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UPPER EAST FORK CAVE CREEK
BENEFIT COST ANALYSIS
PARADISE VALLEY PARK DETENTION BASIN

PREPARED BY

NBS/LOWRY
ENGINEERS & PLANNERS

OCTOBER 1989

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EXECUTIVE SUMMARY

ABSTRACT

This report summarizes a benefit cost study done for the Paradise Valley Park Detention Basin located in the Upper East Fork Cave Creek watershed. The Paradise Valley Park Detention Basin is also identified as Detention Basin Number 4. **Figure 1.1** shows the location of Detention Basin Number 4 at Paradise Valley Park.

CONCLUSIONS

The recommendations made in this report are based on the following conclusions.

1. Equivalent annual damages without Detention Basin Number 4 are expected to be $1,502,730 per year.

2. Equivalent annual damages with Detention Basin Number 4 are expected to be $819,510 per year.

3. Total benefits of the project, including reductions in both flood damages and nonphysical costs, are valued as follows:

Equivalent Annual Reduction in Flood Damages	$683,230/yr
Annual Reduction in Nonphysical Costs	
Traffic Rerouting	$ 11,626/yr
Total	$694,856/yr

4. Total costs of the project are estimated as follows:

	Capital Cost	Annual Cost @ 3%-100yr
Project Construction Cost	$6,863,600.	$216,900/yr
Maintenance Cost		$ 16,000/yr
Total		$232,900/yr

5. The computed benefit cost ratio B/C for Detention Basin Number 4 is 3.0.

RECOMMENDATIONS

Because the benefit cost ratio for Detention Basin Number 4 is greater than 1.00, full funding of this project by the Flood Control District of Maricopa County can be justified. Prioritizing expenditures for this project should be pursued after considering the availability of funding, and the benefit cost ratios computed for competing projects.

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CHAPTER 1
BACKGROUND

SCOPE OF WORK

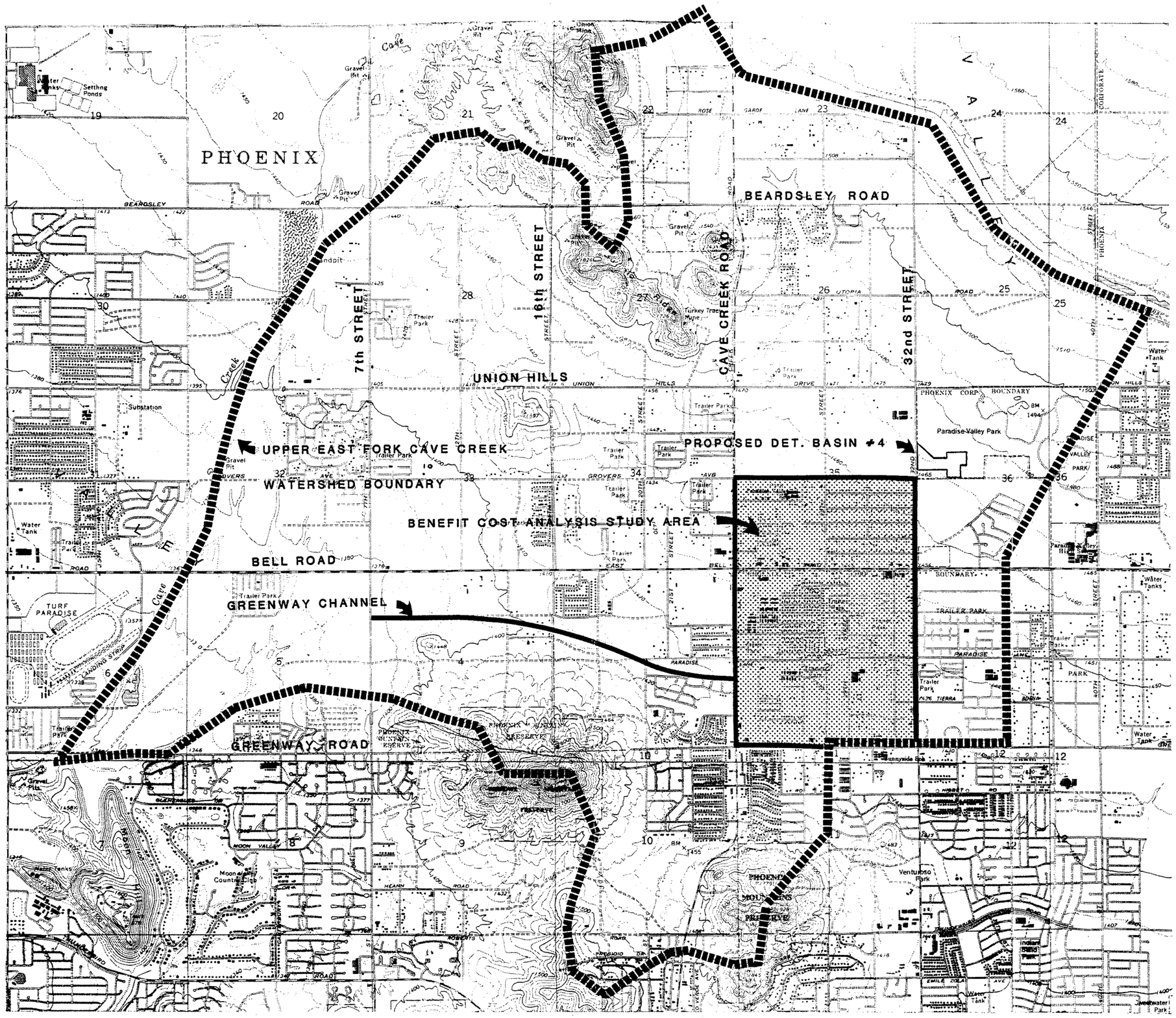
This Benefit Cost Analysis has been prepared for the Flood Control District of Maricopa County to assist in determining funding availability and priority for the proposed Detention Basin Number 4 in the Upper East Fork Cave Creek Watershed. This detention basin was originally identified as a component of the Upper East Fork Cave Creek Area Drainage Master Plan. Preliminary design development for the detention basin has been documented in the Upper East Fork Cave Creek Detention Area Sizing Study prepared in February, 1989 and the Engineering Design Descriptions dated June, 1989.

A benefit cost ratio has been computed for the proposed detention basin following procedures outlined in the Economic Analysis Procedure developed by the Flood Control District of Maricopa County. This report summarizes the procedures followed.

PROJECT DESCRIPTION

Project Location

Figure 1.1 shows the location of the Upper East Fork Cave Creek watershed and the proposed Detention Basin Number 4. The available property is irregular in shape, and must be shared with the proposed Maricopa County Library. The basin occupies approximately 29 acres of shared use land that will contain parking or other amenities to be used by the adjacent Paradise Valley Community College on the upper terrace of the basin. The upper terrace will only be inundated during rare storm events.



LOCATION PLAN

FIGURE 1.1

Project Dimensions

The detention basin covers an area of approximately 29 acres, containing a storage volume of 36 acre-feet at a maximum depth of 8.1 feet. Outflow occurs through a proposed 42-inch concrete pipe.

Estimated earthwork is 86,000 cubic yards of haul-off.

Hydraulic Parameters

TR-20 runs for the watershed upstream of the detention basin estimate the peak 100-year runoff into the detention basin to be 535 cubic feet per second. Construction of the basin is expected to reduce the peak outflow to 139 cubic feet per second.

FLOODING

Flooded Area

Figure 1.2 shows the flooded area (0.5 ft. deep or greater) expected for a 100-year storm with and without the project.

