre area (subareas R and N).

e. All the existing storm drain improvements were cleared and cleaned.

These were the only improvements considered in the analysis of Condition No. 3.

The 5-foot high dike was the same as the one described in Condition No. 1.

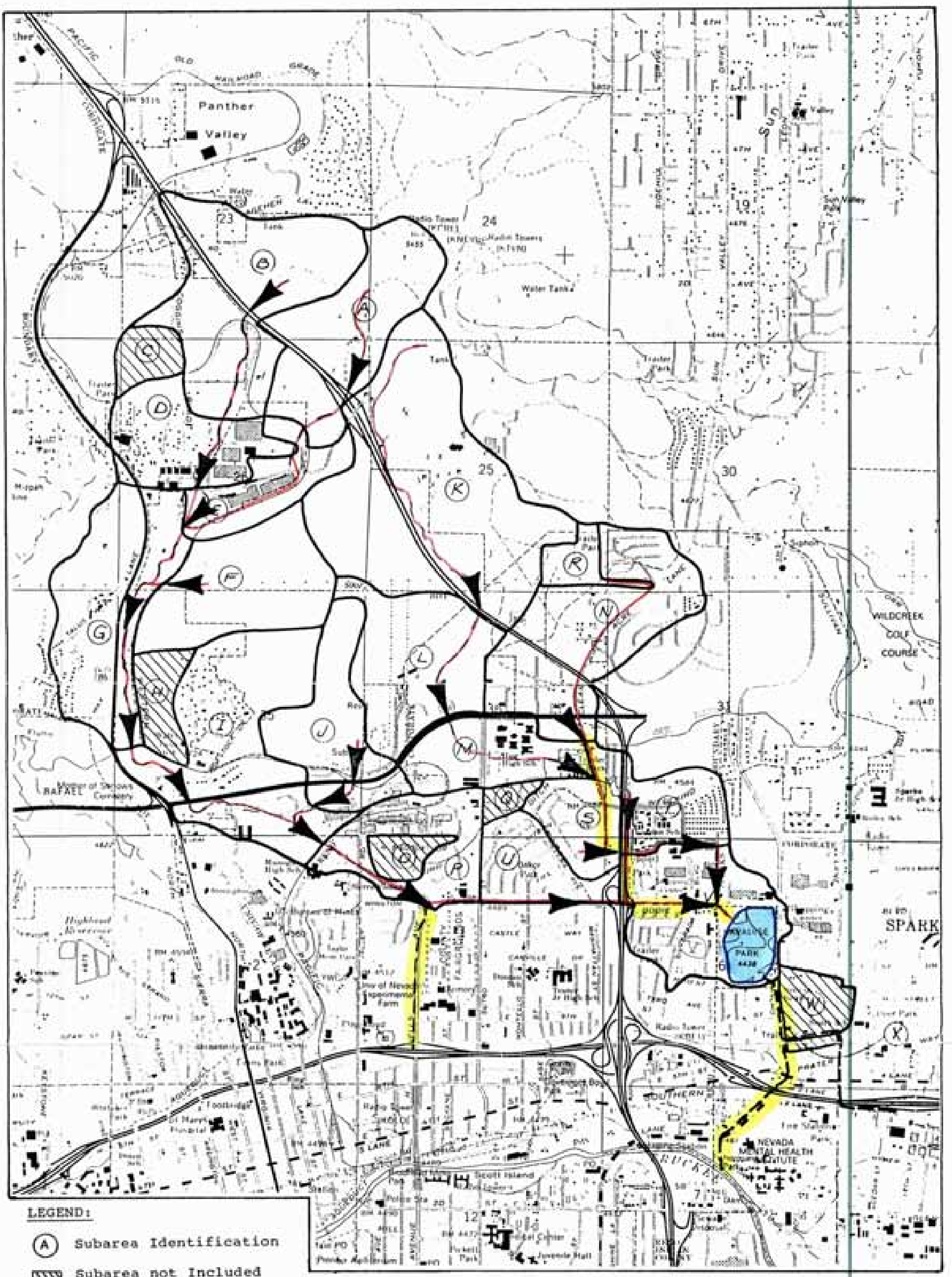
The improved outfall to the North Truckee Drain was the same as the one described in Condition No. 2. This outfall eliminated overflow of the improved Paradise Pond during all but the 25-year, 24-hour storm; the 50-year, 24-hour storm; and the 100-year, 24-hour storm. For these storms a channel following the alignment of the 60-inch pipe described in Condition No. 1 to the Truckee River was needed to eliminate overflow of the improved Paradise Pond. A 60-inch pipe using this alignment eliminated overflow during a 25-year, 24-hour storm. Two 60-inch pipes were required to eliminate overflow during a 50-year, 24-hour storm. Two 66-inch pipes eliminated overflow during the 100-year, 24-hour storm.

The split box would be structure placed west of the Reno Rendering Plant on Wells Avenue, which takes the first 50 cfs of storm runoff coming from the railroad acting detention pond at Manogue High School and diverts it down Wells Avenue to the freeway's (I-80) storm drain system, which is located on the south side of the freeway's right-of-way. The remaining flow, if any, at the split box will be routed its normal path to the Paradise Pond through the storm drainage pipe underneath Oddie Boulevard. The quantity of 50 cfs was

TABLE 4

THE DETENTION STORAGE OF THE PROPOSED EVANS AVENUE DETENTION POND

Elevation	Acre Feet of Storage	Capacity of Outlet	Description
4560.0	0	0	Begin Storage
4562.0	0.32	13	2 ft. depth
4564.0	1.60	36	4 ft. depth
4566.0	4.07	65	6 ft. depth
4568.0	7.76	100	8 ft. depth
4570.0	12.92	139	10 ft. depth
4772.0	19.70	183	12 ft. depth
4773.0	23.92	183	13 ft. depth Top of Detention Structure - Begin Overflow
4574.0	28.15	231	14 ft. depth
4576.0	38.41	395	16 ft. depth
4578.0	50.43	407	18 ft. depth
4580.4			Lowest elevation of Evans Avenue



DRAINAGE DIAGRAM FOR STORM
DRAIN CONDITION NO. 3

- FIGURE 4 -

used for the split box because that is about the full capacity of the freeway's existing 54-inch diameter storm drainage pipe. The 54-inch diameter pipe is where the diverted runoff water will tie into the freeway's storm drainage system.

The existing 54-inch diameter pipe was sized for the 25-year, 24-hour storm. During this storm the flow in the pipe without the split box was 48.79 cfs. With the split box in place, the flow in the pipe was 49.55 cfs. The increase of less than 1 cfs demonstrates the fact that the 50 cfs peak from the split box occurs after the 48.79 cfs flow has passed.

The Clearacre area (subareas R and N) in the present state flows into the Orr Ditch. The Orr Ditch then flows into the City of Sparks, which has the next in-line flood releasing gate for the Orr Ditch. Therefore, all the water runoff from the Clearacre area will be contributing to the flooding of Sparks, when the flood gate releases. This is the reason why the Clearacre area was routed into the Paradise Pond. A 48-inch enlarging to a 54-inch diameter storm drain pipe from the Orr Ditch to the Paradise Pond will carry the storm runoff from subareas R and N for all the storms, except for the 25-year, 24-hour; 50-year, 24-hour; and the 100-year, 24-hour storms. These three storms will require much larger diameter channels.

The runoff from subareas A, B, C, D, E, F, G, H, I, and J was routed the same way as in Condition No. 1.

Reference Appendix "C" in the separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" for the hydrographs and the data compiled for Condition No. 3.

The major problems that surfaced in the analysis of Condition No. 3 were threefold:

1. The railroad acting detention at Manogue High School overflowed during the 50- and 100-year, 24-hour duration storms, causing as much as 16.5 cfs to travel through the existing Evans Avenue area.

2. Subarea S and subarea T had standing flood waters. This occurred during a 5-year, 24-hour storm; a 5-year, 6-hour; a 25-year, 3-hour storm; or any storm greater than these. This flooding was caused mainly by the channeling of storm water runoff from subareas K, L, and M into subarea S.

3. Construction of the two 66-inch pipes under El Rancho Drive would be difficult and costly. This is because there would be inadequate cover over the pipes in the lower areas of El Rancho Drive. Existing utilities under El Rancho Drive might also interfere.

Condition No. 4 - Additional Pond Capacity, Improved Pond Outfall, Split Box, Clearacre Area Addition, Evans Avenue Detention.

The storm drain improvement Conditon No. 4 included the following improvements:

a. Construction of a 5-foot high dike along the southeastern corner of Paradise Pond.

b. Construction of an improved Paradise Pond outfall. This was either a 30-inch pipe to the North Truckee Drain or a larger pipe directly to the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drainage system.

