FLOOD CONTROL DISTRICT
OF
MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

FLOODPLAIN MITIGATION STUDY

FCD #93-29

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November, 1997

Final Report

MARYVALE AREA DRAINAGE MASTER STUDY
FLOODPLAIN MITIGATION STUDY

FCD #93-29

Prepared for:

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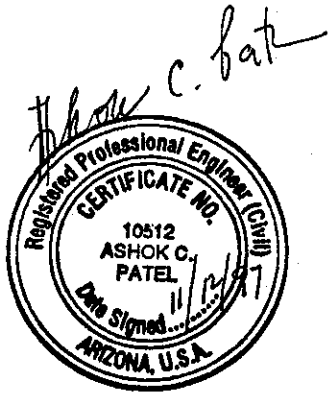

November 12, 1997
WP #94154.00

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February 10, 1998

Mr. Russ Miracle, P.E.
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009

Re: **Maryvale ADMS**
FCD #93-29
WP #94154

Dear Mr. Miracle:

We are pleased to submit four (4) sets of final report on *Floodplain Mitigation Study* in conjunction with the referenced project.

As you are aware, Wood/Patel completed a detailed hydrologic analysis for the study area in February 1997. This submittal represents a major milestone in the District's effort to define flood problem areas within the study area and then determining flood mitigation options on a conceptual level.

Per your direction, a separate submittal is being made (two 2 sets each) to the Cities of Phoenix, Glendale and Peoria.

On behalf of Wood/Patel project team, we would like to thank the representatives of the District, Cities of Phoenix, Glendale and Peoria for their continued support and guidance.

We have enjoyed this complex and challenging project and truly believe our knowledge can benefit the District for the next phases of work including pre-design, and final design efforts.

Please feel free to call if I can be of any help.

Very truly yours,

WOOD, PATEL & ASSOCIATES, INC.

Ashok C. Patel, P.E., R.L.S.
Project Manager

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Enclosure

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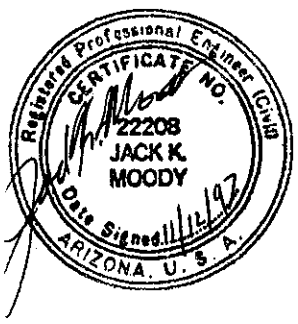

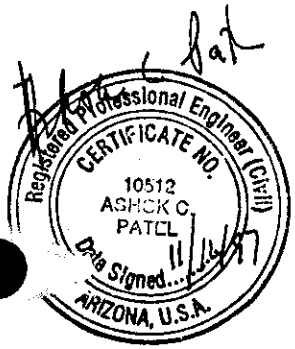

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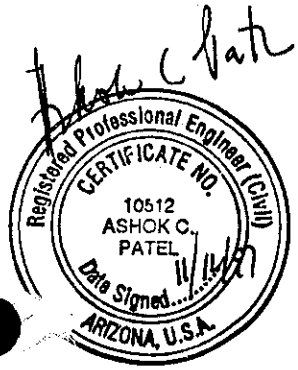

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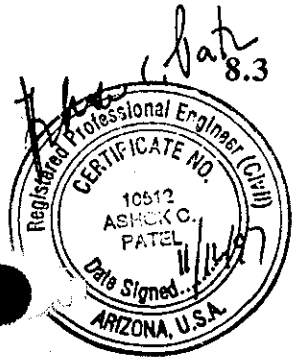

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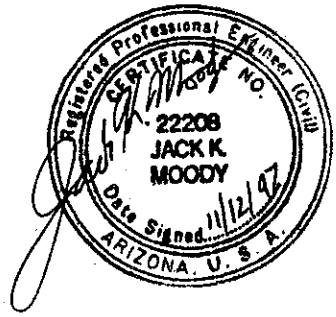

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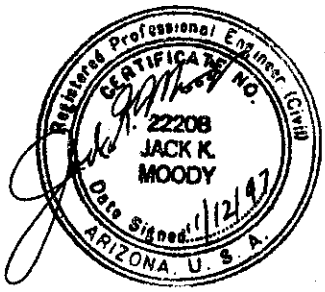