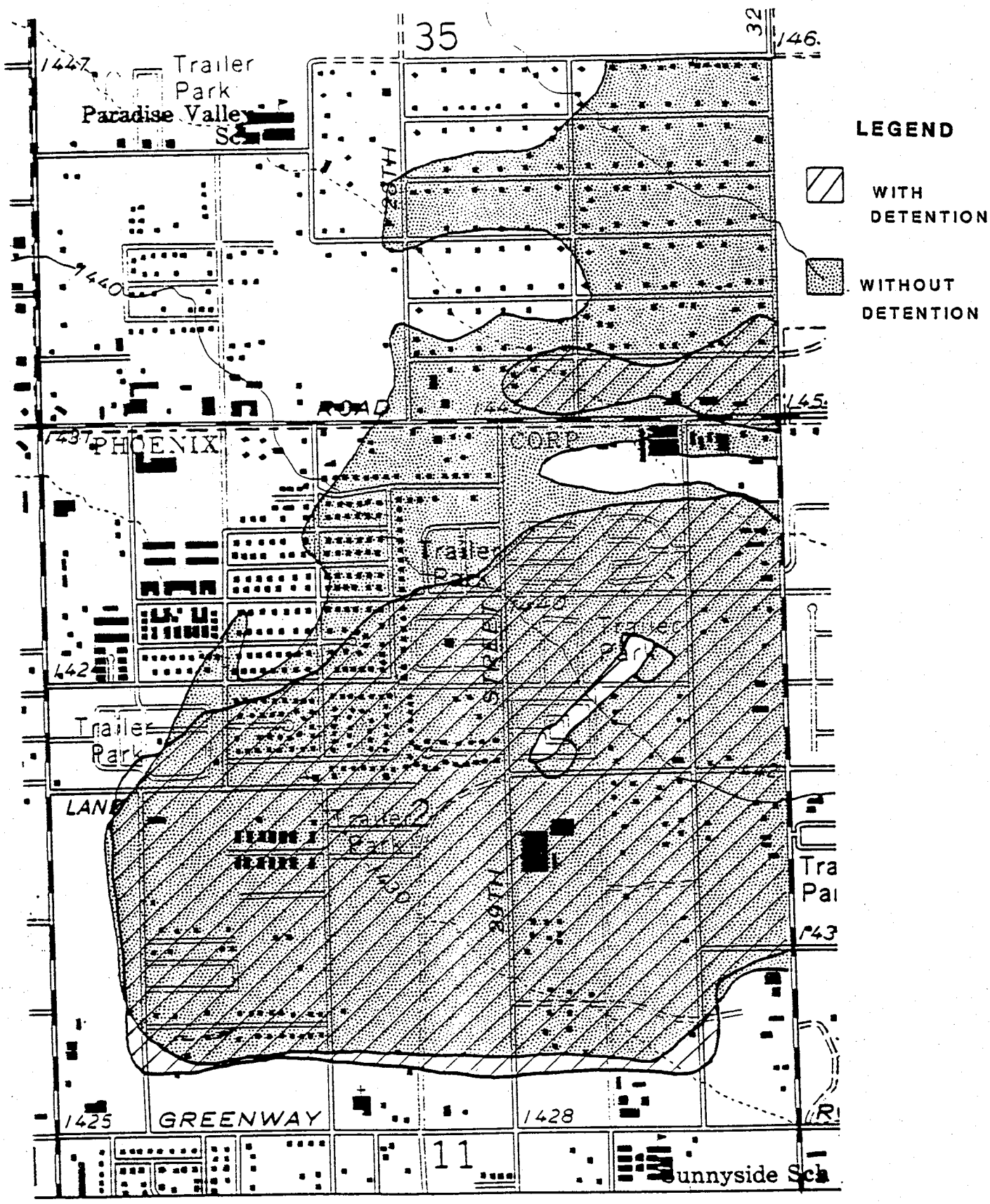
Land Use

Land use within the flooded area consists primarily of single family and multi-family housing. Some commercial-industrial property and mobile home properties also lie within the flooded area.

ACKNOWLEDGMENTS

The completion of this Engineering Report was made possible by the assistance and data furnished by many individuals whose valuable assistance is gratefully acknowledged.

We especially wish to thank Mr. Dan Sagramoso, P.E., Mr. Stan Smith, P.E., and Mr. Lionel Lewis, P.E. of the Flood Control District of



AREAS WITH 0.5 FEET OF FLOODING OR GREATER
WITH AND WITHOUT DETENTION

FIGURE 1.2

Maricopa County for their close involvement and assistance in the preparation of this report.

Those individuals on the NBS/Lowry staff who contributed to this report are as follows: Mr. Richard Perry, P.E. served as principal in charge. Mr. Brian Fry served as project manager. Graphics were prepared by Mr. Mike Hall. Typing and proofreading were done by Mrs. Debra Thomsen. Mr. Dennis Phinney, and Mr. Andrew Spear served as project staff.

CHAPTER 2
DAMAGE CALCULATIONS

EXISTING CONDITION WITHOUT PROJECT

General

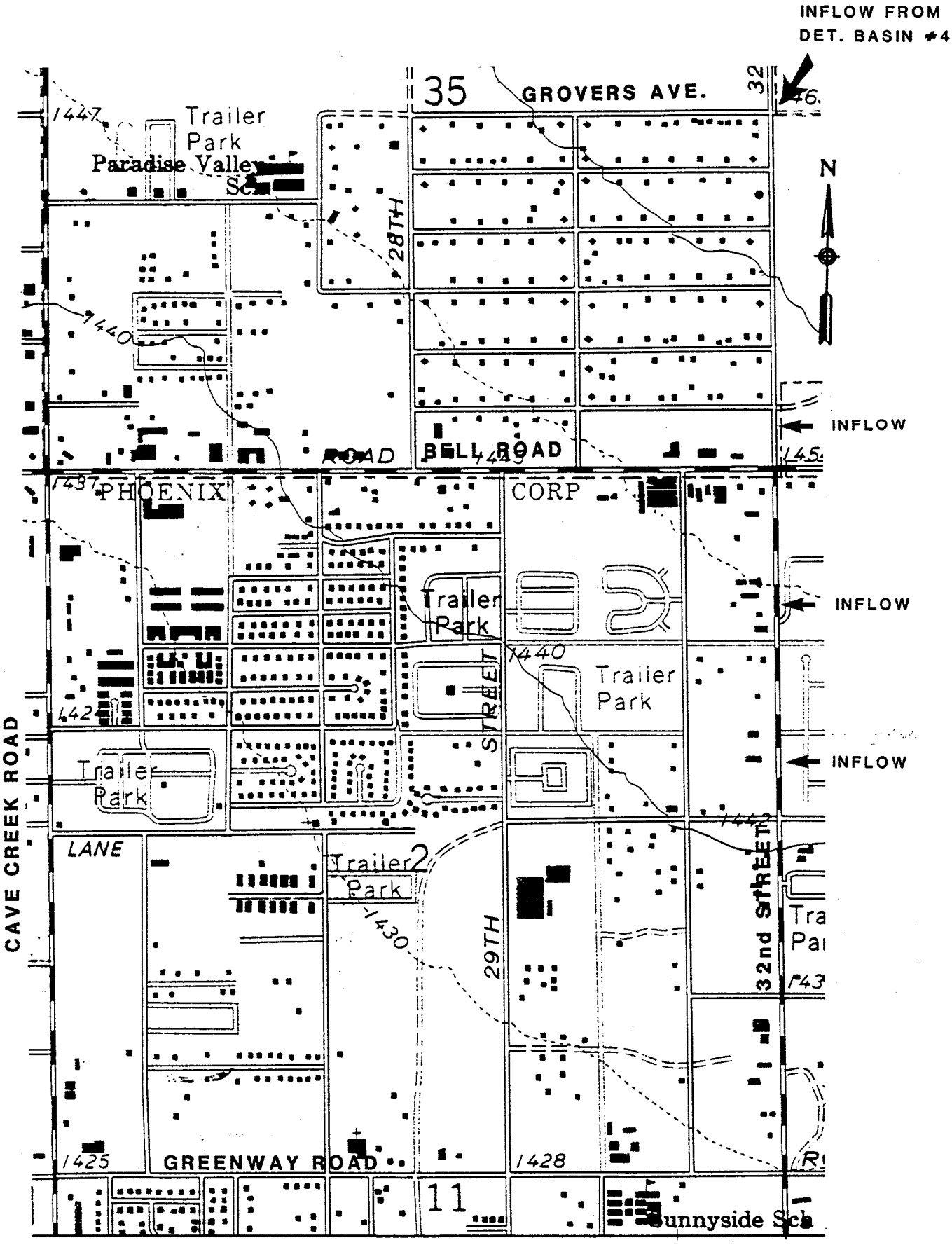
The expected annual flood damages for the existing condition without the detention basin in place have been computed following the eight steps itemized in the Economic Analysis Procedure of the Flood Control District of Maricopa County. These procedures have been taken from the National Economic Development Procedures Manual - Urban Flood Damage with minor changes to reflect District policies.

The specific application of each of these steps to the estimation of flood damages within the flooded area are discussed below.

Step 1 - Delineate Affected Area

Figure 2.1 shows the 1.5 square mile area for which flood damage calculations were done. The area is bounded on the North by Grovers Avenue, on the East by 32nd Street, on the South by Greenway Road, and on the West by Cave Creek Road. Outflow from this area drains to the Greenway Channel. The Greenway Channel has been designed to convey a 100-year flood. Damages for areas downstream from Cave Creek Road along the Greenway Channel would only occur for floods having recurrence intervals exceeding 100 years. Any impact of the proposed detention basin on damages along the Greenway Channel from floods with recurrence intervals in excess of 100 years has been neglected.

Not all of the inflow to the flooded area passes through the detention basin. Other points of inflow are shown on **Figure 2.1.** These other points of inflow plus direct rainfall on the flooded area will cause flooding within the study area which cannot be prevented by Detention Basin Number 4.