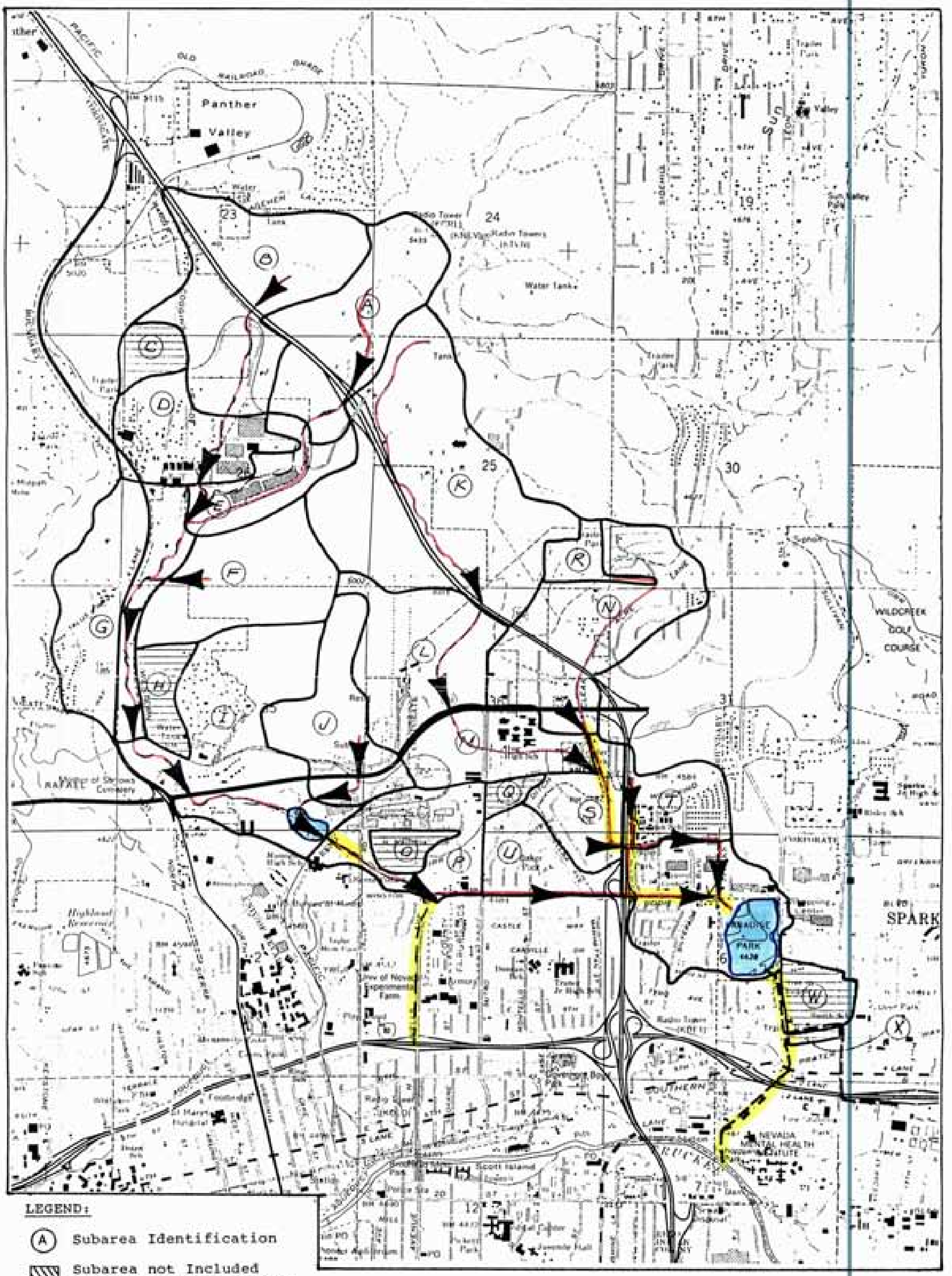
d. Construction of a channel from the Orr Ditch to Paradise Pond to carry the storm water runoff from the Clearacre area (subareas R and N).

e. Construction of a detention structure and pond in the area just west of the proposed Evans Avenue extension in place of the railroad acting detention.

f. All the existing storm drain improvements considered in the analysis of Condition No. 4.

These were the only improvements considered in the analysis of Condition No. 4.

The 5-foot high dike was the same as the one described in Condition No. 1. The improved outfall to the North Truckee Drain was the same as the one described in Condition No. 2. This outfall eliminated overflow of the improved Paradise Pond during all but the 25-year, 50-year, and 100-year 24-hour storms. These storms required a larger outfall along the same alignment as the 60-inch pipe described in Condition No. 1. Two 60-inch pipes were required to eliminate any overflow during a 25-year, 24-hour storm. The 50-year, 24-hour storm required three 66-inch pipes to prevent any overflow of the improved Paradise Pond. During a 100-year, 24-hour storm, four 66-inch pipes were required to eliminate overflow of the improved Paradise Pond.



DRAINAGE DIAGRAM FOR STORM DRAIN CONDITION NO. 4

- FIGURE 5 -

The split box was the same as the one described in Condition No. 3. Also, the Clearacre area was channeled the same as in Condition No. 3.

The detention structure just west of the proposed Evans Avenue extension was calculated to contain a 100-year, 24-hour storm and leave at least two feet of freeboard under the lowest point of the new Evans Avenue profile, which is at the southern end of the pond. (Reference Table 4 for the detention storage of the proposed Evans Avenue detention pond).

To carry a 100-year, 24-hour storm within the limits of the pond area available, the structure was attached to a 66-inch diameter pipe, which ran from the structure to the existing Valley Road 72-inch pipe. This was approximately 1250 feet in length.

The Evans Avenue detention pond has a little less than one-half the capacity of the railroad acting detention. To make the Evans Avenue detention pond capable of holding a 100-year, 24-hour storm without overflow required releasing more water downstream. This is the reason such large pipes were required for the Paradise Pond outfall. One possibility for the Evans Avenue detention pond to increase its detention capacity is to design both sides of the Evans Avenue roadway fill to hold detention water.

Storm water runoff was routed the same in Condition No. 4 as in Condition No. 3 except runoff that entered the railroad acting detention in Condition No. 3 entered the Evans Avenue detention in Condition No. 4.

Reference Appendix "D" in the separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" for the hydrographs and the data compiled for Condition No. 4.

The major problems that surfaced in the analysis of Condition No. 4 were three fold:

1. Subareas S and T had standing flood waters. This occurred during a 5-year, 24-hour storm, a 5-year, 6-hour storm; a 25-year, 3-hour storm or any storm greater than these.

2. Construction of anything larger than a 60-inch pipe under El Rancho Drive would be difficult and costly.

3. The existing storm drainage system that runs along Oddie Boulevard does not have the capacity to carry a 25-year, 24-hour; 50-year, 24-hour; or a 100-year, 24-hour storm.

With one improvement the system would be capable of carrying the 25-year, 24-hour storm. This improvement would be extending the 42-inch diameter pipe, that stops at the corner of Sutro Street and Oddie Boulelvard, on to the agricultural field just west of the Reno rendering plant (approximately 1350 feet) and construct a small detention pond at the mouth of the pipe or attach to the split box.

Condition No. 5 - Additional Pond Capacity, Improved Pond Outfall, Split Box, Clearacre Area Addition, Evans Avenue Detention, Sutro Street Dentention.

The storm drain improvement Conditon No. 5 included the following improvements:

a. Construction of a five-foot dike along the southeastern corner of Paradise Pond.

b. Construction of an improved Paradise Pond outfall. This was either a 30-inch pipe to the North Truckee Drain or a larger pipe directly to the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drainage system.

d. Construction of a channel from the Orr Ditch to Paradise Pond to carry the storm water runoff from the Clearacre area (Subareas R and N).

e. Construction of a detention structure and pond in the area just west of the proposed Evans Avenue extension in place of the railroad acting detention.

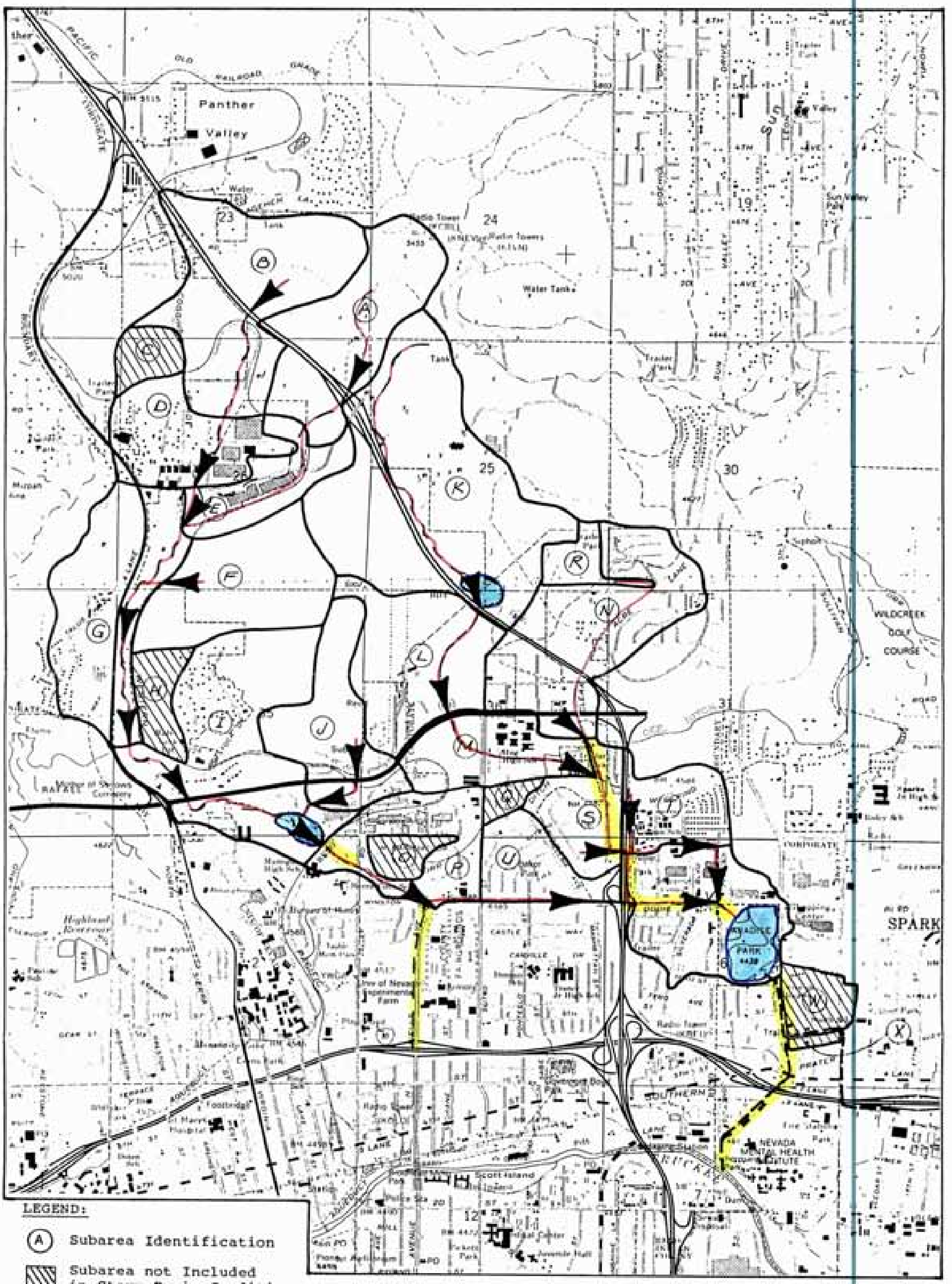
f. Construction of detention structure and pond at the lower end of Subarea K. This is located on the north side of I-580 near the future Sutro Street overpass.

g. All the existing storm drain improvements were cleared and cleaned.