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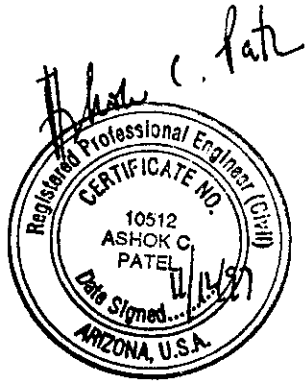

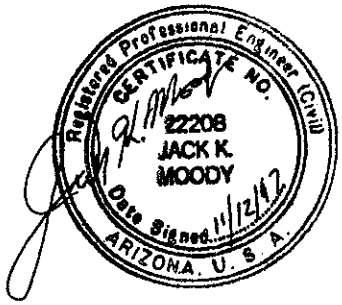

ACKNOWLEDGMENTS

Wood, Patel & Associates, Inc. is pleased to have represented the Flood Control District of Maricopa County in preparation of this Floodplain Mitigation Study as a part of the Maryvale Area Drainage Master Study. This professional assignment presented many interesting and unique challenges requiring creative teamwork solutions.

Mr. Russ Miracle, P.E. of the Flood Control District of Maricopa County; Mr. Ray Acuna, P.E. of the City of Phoenix, Mr. Grant Anderson, P.E. and Mr. Daniel Sherwood, P.E. of the City of Glendale; Mr. Dave Moody, P.E. and Mr. Dan Nissen, P.E. of the City of Peoria provided critical technical support and decision-making guidance throughout the study phase.

Their individual and group contributions represent a key role in the successful and timely completion of this report.

We sincerely enjoyed these relationships and look forward to similar support through the design implementation phases.

WOOD, PATEL & ASSOCIATES, INC.

Ashok C. Patel, P.E., R.L.S.
Principal

1.0 EXECUTIVE SUMMARY

1.1 Background

Wood, Patel & Associates, Inc. has been contracted by the Flood Control District of Maricopa County (District) to prepare the Maryvale Area Drainage Master Study (ADMS). CH2M HILL assisted Wood, Patel and Associates, Inc. by preparing the "existing conditions" hydrologic analysis for the approximately 100-square-mile Maryvale ADMS study area. The hydrologic analysis was documented in the report *Maryvale Areas Drainage Master Study - Hydrology*, dated February 1997 and is discussed further in Section 4. Subsequent to that report, the Floodplain Mitigation Study was performed which is documented in this report.

1.2 Study Areas

The overall study area for the Maryvale ADMS is approximately 100 square miles in size and encompasses portions of the City of Peoria, the City of Glendale, the City of Avondale, the City of Tolleson, the City of Phoenix, and un-incorporated areas of Maricopa County. As indicated in Figure 1, the study area is bounded on the north by the Arizona Canal Diversion Channel (ACDC) and Skunk Creek, on the east by the Black Canyon Highway, Interstate 17 (I-17), on the south by the Papago Freeway, Interstate 10 (I-10), and on the west by the Agua Fria River, New River, and the Agua Fria Freeway.

The overall study area can be characterized as follows.

- **Slope.** The slope of the land is generally from the northeast to the southwest at approximately 0.4 percent.

- **Land Uses.** The primary land use within the Maryvale study area is urbanized single family residential. However, essentially all of the study area had been agricultural land at some point in the past and several sections of land are still agricultural. Commercial and industrial land use also exists throughout the study area.

- **Drainage Systems.** The Maryvale study area is drained mainly from north to south and from east to west via the surface flow street system, an underground storm drain system, and the ADOT channels. All runoff is ultimately discharged into New River or Agua Fria River. The street system ideally provides surface drainage within the curb limits. However, streets alone cannot provide the conveyance capacity needed for annual storm events, much less for major storm events. The storm drain system, mainly designed to convey the 2-year storm event and in some places the 10-year event, is typically located in the north/south and east/west arterial streets (one mile streets) and major collector streets (one-half mile streets). The major streets system and storm drain system is depicted on Figure 2.

  Several other drainage structures including detention/retention/surge basins have been constructed or are planned throughout the Maryvale study area to help mitigate flooding as shown on Figure 2. ADOT has constructed a drainage channel along the north side of the Interstate 10 (I-10) and along the east side of completed portions of the Agua Fria Freeway. The channels collect surface and storm drain runoff. The existing drainage system is discussed in more detail in Section 3.0 of this report. The Grand Canal and the Roosevelt Irrigation District (RID) Canal are intended solely to deliver irrigation water. However, these canals become partial storm conveyance corridors during a significant runoff event and may contribute to flooding/ponding in certain areas.