AFFECTED AREA AND POINTS OF DRAINAGE INFLOW

FIGURE 2.1

Step 2 - Select Planning Reaches

Flow through the study area is not channelized. The HEC 2 program, which assumes channelized flow, has therefore not been used. Instead, a finite element diffusion model has been used to determine the extent of flooding. This model portrays the nonchannelized nature of flooding expected in this alluvial fan area.

The finite element diffusion model computes the depth of flooding expected within each 10-acre (660 feet x 660 feet) square cell within the modeled area. For this study, each 10-acre square cell has been modeled as a planning reach.

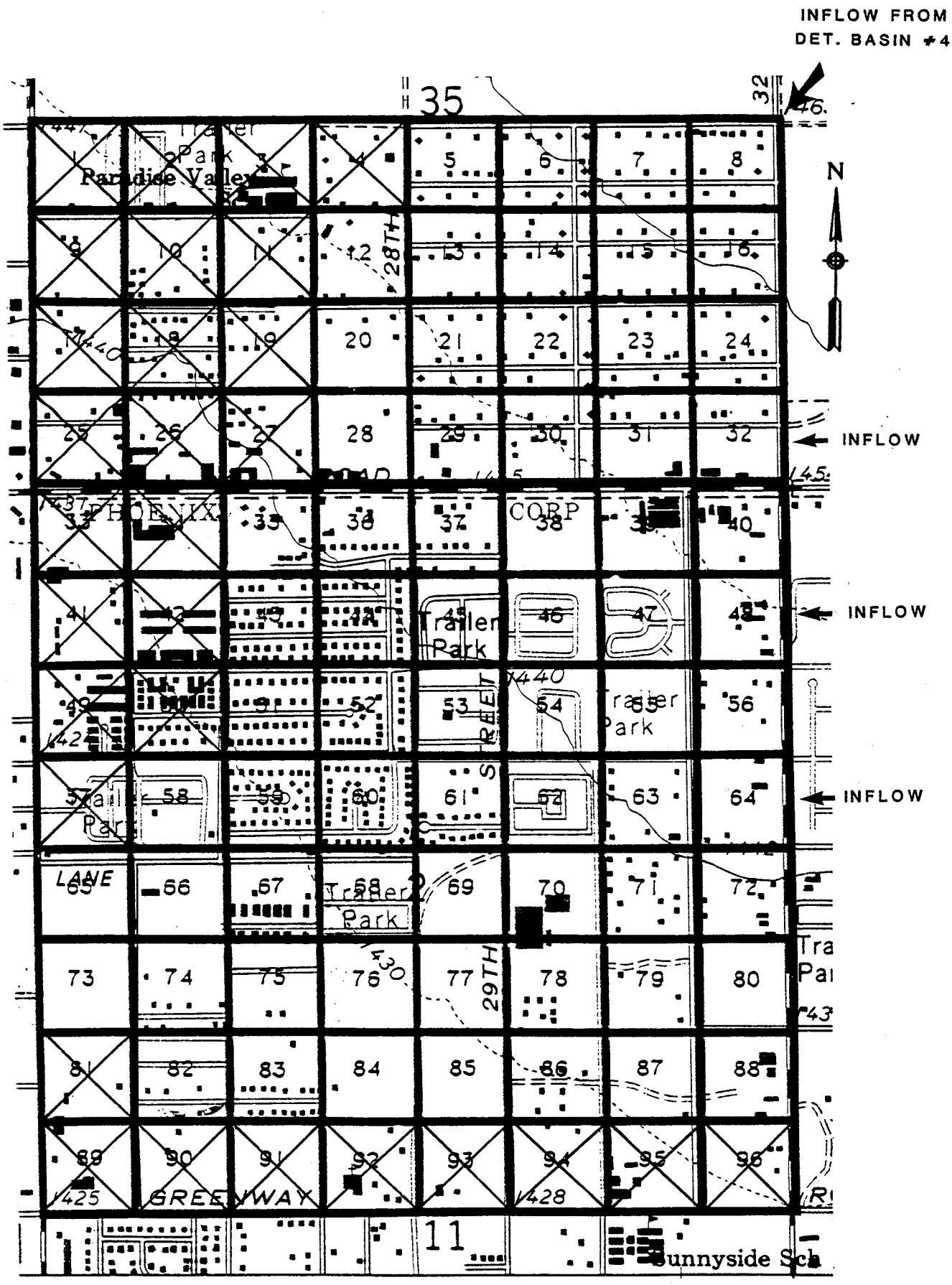
Figure 2.2 shows the diffusion model grid used along with the grid cell numbering. Several grid cells were eliminated from the economic analysis as shown because initial diffusion model runs indicated that flooding from the area did not reach those grid cells.

Step 3 - Establish Elevation Frequency

Using the diffusion model, the maximum flood depths in each reach were computed for the following storm recurrence intervals for land use existing conditions without the proposed detention basin in place:

10-year storm
50-year storm
100-year storm
500-year storm

Results were computed assuming a Manning's n factor of 0.80 for overland flow. The runoff hydrographs for inflows entering the area from outside the diffusion model grid were developed with the TR-20 computer model developed in previous studies for this area. The locations of the hydrograph inflows are as shown on Figure 2.2.



DIFFUSION MODEL GRID WITH CELL NUMBERING AND CELLS ELIMINATED FROM ECONOMIC ANALYSIS

FIGURE 2.2

Step 4 - Outline Flooded Area

Figure 2.3 shows the flooded area expected for a 100-year storm under existing land use conditions without the proposed detention basin in place.

Similar results were computed for each of the four recurrence intervals listed above.

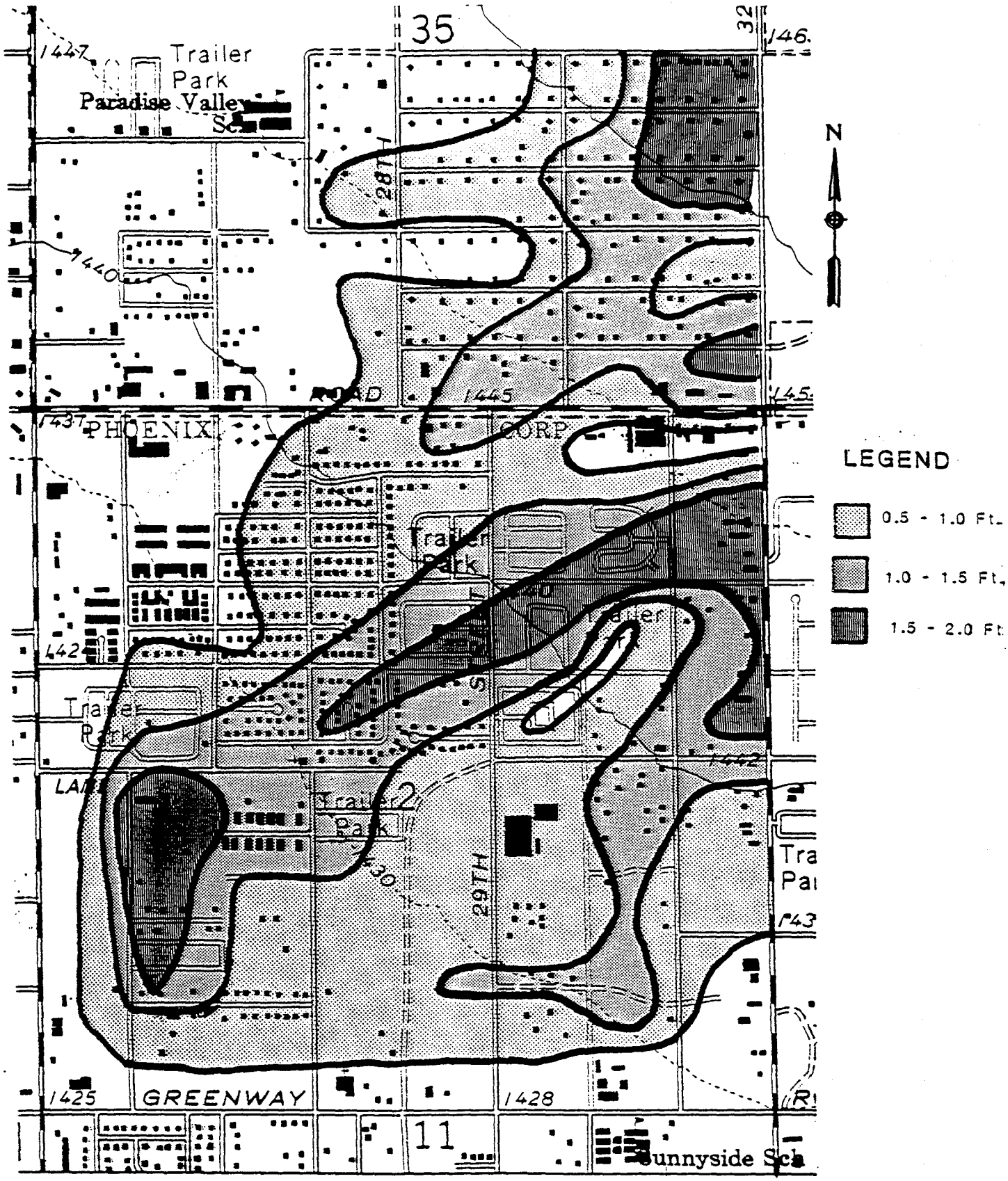
Step 5 - Inventory Existing Flood Plain

An inventory of existing structures within the flooded area was completed using 1-inch = 200 feet scale aerial photographs dated 11 December, 1988 prepared by Rupp Aerial Photography. Supplemental information on existing structures was gathered through a windshield survey completed on 27 January, 1989 by NBS/Lowry.