These were the only improvements considered in the analysis of Condition No. 5.

The five-foot high dike was the same as the one described in Condition No. 1.

The improved Paradise Pond outfall was the same as the one described in Condition No. 4.



DRAINAGE DIAGRAM FOR STORM DRAIN CONDITION NO. 5

- FIGURE 6 -

The split box was the same as the one described in Condition No. 3.

The Clearacre area was channeled the same as in Condition No. 3.

The Evans Avenue detention area is the same as the one described in Condition No. 4.

There is a low area created by the I-580 road fill at the lower end of Subarea K on the north side of I-580 near the future Sutro Street overpass. An existing 72-inch diameter pipe drains the area. To induce storm water detention, a 24-inch diameter pipe was used at the outlet which would flow into the 72-inch diameter pipe under I-580.

This detention area decreased the peak discharge of Subarea K dramatically. For example, the 5-year, 24-hour peak was reduced from 75.3 cfs to 11.2 cfs. The 100-year, 24-hour peak was reduced from 379.6 cfs to 35.1 cfs. Even though this is a significant decrease, its effect on the total discharge from Subarea M is negligible. For example, the 5-year, 24-hour total discharge from Subarea M was 106.2 cfs without the detention area and 106.0 cfs with the detention area. The 100-year, 24-hour peak was 382.2 cfs without the detention and 359.2 cfs with the detention. The reason for this minimal effect on the downstream subareas is the time at which the peak discharges occur. Since Subarea K is largely undeveloped and hydraulically distant from Subarea M, the routed peak discharge from Subarea K occurs later than the peak for Subarea M. This is true whether the storm detention is utilized or not. If future development decreases the time required for Subarea K to develop its peak discharge, then utilization of the detention capacity would have an increased effect. (Reference Table 5 for the detention storge of the proposed I-580 and future Sutro Street overpass detention pond).

Reference Appendix "E" in the separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" for the Hydrographs and the data compiled for Condition No. 5.

The major problems that arose in the analysis of Condition No. 5 were the same as the problems in Condition No. 4. This is because the only difference between Condition No. 4 and Condition No. 5 was the utilization of the detention storage at I-580 and the future Sutro Street overpass. The effect of this detention storage on the overall behavior of the Paradise Pond watershed was negligible.

TABLE 5

THE DETENTION STORAGE OF THE PROPOSED I-580 AND FUTURE SUTRO STREET OVERPASS DETENTION POND

Elevation	Acre Feet of Storage	Capacity of Outlet	Description
4690.0	0	0	Begin Storage
4700.0	15	30	10 ft. depth
4710.0	52	43	20 ft. depth
4720.0	147	80	30 ft. depth

Condition No. 6 - Additional Pond Capacity, Improved Pond Outfall, Split Box, Clearacre Area Addition, Evans Avenue Detention, Sutro Street Detention, Fife Street Detention.

The storm drain improvement Condition No. 6 included the following improvements:

a. Construction of a five-foot dike along the southeastern corner of Paradise Pond.

b. Construction of an improved Paradise Pond outfall. This was either a 30-inch pipe to the North Truckee Drain or a larger pipe directly to the Truckee River.

c. Construction of a split box to divert the runoff from upstream of Wells Avenue into the freeway's (I-80) storm drainage system.

d. Construction of a channel from the Orr Ditch to Paradise Pond to carry the storm water runoff from the Clearacre area (Subareas R and N).

e. Construction of a detention structure and pond in the area just west of the proposed Evans Avenue extension in place of the railroad acting detention.

f. Construction of detention structure and pond at the lower end of Subarea K. This is located on the north side of I-580 near the future Sutro Street overpass.

g. Construction of a detention structure and pond at the lower end of Subarea S, which is at I-580 and Fife Drive, between Oddie Boulevard and Wedekind Road.

h. All the existing storm drain improvements were cleared and cleaned.

These were the only improvements considered in the analysis of Condition No. 6.

The five-foot high dike was the same as the one described in Condition No. 1. The improved outfall to the North Truckee Drain was the same as the one described in Condition No. 2. This outfall eliminated overflow of the improved Paradise Pond during all but the 25-year, 50-year, and 100-year, 24-hour storms. These storms required a larger outfall along the same alignment as the 60-inch pipe outfall described in Condition No. 1. One 60-inch pipe along this alignment prevented any overflow during a 25-year, 24-hour storm. The 50-year, 24-hour storm required 3 60-inch pipes and the 100-year, 24-hour storm required 3 66-inch pipes to eliminate overflow of the improved Paradise Pond.

The split box was the same as the one described in Condition No. 3.

The Clearacre area was channeled the same as in Condition No. 3.

The Evans Avenue detention was the same as the one described in Condition No. 4.

The I-580 and future Sutro Street overpass is the same as the one described in Condition No. 5.

There is a natural low point at the I-580 and Fife Drive proposed detention pond location, but the area is completely built up with homes. For the pond to be constructed, the homes would have to be condemned and removed since most of the detention pond will be built above the existing ground with a dike surrounding the pond. (Reference Table 6 for the detention storage of the proposed I-580 and Fife Drive detention pond).

A 48-inch diameter pipe was used at the outlet of this detention pond. Also, a 54-inch diameter pipe was run to the Paradise Pond by using the existing 48-inch diameter pipe under I-580 then following I-580 on the east side, south to Oddie Boulevard and out to the Paradise Pond. This detention pond has the storage capacity to greatly decrease the peak flows coming from the Clearacre area (Subarea R and N), and Subareas K, L, and M.

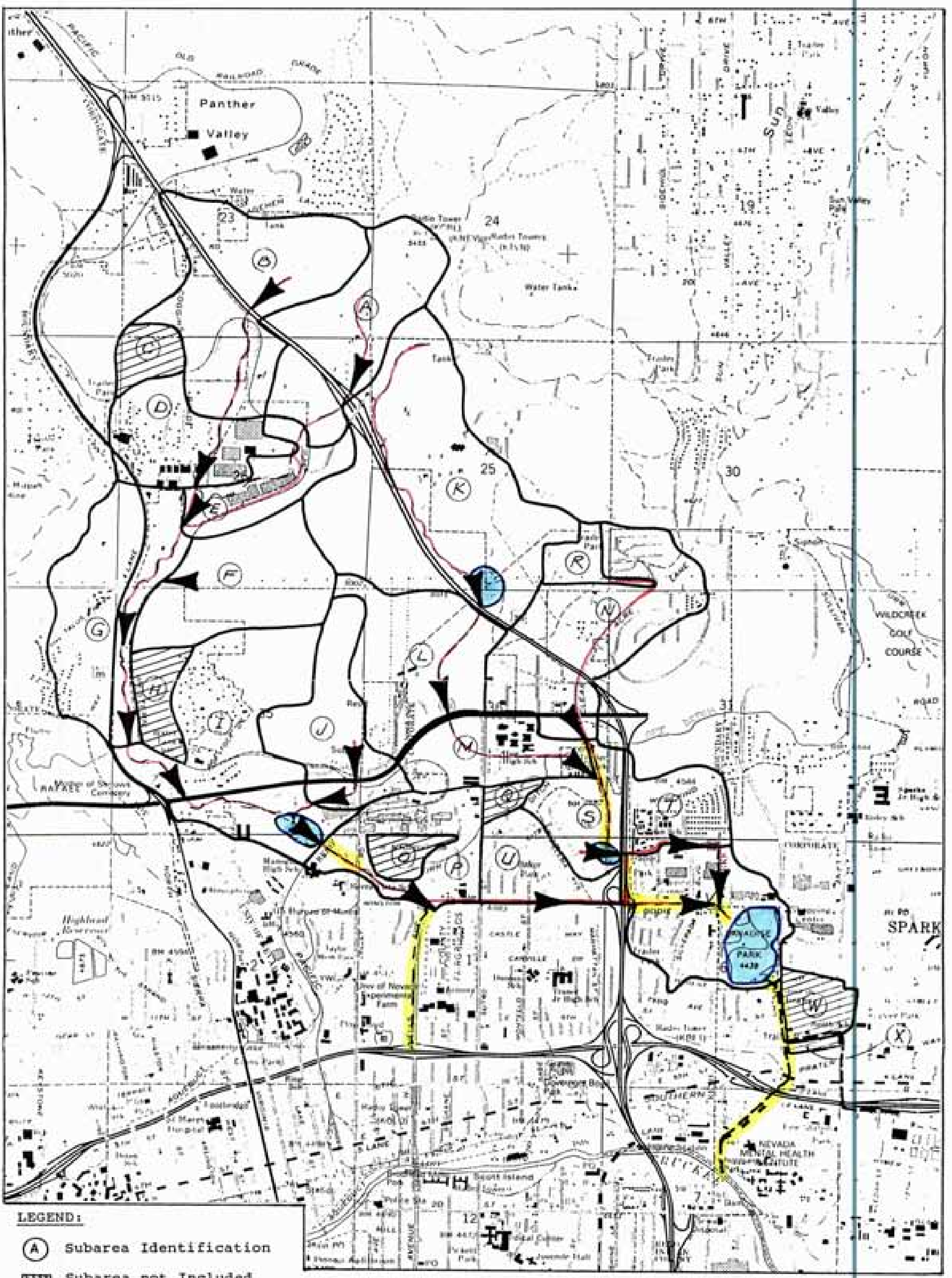
The effect of this detention area on the Paradise Pond watershed as a whole was small. As such, its construction allowed a small reduction (compared to Condition No. 4 and Condition No. 5) in the size of the Paradise Pond outfall.

Reference Appendix "F" in the separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" for the hydrographs and the data compiled for Condition No. 6.

The major problems that surfaced in the analysis of Condition No. 6 were two-fold:

1. Construction of the I-580 and Fife Drive detention would be prohibitively expensive. Condemning and acquiring the ten acres of existing homes would cost approximately three million dollars. Demolition and removal of the houses and construction of the detention would cost an additional two million dollars.

2. Construction of anything greater than one 60-inch pipe under El Rancho Drive would be difficult and costly.



DRAINAGE DIAGRAM FOR STORM DRAIN CONDITION NO. 6

- FIGURE 7 -

THE RECOMMENDED IMPROVEMENTS

The recommended improvements for the Paradise Pond watershed are based on how the watershed functions with and without the improvements, the economics of constructing and maintaining the improvements, the decreased amount of flood damage resulting from the improvements, and how the improvements will fit into the future planning of the watershed.

Table 7 lists the various improvements analyzed in this report. The priority assigned to each improvement was based on the severity of the problem the improvement would eliminate. Also, the initial capital cost of each improvement was estimated.

Two improvements received top priority. These were the five-foot dike around the southeastern corner of Paradise Pond and the 60-inch outfall pipe under El Rancho Drive, Kietzke Lane, and Galletti Way to the Truckee River. The combined estimated cost of these improvements is 1.3 million dollars in 1985 dollars. Condition No. 1 covered the analysis of these two improvements. (For a complete discussion of how the watershed functions with these two improvements, refer to the section on Condition No. 1.) Top priority was assigned to these two improvements because they are the most cost effective way of eliminating the overflow of Paradise Pond.

Second priority was assigned to the construction of the channel from the Orr Ditch to Paradise Pond. This improvement is necessary to prevent runoff from the Clearacre area (Subarea R and N) from entering the Orr Ditch and causing flooding in the City of Sparks. Construction of this improvement would cost approximately one million dollars in 1985 dollars. This improvement would prevent runoff from the Clearacre area (Subareas R and N) from causing the Orr Ditch to overflow. It would also help decrease the volume of standing flood waters in Subareas S and T. Diversion of this additional runoff to the Paradise Pond will cause overloading of the 60-inch Paradise Pond outfall during a 25-year, 50-year, or 100-year, 24-hour storm under Conditions No. 4, 5, and 6 and during a 50-year, 24-year or 100-year, 24-hour storm under Condition No. 3. The storm water runoff overflowing the Paradise Pond does develop a large peak, but the duration of the overflow is quite short, with an average duration of about four hours. The overflow water will flow down El Rancho Drive to "D" Street, where it will turn and head east, depositing water into all the detention pockets along the way. These detention pockets will drain once the storm drainage system in its area has the capability of holding this additional storm water.

TABLE 6

THE DETENTION STORAGE OF THE PROPOSED I-580 AND FIFE DRIVE DETENTION POND

Elevation	Acre Feet of Storage	Capacity of Outlet	Description
0	0	0	Begin Storage
1	10	6.8	1 ft. depth
2	20	24	2 ft. depth
3	30	47	3 ft. depth
4	40	72	4 ft. depth
5	50	95	5 ft. depth
6	60	80	6 ft. depth
7	70	86	7 ft. depth
8	80	92	8 ft. depth
9	90	97	9 ft. depth
10	100	102	10 ft. depth

TABLE 7

The Construction Priorities of the Various Storm Drain Improvements

Improvement	Priority	Estimated Capital Cost (1985 Dollars)
5-foot Paradise Pond dike	Top	$ 50,000
1-60" pipe Paradise Pond outfall to Truckee River	Top	1,250,000
Divert Clearacre area to Paradise Pond	2nd	1,000,000
Split box and 42" pipe from split box to corner of Oddie Blvd. and Sutro St.	3rd	800,000
Evans Ave. detention and 66" pipe to Valley Road	4th	1,000,000
1-30" pipe Paradise Pond outfall to North Truckee Drain	Not Recommended	775,000
1-66" pipe Paradise Pond outfall to Truckee River	Not Recommended	1,600,000
2 or more 60" or 66" pipes Paradise Pond outfall to Truckee River	Not Recommended	2,500,000
I-580 and future Sutro Street overpass detention area	Depends on Future Dev.	2,000,000
I-580 and Fife Dr. detention area	Not Recommended	5,100,000

Third priority was assigned to the construction of the split box and 42-inch pipe from the split box to the corner of Oddie Boulevard and Sutro Street described in Condition No. 4. These improvements received third priority because of their ability to reduce the flow over the 30-foot spillway in the Paradise Pond dike. With the split box in place there was no overflow of the Paradise Pond spillway during a 50-year, 24-hour storm. During the 100-year, 24-hour storm the peak flow over the 30-foot spillway was 6.6 cfs. This would cause minimal flooding of El Rancho Drive. The combined effect of the top priority, second priority, and third priority improvements, was analyzed in Condition No. 3.

Fourth priority was assigned to construction of the Evans Avenue detention and the 66-inch pipe to Valley Road. Actual construction of these improvements should coincide with construction of the Evans Avenue extension. The cost of one million dollars, in 1985 dollars, does not include the cost of constructing the Evans Avenue extension. The one million dollars is only for the detention structure and the 66-inch pipe. The construction of the Evans Avenue extension reduces the storm water detention capacity in this area by half. Consequently, more water must be released downstream. This will cause more water to flow over the 30-foot spillway in the Paradise Pond dike. With the top, second, third, and fourth priority improvements in place, there will be no flow over the 30-foot spillway during a 25-year, 24-hour storm. During a 50-year, 24-hour storm there will be a peak flow of 143 cfs over the 30-foot spillway. This overflow will be 184 cfs during a 100-year, 24-hour storm. The combined effect of the top, second, third, and fourth priority improvements was analyzed in Condition No. 4.

Construction of a 30-inch pipe from the Paradise Pond outfall to the North Truckee Drain was not recommended. The cost of constructing this pipe would be $775,000.00. The pipe would have an approximate capacity of 21.5 cfs which is insufficient to prevent major flood damage downstream of Paradise Pond. The 21.5 cfs is less than one-fourth the capacity of the 60-inch outfall pipe.

Construction of a 66-inch pipe instead of the 60-inch outfall pipe was not recommended. The 60-inch pipe has a maximum capacity of 91 cfs. The 66-inch pipe has a maximum capacity of 103 cfs. The extra expense and difficulty of contracting the 66-inch pipe instead of the 60-inch pipe is not necessary.

Construction of two or more 60-inch or 66-inch outfall pipes was not recommended for the same reason. A larger diameter pipe, or the addition of another adjoining pipe to the channel from Paradise Pond to the river would help the

channel's efficiency; but, the cost of the channel would increase sharply, approximately 1.7 times the original cost for constructing another adjoining pipe. The original cost for the 60-inch diameter pipe is approximately 1.25 million dollars. The centerline profile of El Rancho drive and of Kietzke Lane limits the maximum pipe diameter to be 60- or 66-inch maximum. Anything over that size of pipe will lead to installing a longer length of channel to reach the Truckee River at a lower water surface elevation.

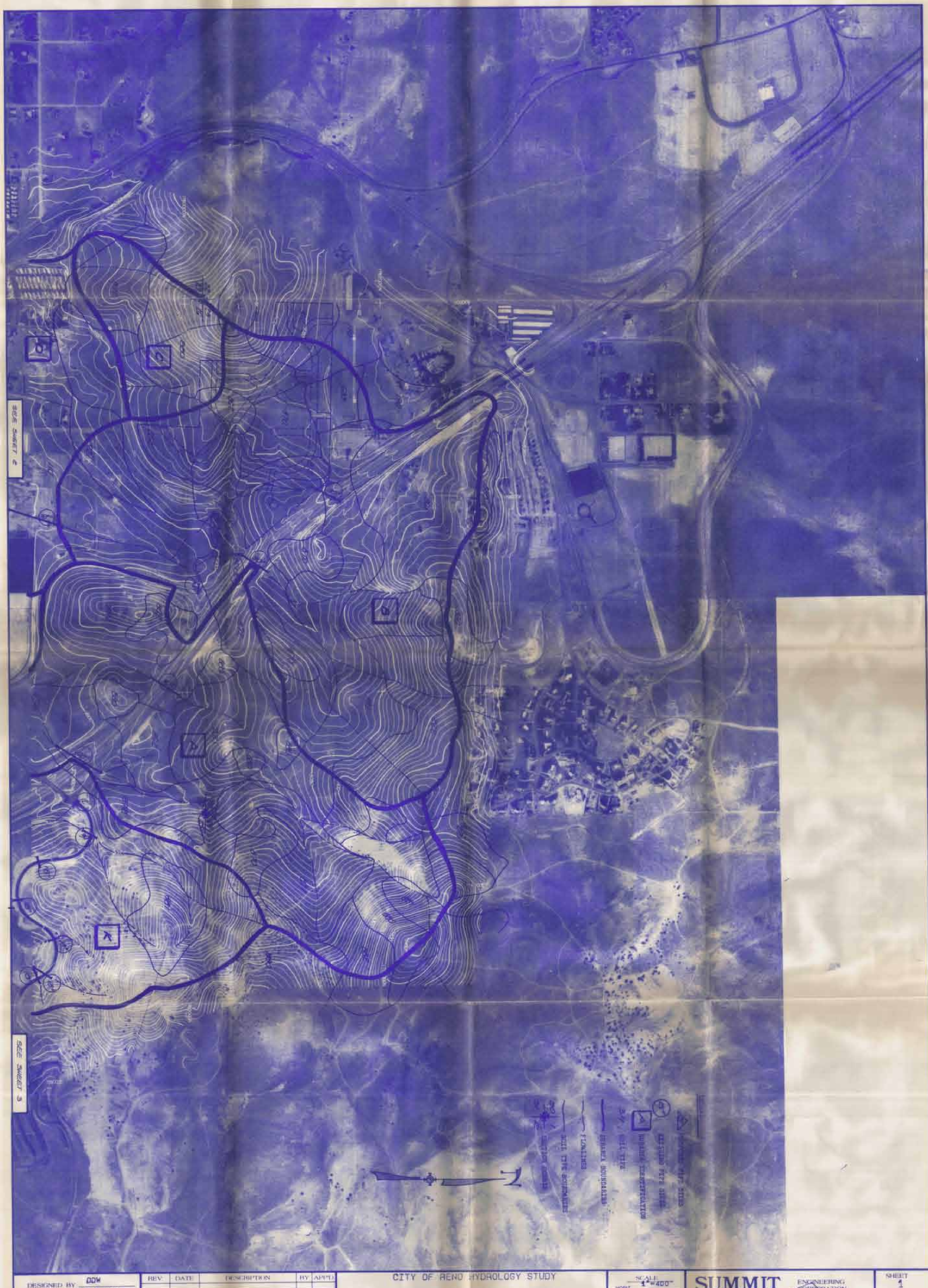
The I-580 and the future Sutro Street overpass detention pond should be considered as development begins in that area. As development proceeds in Subarea K the peak runoff from that subarea will hit sooner and be larger. The logical location for a detention area will be the low area created by the I-580 road fill. The I-580 and Fife Drive detention pond would greatly decrease the amount of flooding that would occur in that area, and help the Paradise Pond's capacity to contain a 50- or 100-year storm water runoff. But, the cost of removing ten acres of residentially developed land is very high. Additionally, building another park detention pond would add a lot of maintenance costs. The I-580 and Fife Drive detention pond is not recommended.