Structure types were classified as either single family, multi-family, mobile home or commercial buildings. The number or square footage of each structure type was inventoried by 10-acre cell.

Structure values were estimated based on discussions with appraisers at the Flood Control District along with review of published appraisers guides. Values were estimated as follows:

Structure Type	Value
Single Family	$75,000/home
Multi-Family	$50/square foot footprint
Mobile Home	$42,000/home
Commercial	$45/square foot footprint



100 YEAR DEPTHS-EXISTING CONDITIONS

FIGURE 2.3

Based on the windshield survey, mobile homes were assumed to lie 1 foot in elevation above the ground surface. All other structures were assumed to lie 6 inches above the ground surface. This allows for the fact that grid cells are assumed by the diffusion model program to be perfectly flat, with no allowance for onsite grading to prevent ponding.

The value of the contents of buildings were estimated as follows:

Structure Type	Content Value
Single Family	20% of structure value
Multi-Family	20% of structure value
Mobile Home	30% of structure value
Commercial	20% of structure value

Value for outside property and for public utilities has been neglected.

Step 6 - Elevation Damage Relationships

Elevation vs Damage relationships were taken from the FEMA 1988 Flood Insurance Rate Report. **Figure 2.4** shows damages as a percentage of total value used for a single family residential building with one floor and no basement. It has been assumed that damages for other structure types would follow a similar curve. **Figure 2.5** shows expected content damages as a percentage of total value for each of the various structure classifications used.

Step 7 - Damage Frequency Relationships

The Corps of Engineers Structure Inventory for Damage Analysis (SID) computer program was used to compute damage frequency relationships. Input to this program includes the elevation vs frequency data computed

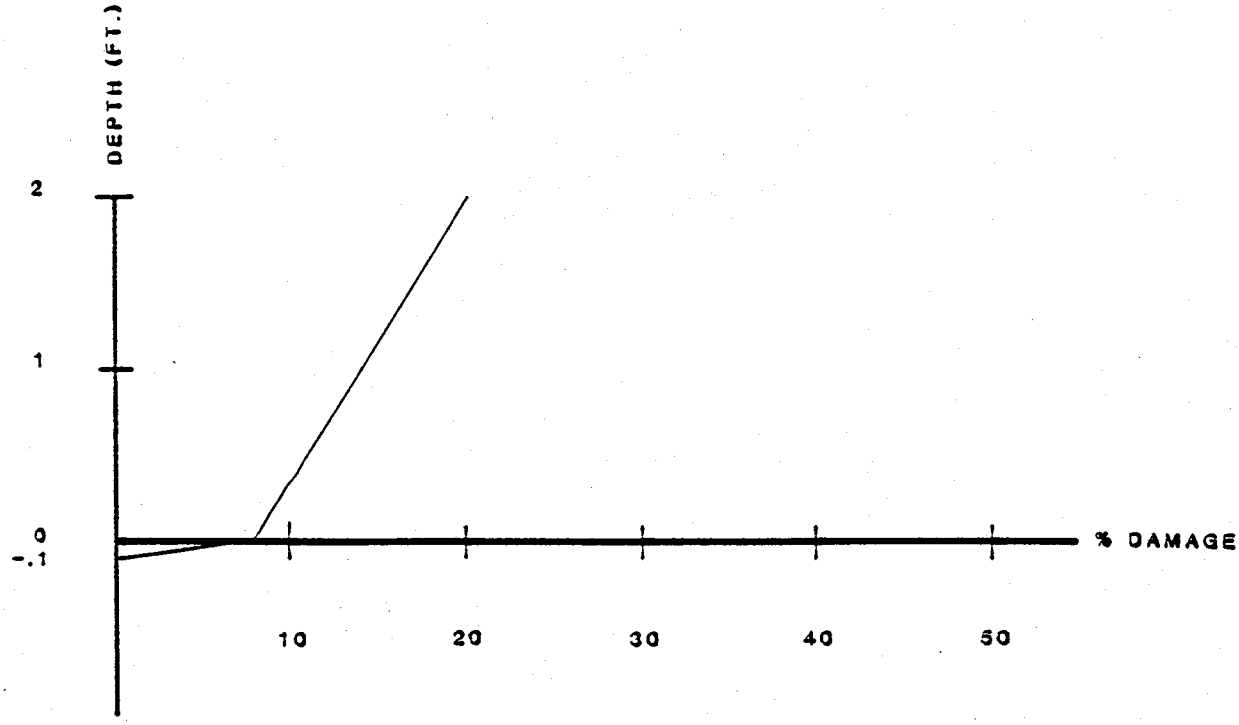


FIGURE 2.4 STRUCTURE DAMAGE AS PERCENT OF STRUCTURE VALUE vs. DEPTH OF FLOODING

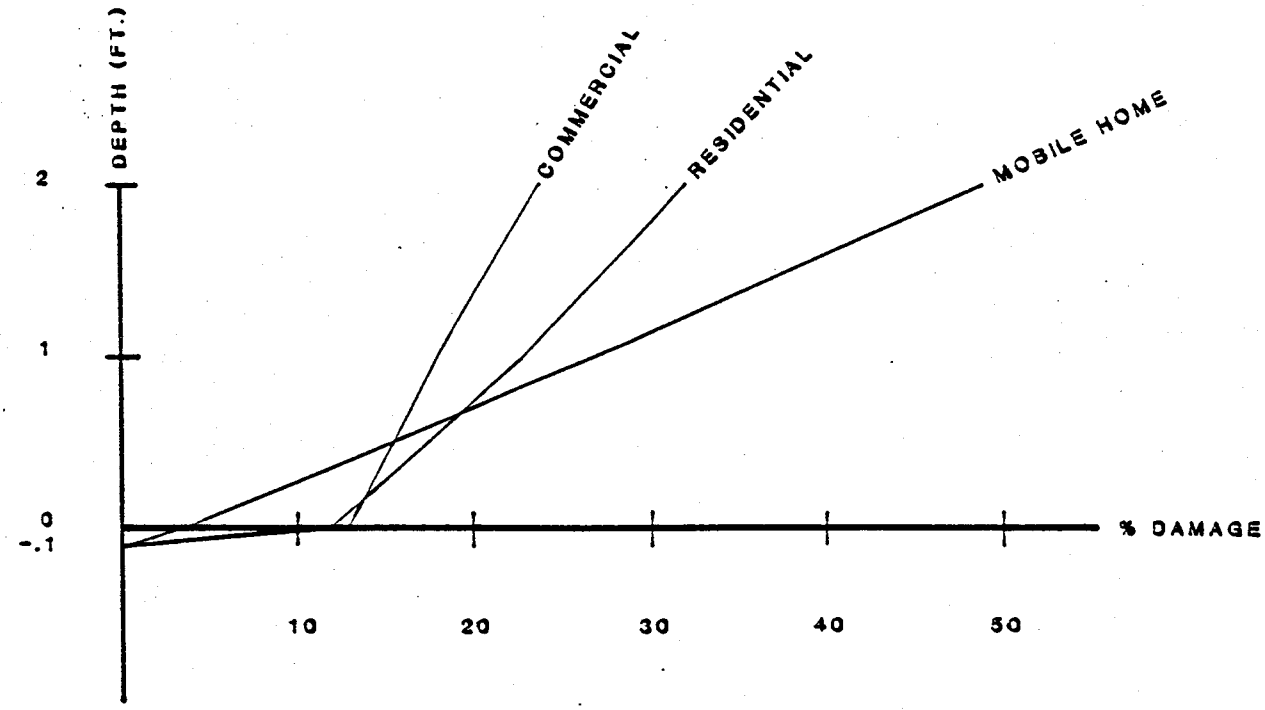


FIGURE 2.5 STRUCTURE CONTENT DAMAGE AS PERCENT OF CONTENT VALUE vs. DEPTH OF FLOODING

using the single element diffusion model, plus the elevation vs damage curves presented on **Figure 2.4 and 2.5.** The SID model then computes the damage vs frequency relationship for each cell. The results for each cell were aggregated to produce a single representative damage vs. frequency relationship for the entire flooded area. The damage vs. frequency relationship for existing conditions without detention are estimated as follows.