APPENDICES

Appendices "A" through "F" are in separate booklet entitled "The Appendix for the Hydrological Analysis of the Paradise Pond Watershed" contain hydrographs for the 5-, 25-, 50-, and 100-year, 24-hour duration storms. They are arranged from upstream (Subarea A) to downstream (Paradise Pond). The hydrographs are read by following the horizontal axis to the desired time; the rate of runoff, in cubic feet per second, is then read from the vertical axis. The area under each curve represents the volume of runoff. In general, a hydrograph is plotted for each separate subarea. That hydrograph is then routed to the next subarea downstream to give a total hydrograph for the downstream subarea. This process is repeated until eventually the runoff has been routed to Paradise Pond. For the 3-, 6-, and 24-hour duration storms, peak runoff values and corresponding times to peak are given in table form.

Appendix 1 contained in this booklet contains the display maps of the project watershed area with the pipe sizes and different condition data.

APPENDIX "1"



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DRAWN BY: VES & EDM					
CHECKED BY: DDW					
DATE: JUNE 1985					

CITY OF RENO HYDROLOGY STUDY

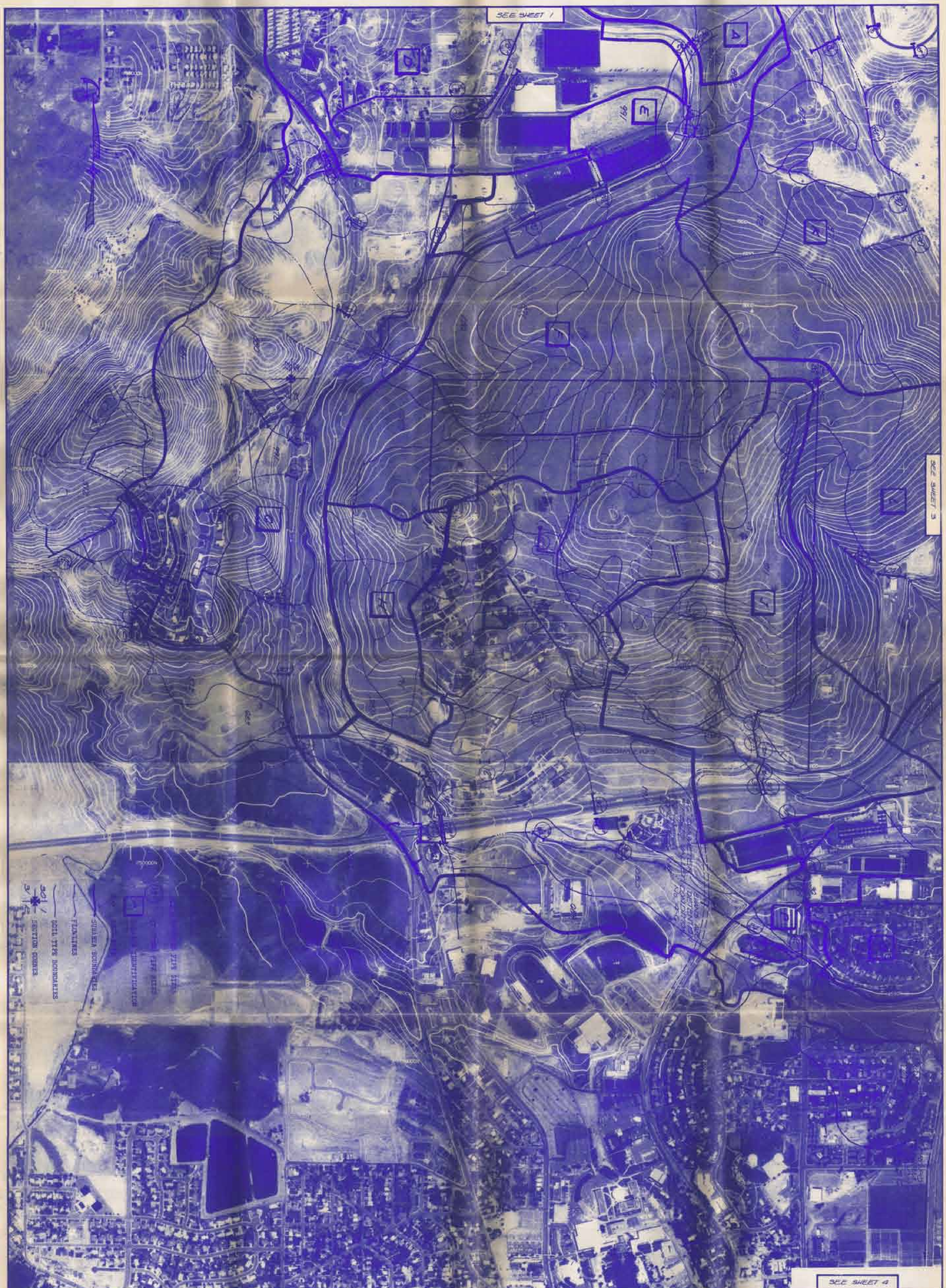
PARADISE POND WATERSHED

RENO WASHOE COUNTY NEVADA

SCALE: 1"=400'
HORIZ
VERT
JOB No: 2058
DRAWING No:

SUMMIT ENGINEERING CORPORATION
CONSULTING ENGINEERS AND SURVEYORS
[illegible] RENO, NEVADA 89503
PHONE (702) 323-1867

SHEET 1 OF 4



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PARADISE POND WATERSHED

RENO, WASHOE CO., NEVADA

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JOB No. 2058
DRAWING No.

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SIERRA SUMMIT, SUITE 1, RENO, NEVADA 89503
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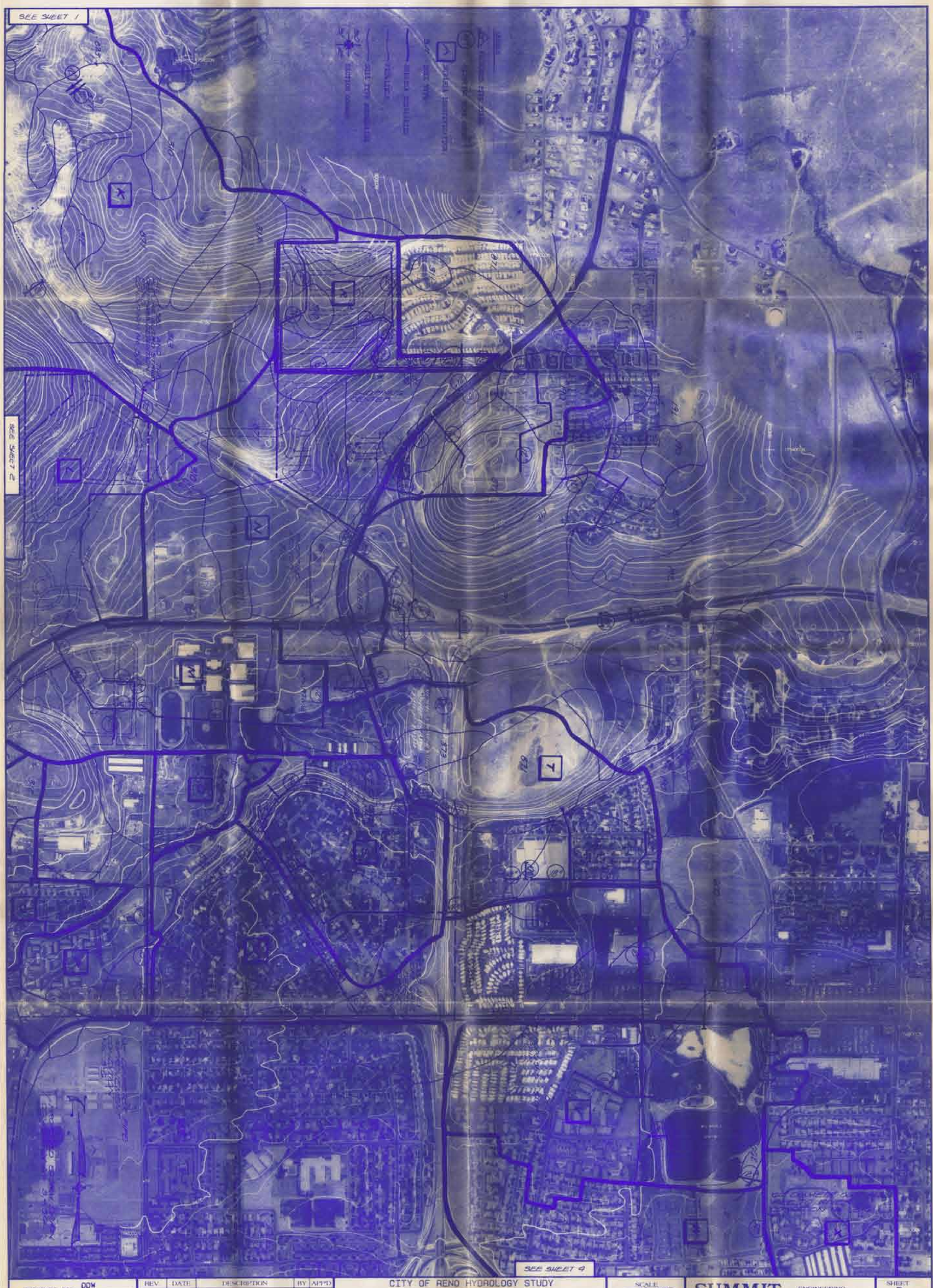