Frequency	Damage ($1000)
10-year	5,988.5
50-year	15,004.9
100-year	17,751.5
500-year	22,814.2

Step 8 - Calculate Expected Annual Damages

The Corps of Engineers Expected Annual Flood Damage Computation (EAD) computer program was used to compute expected annual damages. The frequency vs. damage relationship is entered from the SID output, the EAD program then sums or "integrates" the damages for each event after weighting them for the probability of occurrence in any one year. The result is a single value computed for the expected annual damages per year for the entire flooded area.

Expected annual damages for the existing condition without the detention basin in place were computed to be $2,120,850.

FUTURE CONDITION WITHOUT PROJECT

General

After computing expected annual damages for the existing condition, it is necessary to address the impacts of changes expected to occur within the study area over the project life.

Step 1 - Establish Economic and Demographic Base

Figure 2.6 shows that 82 percent of the flooded area is now built out. The mix of commercial and residential structures appears to be well established. For purposes of this study, the general economic and demographic base has been assumed to remain constant throughout the 100 year study period.

Step 2 - Project Land Use Changes

Land use changes have been projected according to the following assumptions:

1. Zoning maps prepared by the City of Phoenix will be followed for the remaining areas to be developed.

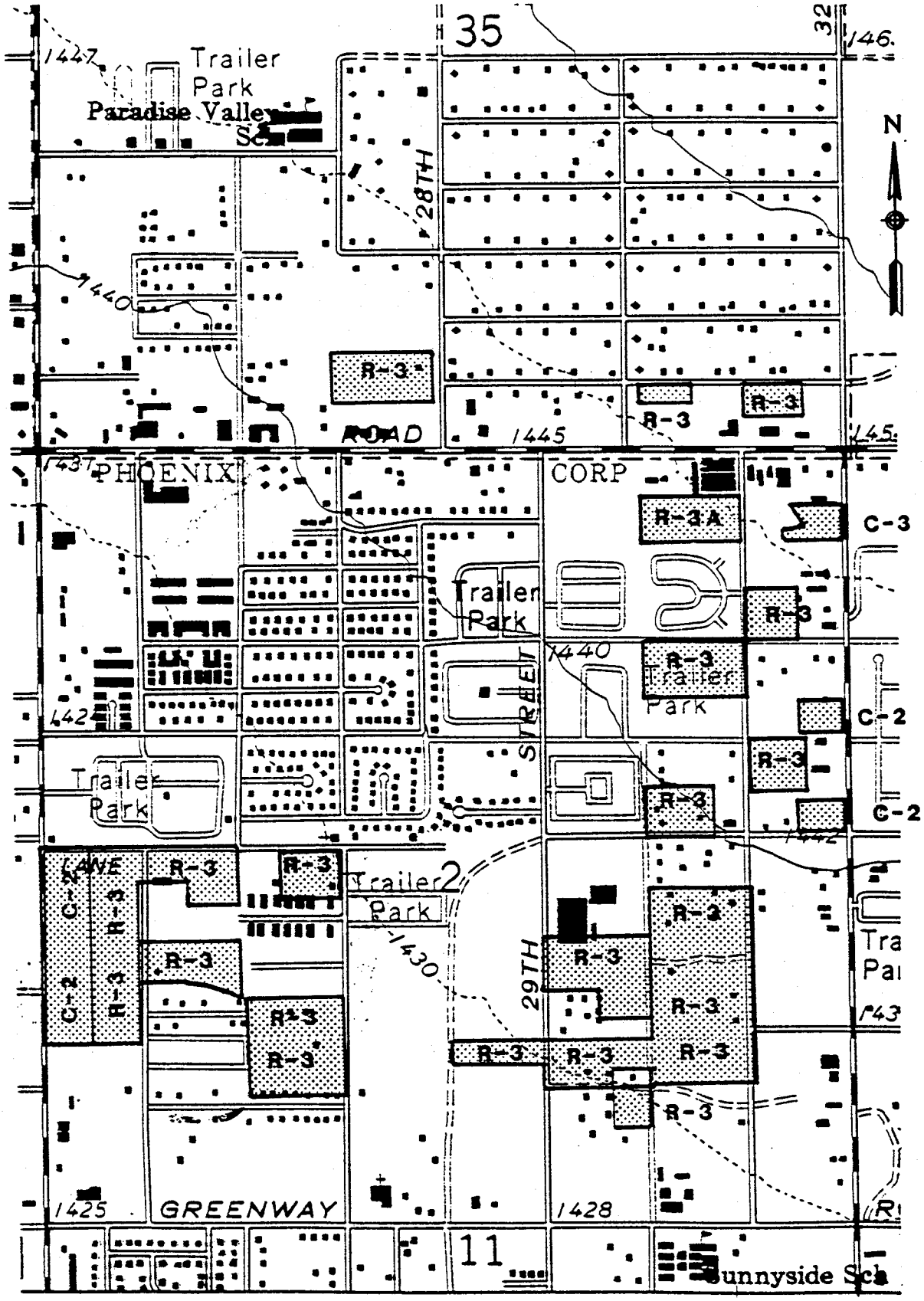
2. 90 percent of the flooded area will be built out by 1994, the year that the detention basin is scheduled to be placed in service.

3. 100 percent build-out will occur by the year 2002, the year that the Squaw Peak Parkway is completed.

4. At the time that the Squaw Peak Parkway is completed, a portion of the area now tributary to the study area will have its runoff diverted to the Indian Bend Wash watershed.

Step 3 - New Floodplain Inventory

To project the future floodplain inventory, vacant areas zoned for commercial and multi-family building were assumed to fill in at a density of 22 percent lot coverage based on gross undeveloped acres. This percentage has been selected after a survey of lot coverages for similar existing structures within the study area. Phoenix zoning



CURRENTLY UNDEVELOPED AREAS AND ZONING CLASSIFICATION

FIGURE 2.6

ordinances allow footprint areas of up to 45 percent of net area for R3 multi-family units and 40 percent of net area for commercial lots. Ratios of this magnitude were not found within the study area at any location. Consequently, the more realistic value was used to avoid overestimating the benefit cost ratio.

Step 4 - New Damage Frequency Relationships

After projecting the future floodplain structure inventory, the SID program described above was updated to estimate damage vs frequency relationships for conditions in the year 1994 and 2002.

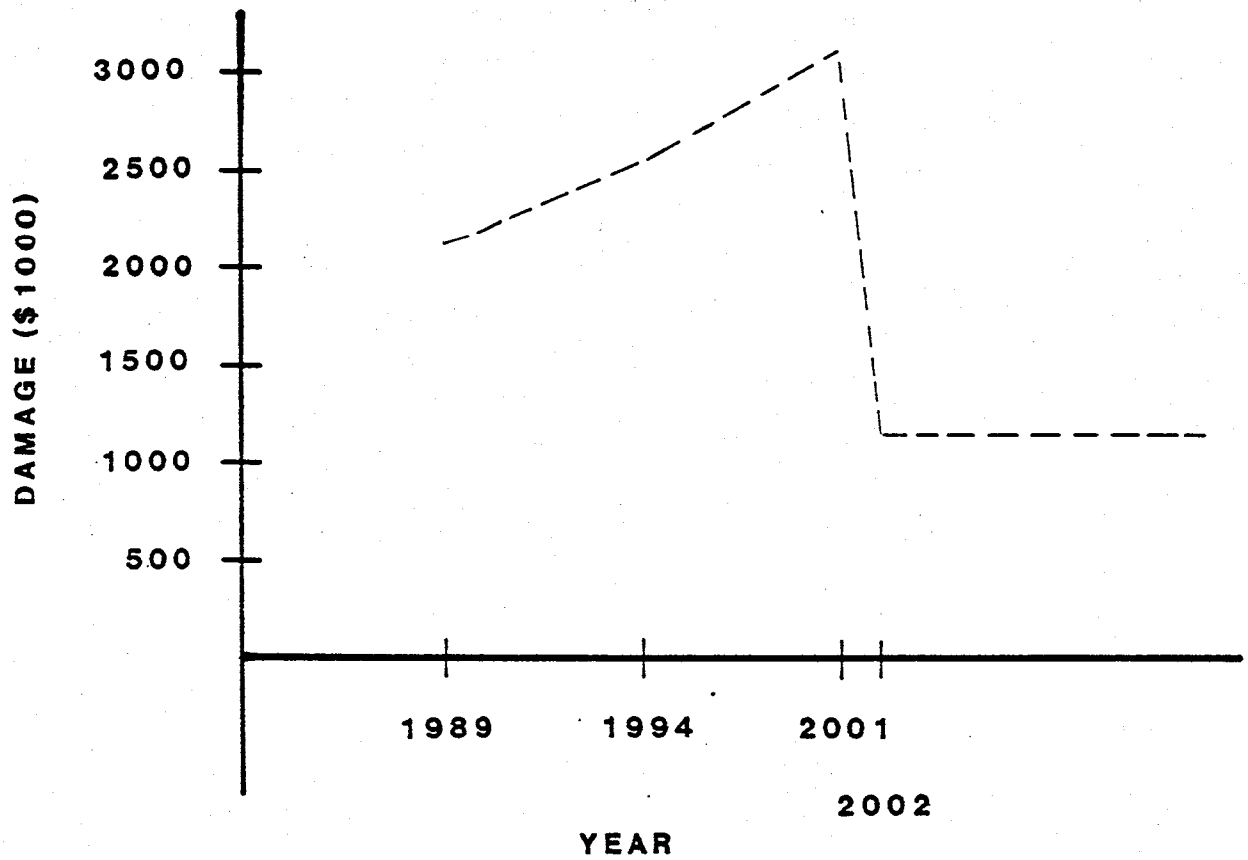
For future conditions, content values were increased to reflect increases in the affluence of the resident population. Future content to structure value ratios were assumed to be as follows:

Structure Type	1994 Content Value	2002 Content Value
Single Family	24% of structure value	30% of structure value
Multi-Family	24% of structure value	30% of structure value
Mobile Home	36% of structure value	45% of structure value
Commercial	24% of structure value	30% of structure value

All costs used in this study were assumed to be in 1989 dollars. Since constant value dollars were used, inflation of housing values was not projected. However, to discount future cash flows, a discount rate below current interest rates was used, to be consistent with the use of constant value dollars.

Step 5 - Calculate Expected Annual Damages

Next, the EAD program was again used to compute expected annual damages for the 1994 and 2002 land use and watershed conditions. Expected annual damages computed for these years are $2,550,090. in 1994 and $1,118,780. in 2002. The Expected Annual Damages by year are plotted on **Figure 2.7** for the condition with no detention. The Expected Annual



EXPECTED ANNUAL DAMAGE -NO DETENTION

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FIGURE 2.7

Damage rises from 1989 to 1994 because of the affluence factor and the infilling of currently undeveloped areas. The Expected Annual Damage continues rising until the year 2002 when the area is assumed to be fully developed. Normally the Expected Annual Damage would remain constant at this value for the remainder of the study period, however in this case, the Squaw Peak Expressway will become operational and will divert runoff away from the study area, thus reducing the Expected Annual Damages from the year 2002 to the end of the study period.

To properly define the Expected Annual Damage relationship it was necessary to compute the conditions at some point just before construction of the Squaw Peak. Otherwise, conditions between 1994 and 2002 would have been assumed to follow a straight line interpolation between those two points when in fact they would continue increasing as shown until construction of the Expressway is completed. To simulate this condition it was assumed that the Squaw Peak would be constructed between the year 2001 and 2002 and would be diverting runoff at the end of 2002.

NON-PHYSICAL COSTS

General

Non-physical costs recognized by the Flood Control District of Maricopa County include the following:

- Income Loss
- Emergency Costs
- Traffic Rerouting
- Floodproofing Costs
- Temporary Relocation and Reoccupation Costs
- Modified Use of Flood Prone Property
- Restoration of Land Market Values

Many of these factors are most significant in areas of channelized flow as opposed to areas of diffuse flow over alluvial fans. Depths of flow observed over alluvial fans are shallower than in channels, and are much less likely to result in total destruction of structures with resulting income losses and relocation costs spanning weeks or months.

A discussion of each of these non-physical costs follows.

Income Loss

Income losses have not been considered as part of this study because the time of inundation should not exceed 48 hours. Allowances for income losses have been made indirectly under the category of traffic rerouting.

Emergency Costs

Emergency costs include costs of forecasting and monitoring flood problems, costs of police and fire department actions to warn or evacuate residents of flooded areas, costs of flood fighting efforts such as sandbagging and building closures, costs of emergency shelters and disaster relief, evacuation costs for residents, and administrative costs of public agencies and private relief agencies.

Emergency cost savings have not been evaluated as a benefit in this study, since only the variable costs of emergency relief would be expected to be reduced by construction of the detention basin, and these variable costs are expected to be less than one percent of the flood damages.

Traffic Rerouting

Table 2.1 summarizes a computation of expected annual costs of traffic rerouting due to flooding.

Traffic flows were based on 1988 City of Phoenix traffic counts for Bell Road and 32nd Street. Traffic rerouting costs were assumed to include the following components:

1. Cost of delay to auto driver and passengers
2. Cost of additional wear on vehicles
3. Cost of expected accidents from rerouting

These costs are expected to total $232,522 for a two day closure during flooding.

The detention basin is estimated to reduce the probability of road closure from flooding in any year from 25 percent to 20 percent prior to 2002. After 2002, probability of road closure will be reduced from 5 percent to less than 1 percent. Since the reduction in the probability of flooding was found to be 5 percent in each case, the expected annual savings in traffic rerouting costs was estimated to be 5 percent of $232,522, or $11,626 per year.

Floodproofing Costs

All lands within the study area are outside of FEMA designated floodplains. Therefore, floodproofing costs would be expected to be minimal and inconsequential with or without the detention basin. These costs have been ignored in this study.

Temporary Relocation and Reoccupation Costs

The Flood Control District of Maricopa County Economic Analysis Procedure states that "Relocation costs apply primarily to high levels of inundation and where there are flood durations of one day or longer." Relocation costs have not been considered in this study.

TABLE
ESTIMATION OF TRAFFIC REROUTING COSTS

AMOUNT OF TIME ROAD IMPASSABLE	2	days
DAILY TRAFFIC - Source: City of Phoenix		
BELL ROAD / CAVE CREEK-32ND STREET	41500	vpd
32ND ST / BELL RD-GROVERS	13600	vpd
MILES IN ORIGINAL ROUTE	1	mile
MILES IN BEST ALTERNATIVE RTE	3	miles
ADDITIONAL MILES PER VEHICLE	2	miles
TOTAL ADDITIONAL VEHICLE MILES		
BELL ROAD / CAVE CREEK-32ND STREET	83000	miles/day
32ND ST / BELL RD-GROVERS	27200	miles/day
TOTAL	110200	miles/day
OPERATING SPEED	20	mph
ADDED TRAVEL TIME	5510	hrs
VALUE OF TIME		
VEHICLE OCCUPANCY	1.3	people/veh
VALUE OF TIME	$12.00	
PASSENGER COST / VEHICLE HR	$15.60	/veh-hr
VEHICLE COST / VEHICLE HR	$5.00	
TOTAL COST / VEHICLE HR	$20.60	
ADDED TRAVEL TIME COST	$113,506	/day
ADDED ACCIDENT COST	25	$/kvm
	$2,755	/day
TOTAL DAILY COST	$116,261	/day
TRAFFIC REROUTING COST PER FLOOD	$232,522	
PROBABILITY OF FLOOD CLOSURE IN ANY YEAR WITHOUT SQUAW PEAK		
WITHOUT DETENTION	25%	
WITH DETENTION	20%	
DIFFERENCE	5%	
PROBABILITY OF FLOOD CLOSURE IN ANY YEAR WITH SQUAW PEAK		
WITHOUT DETENTION	5%	
WITH DETENTION	<1%	
DIFFERENCE	5%	
EXPECTED ANNUAL TRAFFIC REROUTING COST SAVINGS		
REDUCTION IN PROBABILITY OF FLOOD	5%	
TRAFFIC REROUTING COST PER FLOOD	$232,522	
EXPECTED SAVINGS	$11,626	/yr

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EXPECTED ANNUAL COST OF TRAFFIC REROUTING

TABLE 2.1

Modified Use of Flood Prone Property

The Flood Control District of Maricopa County Economic Analysis Procedure states that "For benefits to be considered for this category, there should be evidence of a substantial number of rooms or properties otherwise not in full use." Since occupancy factors in the study area were not observed to differ from those in areas not subject to flooding, no benefit has been added for this category.

Restoration of Land Market Values

All lands within the study area are outside of FEMA designated floodplains. It is our opinion that one cannot restore a market value that has never been removed. Therefore benefits associated with restoring land market values have not been considered.

CHAPTER 3
CALCULATION OF BENEFITS

REDUCTION IN FLOOD DAMAGES

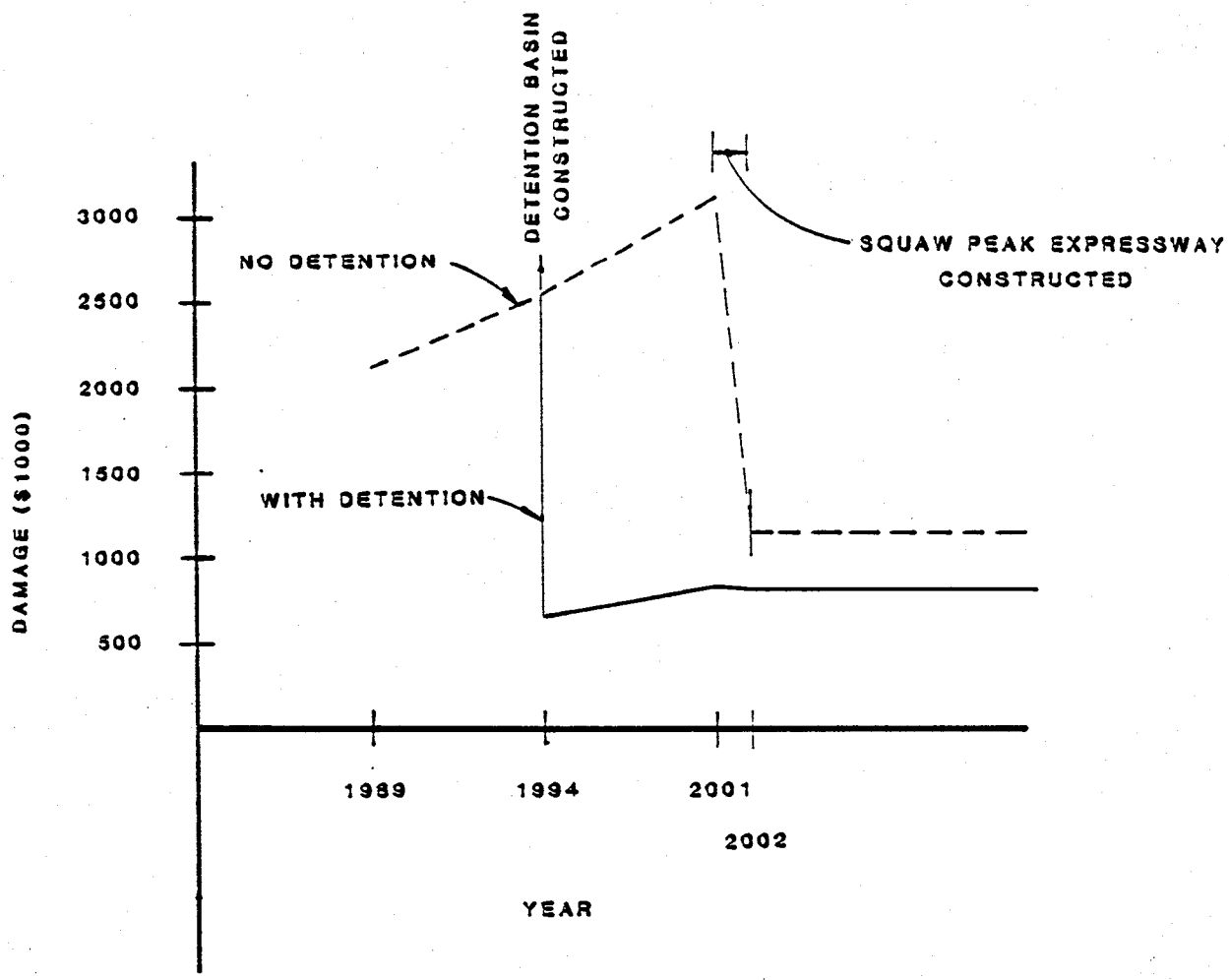
Future Condition With Project

Figure 3.1 shows the reduction in flood damages, by year, which can be expected to result from construction of Detention Basin Number 4. Prior to 1994, no difference occurs because the basin is not scheduled to be in operation before that year. However, expected annual damages increase from 1989 to 1994 because of infill and increased affluence within the community. After construction of the basin, the expected annual damages are greatly reduced due to construction of the project. In 2002, completion of the Squaw Peak Parkway will reduce expected annual damages either with or without the detention basin. This occurs because a portion of the upstream watershed runoff will then be rerouted to the Indian Bend Wash watershed.

Figures 3.2 and 3.3 show the 100-year flooded area both without and with the project following completion of the Squaw Peak Parkway.

Calculation of Equivalent Annual Flood Damages

Calculation of the benefit associated with the construction of the detention basin is done using the Corps of Engineers Expected Annual Flood Damage Computation (EAD) program. To expedite computation of benefit cost ratios, the EAD program will compute a single value for "equivalent annual damages" over the study period. This is done by adding the present worths of the expected annual damages for each year and computing a uniform annual series of payments that would be equivalent to the sum of the present worths.



EXPECTED ANNUAL DAMAGES WITH AND WITHOUT DETENTION

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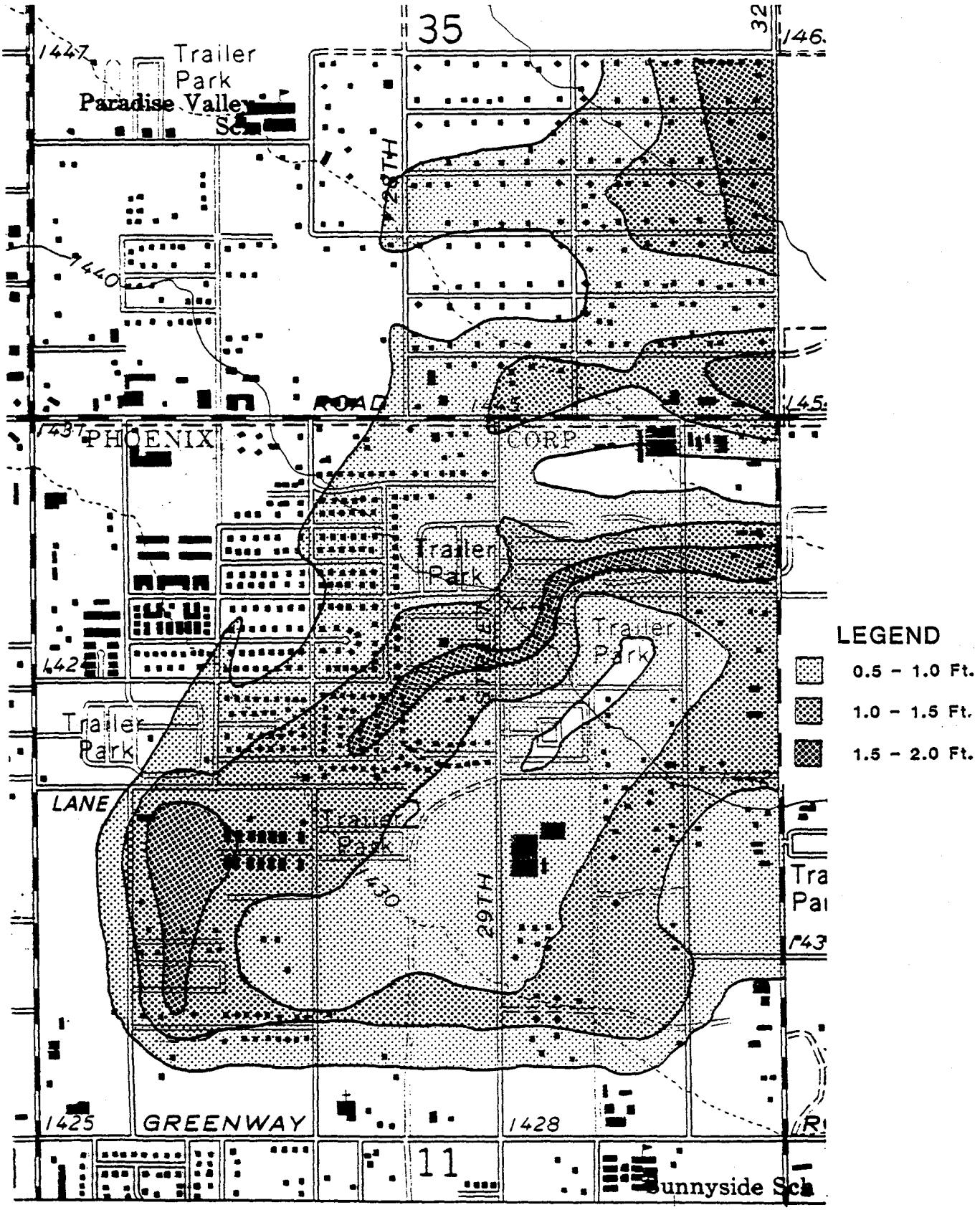
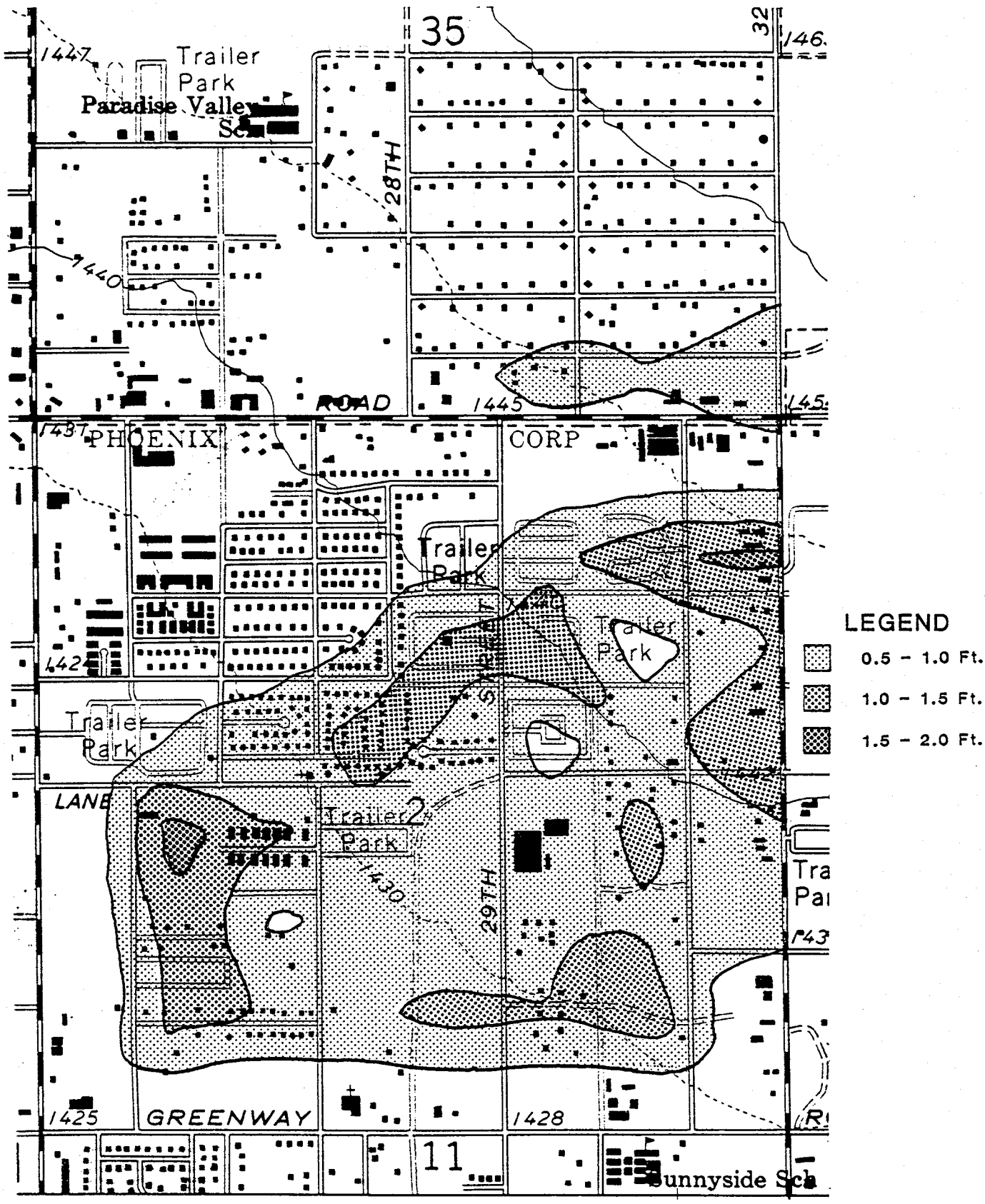
FIGURE 3.1