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PARADISE POND WATERSHED

RENO WASHOE COUNTY NEVADA

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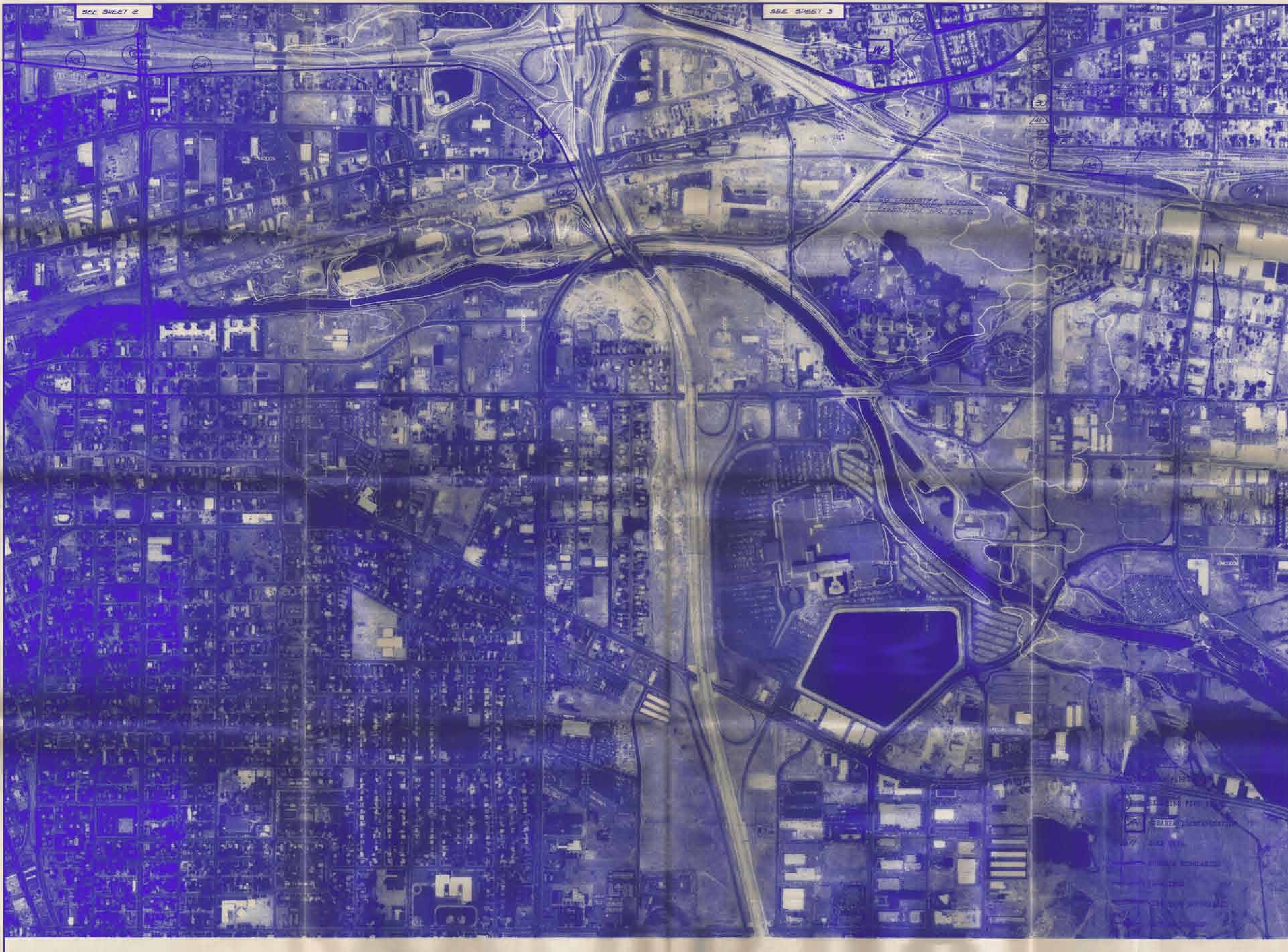

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PARADISE POND WATERSHED

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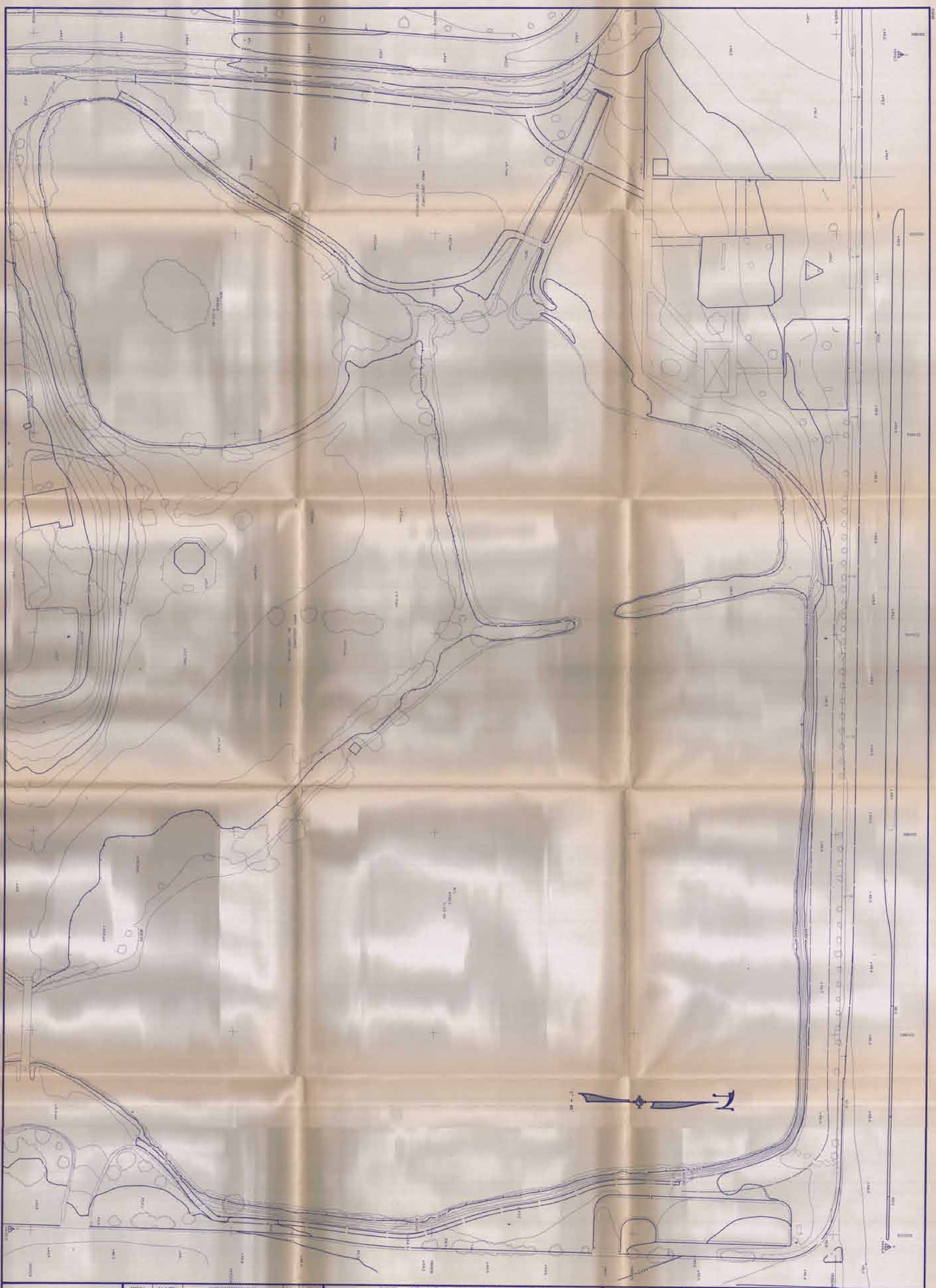

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PARADISE POND

RENO, WASHOE COUNTY, NEVADA

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240 NORTH SIERRA, SUITE 1, RENO, NEVADA 89501
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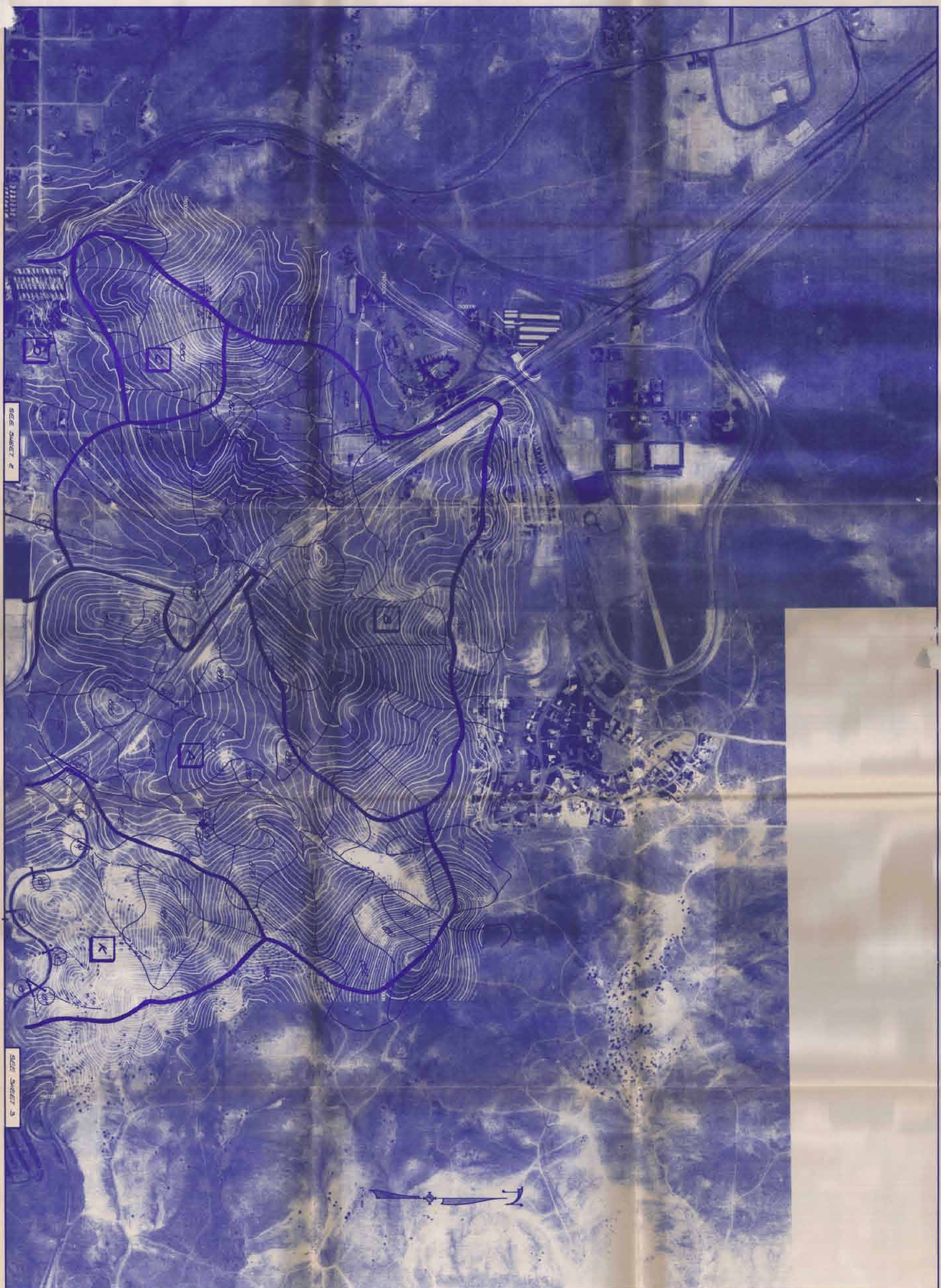

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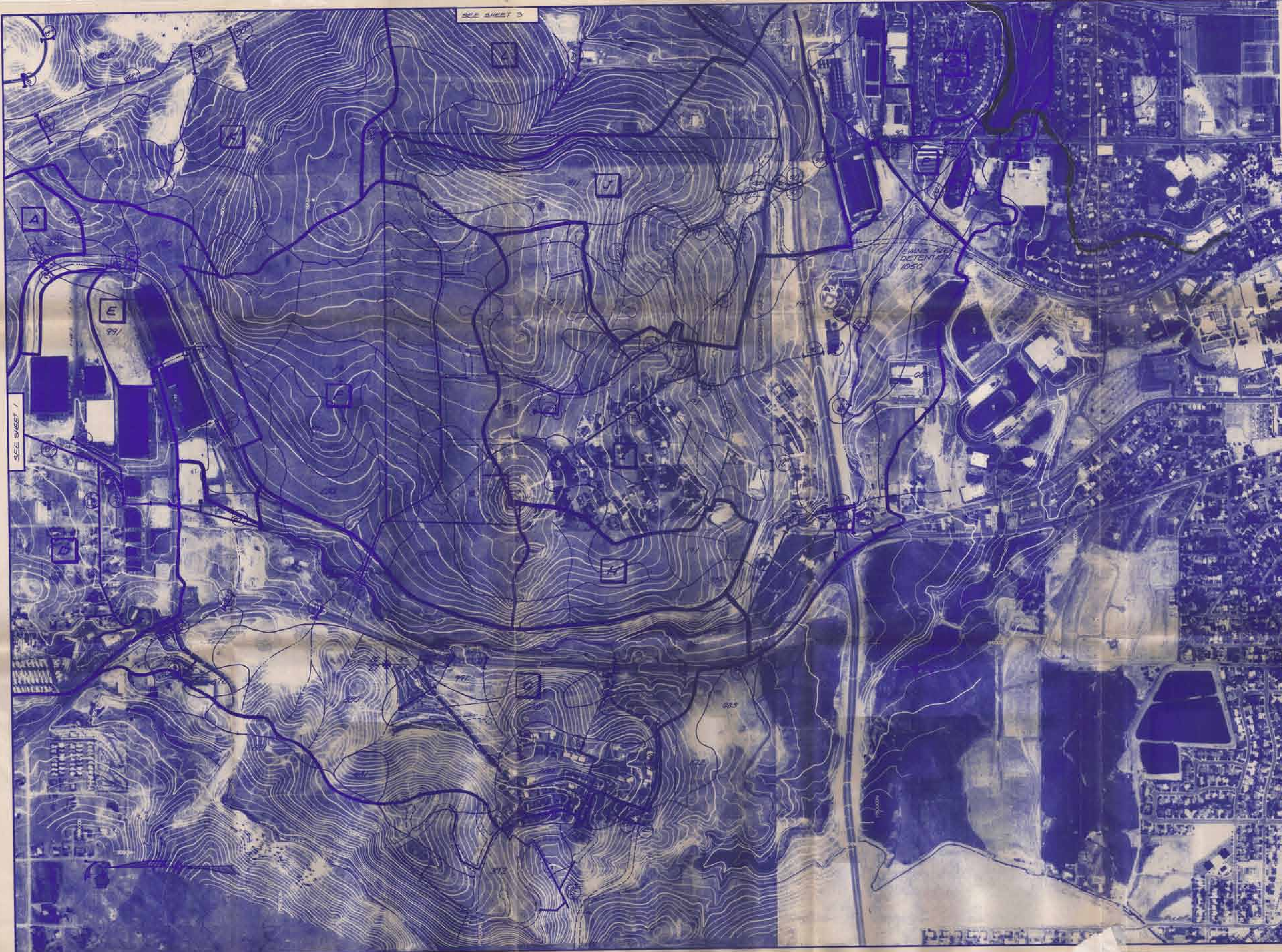

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VERT
JOB No. 2056
DRAWING No.

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PARADISE POND WATERSHED
RENO WASHOE CO. NEVADA

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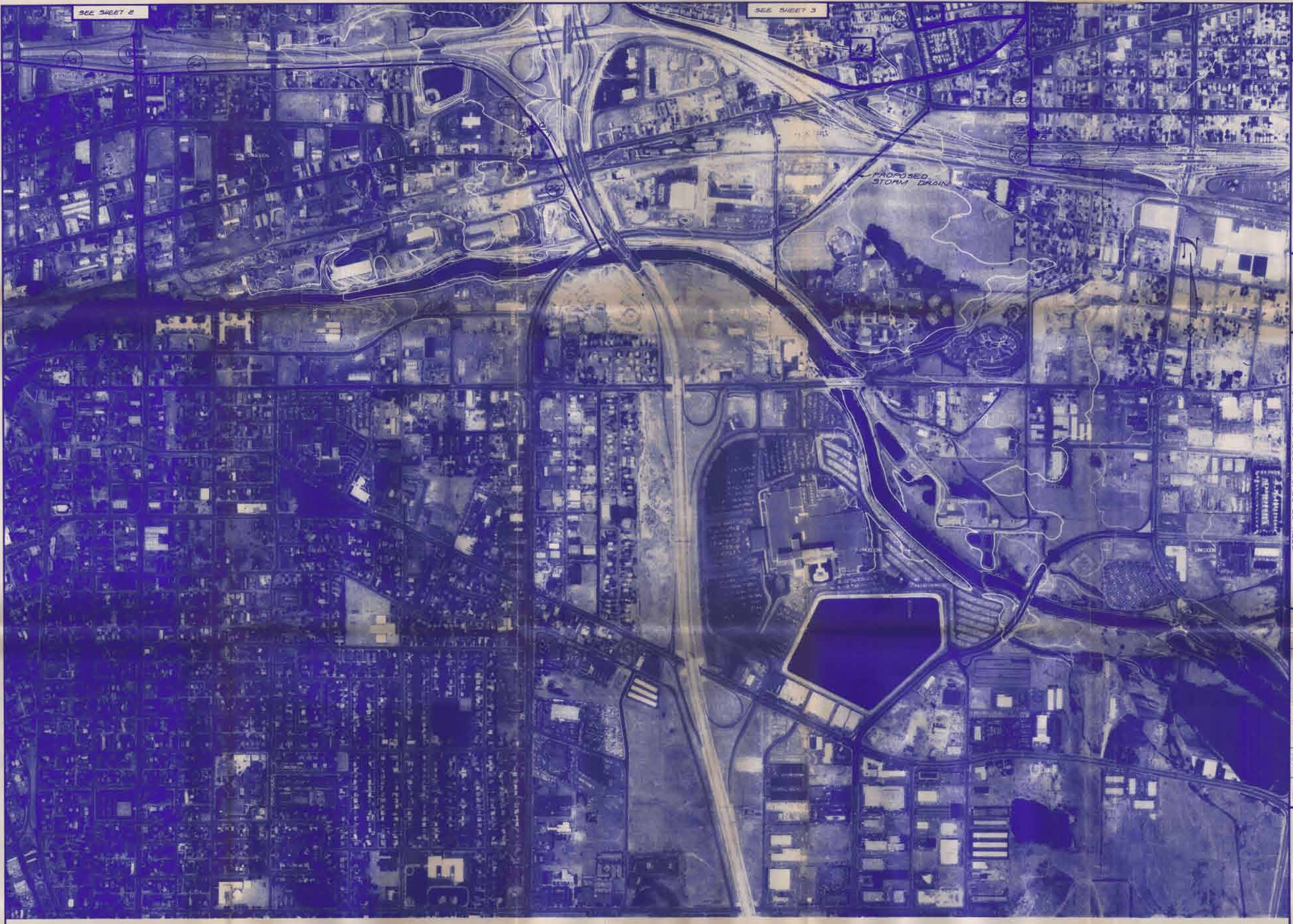
DRAWN BY VES & EDM
CHECKED BY DDM
DATE JUNE 1985