100 YEAR DEPTHS WITHOUT DETENTION

FIGURE 3.2



100 YEAR DEPTHS WITH DETENTION

FIGURE 3.3

REDUCTION IN NON-PHYSICAL COSTS

A benefit has been computed for reductions in costs for traffic rerouting during flooding. Construction of the detention basin is expected to decrease expected annual traffic rerouting costs resulting in a net benefit of $11,626. per year in addition to the flood damage costs.

NET BENEFIT

This study estimates the net benefit of Detention Basin Number 4 to be $694,856. per year, computed as follows:

Equivalent Annual Reduction in Flood Damages	$683,230.
Annual Reduction in Nonphysical Costs	
Traffic Rerouting	$ 11,626.
Total Net Annual Benefit	$694,856.

CHAPTER 4
CALCULATION OF COSTS

CONSTRUCTION AND RIGHT-OF-WAY COSTS

Table 4.1 summarizes construction and right-of-way costs expected for Detention Basin Number 4 in Paradise Valley Park. These costs total $6,863,600.

Costs are in 1989 dollars to be consistent with constant value dollar assumptions used to estimate flood damages. Actual construction costs will escalate over time.

OPERATION AND MAINTENANCE COSTS

Operation and maintenance costs of $16,000 per year are expected for the detention basin. Maintenance costs were prepared based on the following assumptions.

1. Grounds and landscaping maintenance were not included as a cost. These costs would be incurred by the Library District or Parks District irrespective of whether the land is used for stormwater detention.

2. Costs associated with cleanup of silt and debris after flooding of the detention basins were included. It was assumed that clean-up would occur twice per year on the average, requiring approximately 40 crew hours for each cleanup. Crew costs were assumed to be $200 per hour.

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BENEFIT COST ANALYSIS
PARADISE VALLEY PARK DETENTION BASIN
CONSTRUCTION COST ESTIMATE

NO.	ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
1	R/O/W ACQUISITION	29	Ac.	$130,680	$3,789,700
2	ENGINEERING				
	EARTHWORK	86000	C.Y.	$4	$344,000
	OUTLET STRUCTURE	1	L.S.	$6,000	$6,000
	INLET STRUCTURES	1	L.S.	$10,250	$10,300
	OUTLET PIPE - 42" RCP	1080	L.F.	$68	$73,400
	SIDEWALK - 6' WIDE	3000	L.F.	$9	$27,000
3	LANDSCAPING				
	VEGETATION	29	Ac.	$2,500	$72,500
	IRRIGATION	1	L.S.	$60,000	$60,000
	RECREATION	NOT INCLUDED			$0
4	SUBTOTAL				$4,382,900
5	CONTINGENCIES				
	MISC CONTINGENCY	10%			$438,300
	ENGINEERING & ADMIN	15%			$657,400
	FIELD ENGINEERING	10%			$438,300
	SUBTOTAL				$5,916,900
	FINANCING	16%			$946,700
6	TOTAL BASIN #4				$6,863,600
7	AMORTIZED OVER 100 YRS @ 3%				$216,900

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TABLE 4.1

DISCOUNTING PROCEDURES

This study is based on the simplifying assumption that "dollars" are "constant value dollars" identical in purchasing value to the value of one dollar in 1989. This approach is consistent with procedures of the Maricopa County Flood Control District and the U.S. Army Corps of Engineers for economic evaluations.

Since all costs, including construction costs are listed in 1989 dollars, cost estimates used in this benefit cost study will need to be indexed to future cost indices to allow accurate budget programming.

Because of the use of "constant value dollars", a discount rate of three percent has been used in computing equivalent annual flood damages. This discount rate is lower than borrowing rates that would be incurred by the District. The lower rate was used because with "constant value dollars" no allowance was made for inflation in computing future damages. The discount rate of three percent would therefore represent the difference between expected interest rates and expected inflation.

CHAPTER 5
BENEFIT COST RATIO

TOTAL PROJECT BENEFITS

Table 5.1 summarizes the expected annual benefits of the project, using a discount rate of three percent over 100 years. Expected annual benefits are $694,856. per year, expressed in 1989 dollars.

Equivalent annual damages without Detention Basin Number 4 are expected to be $1,502,730.

Equivalent annual damages with Detention Basin Number 4 are expected to be $819,510.

Table 5.1 - Expected Annual Benefits

Equivalent Annual Reduction in Flood Damages	$683,230
Annual Reduction in Nonphysical Costs	
Traffic Rerouting	$ 11,626.
Total Expected Annual Benefit	$694,856.

TOTAL PROJECT COSTS

Table 5.2 summarizes the expected costs of the project. For purposes of this study, costs have been amortized over 100 years at a discount rate of three percent.

The estimated cost of Upper East Fork Cave Creek Detention Basin Number 4 is $6,863,600, expressed in 1989 dollars. This represents an annualized cost in 1989 dollars of $216,900 over 100 years at a three percent discount rate.

Table 5.2 - Expected Annualized Costs

	Capital Cost	Annual Cost @ 3% - 100 yr
Project Construction Cost	$6,863,600	$216,900
Maintenance Cost		$ 16,000
Total Expected Annualized Cost		$232,900

BENEFIT COST RATIO

The benefit cost ratio is computed as follows:

$$\frac{B}{C} = \frac{\text{Total Expected Annual Benefit}}{\text{Total Expected Annualized Cost}}$$

The benefit cost ratio is computed to be $694,856/$232,900 or 3.0.

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