SEE SHEET 1
SEE SHEET 2
SEE SHEET 4
CITY OF RENO HYDROLOGY STUDY
PARADISE POND WATERSHED
RENO WASHOE COUNTY NEVADA
DESIGNED BY DDW
DRAWN BY VES & EDM
CHECKED BY DDW
DATE JUNE 1985
REV DATE DESCRIPTION BY APP'D
SCALE HORIZ 1"=400'
VERT
JOB No. 2058
DRAWING No.
SUMMIT ENGINEERING CORPORATION
CONSULTING ENGINEERS AND SURVEYORS
SHEET 3 OF 4



REV.	DATE	DESCRIPTION	BY	APP'D

DESIGNED BY DDW
DRAWN BY VES & EDM
CHECKED BY DDW
DATE JUNE 1985

CITY OF RENO HYDROLOGY STUDY

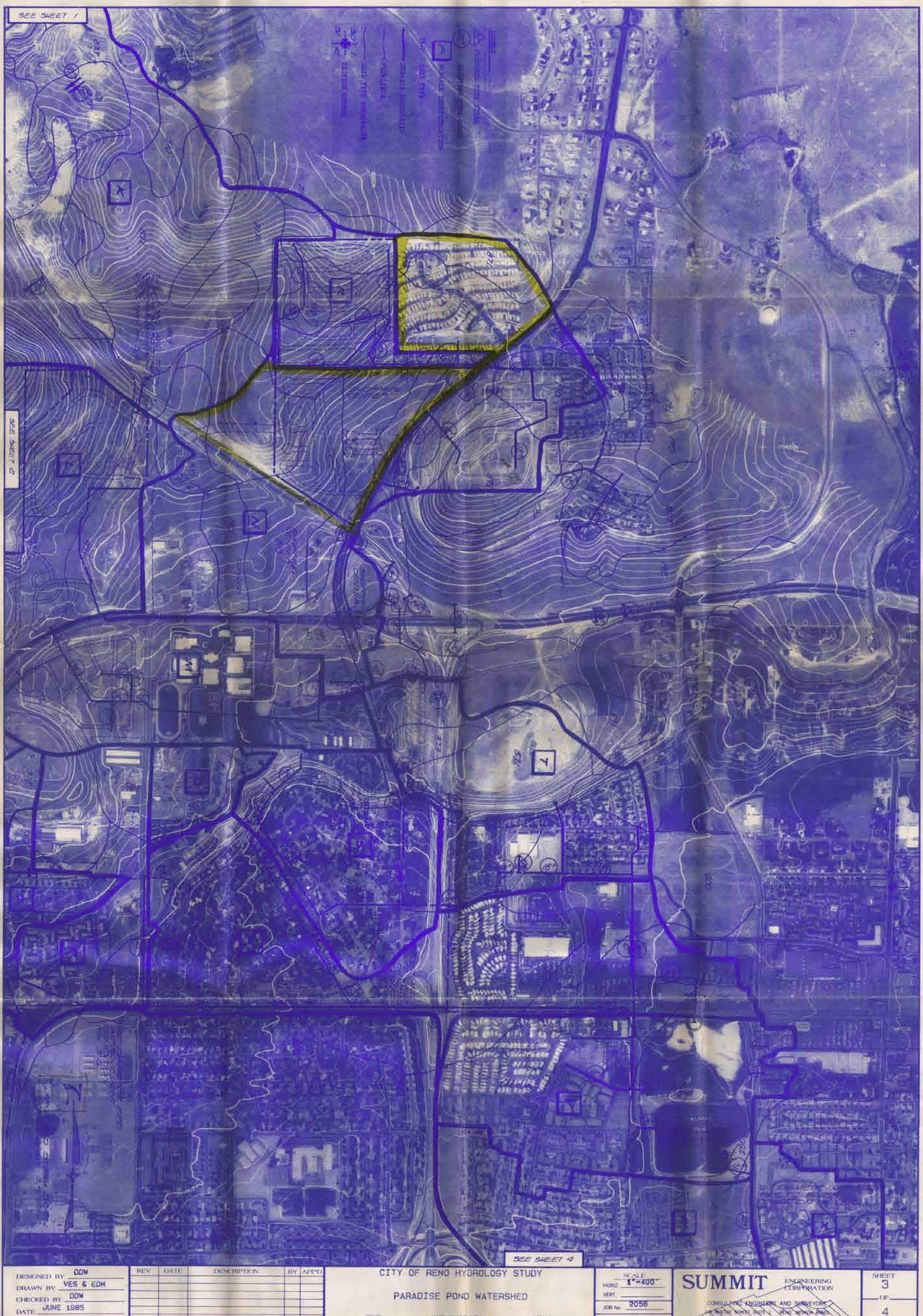
PARADISE POND WATERSHED

RENO, WASHOE COUNTY, NEVADA

SCALE
HORIZ. 1"=400'
VERT.
JOB No. 2058
DRAWING No.

SUMMIT ENGINEERING CORPORATION
CONSULTING ENGINEERS AND SURVEYORS

SHEET 4 OF 4



DESIGNED BY: DDW
DRAWN BY: VES & EDM
CHECKED BY: DDW
DATE: JUNE 1985

REV	DATE	DESCRIPTION	BY	APP'D

CITY OF RENO HYDROLOGY STUDY

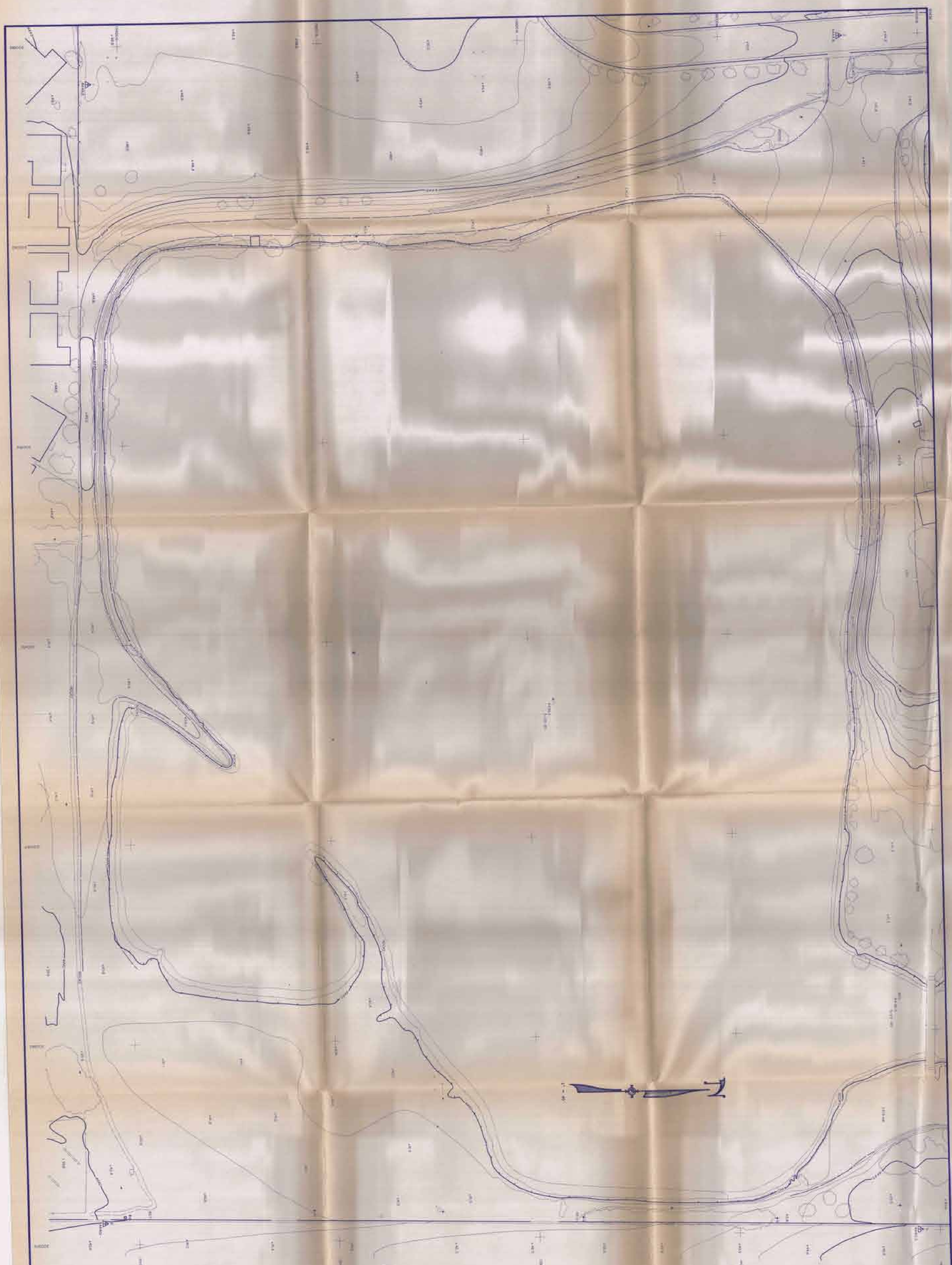
PARADISE POND WATERSHED

RENO, WASHOE COUNTY, NEVADA

SCALE
HORIZ 1"=400'
VERT
JOB No. 2056
DRAWING No.

SUMMIT ENGINEERING CORPORATION
CONSULTING ENGINEERS AND SURVEYORS
240 WINTER KIRKET, SUITE 1 RENO, NEVADA 89503
PHONE (702) 323-3917

SHEET 3 OF 4



DESIGNED BY:					
DRAWN BY:	REV	DATE	DESCRIPTION	BY	APP'D
CHECKED BY:					
DATE: JUNE 1985					

CITY OF RENO HYDROLOGY STUDY

PARADISE POND

RENO, WASHOE COUNTY, NEVADA

SCALE: HORIZ 1"=40' VERT

JOB No. 2056

DRAWING No.

SUMMIT ENGINEERING CORPORATION

CONSULTING ENGINEERS AND SURVEYORS

SIERRA SUITE 4 RENO, NEVADA 89503

PHONE (702) 323-3963

SHEET 1 OF 2