1.3 Report Objectives

This phase of the study was initiated to identify, then evaluate feasible 10-year and 100-year mitigation options for each of the flood prone areas. After identifying and evaluating the mitigation options, the most viable options are recommended for further evaluation.

The hydrology used for this phase was developed in the *Maryvale Area Drainage Master Study - Hydrology*.

The objective of this phase is to document the results of the evaluation for the Maryvale ADMS, outline the decision-making process used, and present the pre-design solutions for the identified flooding areas. Included in the report are preliminary cost estimates for each option.

1.4 Flood Prone Areas

Detailed hydrology for the study area has been prepared and documented in the report *Maryvale Area Drainage Master Study - Hydrology*. That report identified five corridors that have potential stormwater ponding concerns. These corridors are depicted on Figure 4 and are listed below:

Grand Avenue
Grand Canal
Interstate 10 (I-10)
Agua Fria Freeway (AFF)
Roosevelt Irrigation District (RID) Canal.

Areas along these corridors are subject to periodic flooding, typically due to ponding upstream of elevated obstructions. The ponding areas, as a result of this study, are depicted in Figure 4. The ponding ranges from one to four feet in depth. Figure 7, however, depicts both the ponding areas per the Maryvale ADMS and the FEMA-defined approximate floodplains. Since the FEMA work was based on the ponding as well as riverine type flooding, the FEMA floodplain is generally contiguous along the study corridors.

It should be noted that obtaining a Letter of Map Revision (LOMR) from the Federal Emergency Management Agency (FEMA) was not the purpose or objective of this study. Therefore, this study has not been performed or documented to a standard sufficient to obtain a LOMR. However, this study will serve as a basis for identifying areas that could potentially be removed from the floodplain.

Grand Avenue and Grand Canal were selected for further study. The selection was made by the District because the study areas are highly urbanized and there have been numerous complaints from area residents for the flooding problem. The existence of poor drainage also has caused traffic problems in the area.

The drainage corridors associated with I-10 and the proposed Agua Fria Freeway are managed by ADOT. ADOT has built a drainage channel along I-10 and enhancements to drainage improvements are being considered for the outfall portion of the channel. The Agua Fria Freeway corridor is being designed to manage the 100-year storm event. The design is expected to be completed within the next two years. For these reasons, these two corridors were not evaluated as part of this study.

The RID Canal corridor is currently agricultural land without any significant development. The ponding areas created by the raised canal banks are anticipated to be reduced or eliminated as a result of the planned drainage diversion by the AFF channel. For these reasons, the RID Canal corridor was not considered for further study.

Flood mitigation options were studied at the following locations:

Grand Avenue at:

- 83rd Avenue
- 79th Avenue
- 75th Avenue
- 73rd Avenue
- 67th Avenue
- 51st Avenue
- 43rd Avenue
- Interstate 17

Grand Canal at:

- 67th Avenue to the proposed Agua Fria Freeway
- 31st Avenue

1.5 Study Approach

The drainage area, including the study corridors, cover a vast geographical area. Therefore, numerous options, sub-options, and combinations of options were possible to mitigate various frequency of storms.

To facilitate the selection of the most feasible options in a timely manner and under budgetary constraints, a three level analysis approach was performed as follows:

Level I: Based on the results of hydrology and ponding delineations, a reconnaissance level study was performed to identify flood problem areas and potential flood mitigation options. These options consist of detention basins, channels, and storm drains. The analysis was based on past flood control project experience, "order of magnitude" cost, available funding, current development activities, general land use plans, regulatory floodplain impacts, traffic issues, and park issues. Mitigation options were presented to the District and pertinent cities (Phoenix, Glendale, and Peoria) for review and comment. The results of this analysis are documented in a separate report, *Conceptual Flood Mitigation Options (Level I)*. The Report eliminated options that were not feasible for further detailed study.

Level II: The short-list of feasible mitigation options from Level I were then further studied at an appraisal level of analysis based on a detailed hydraulic design, potential conflicts with existing major utilities, cost analysis for major drainage elements (earthwork, drains, channels, culverts, pumps, etc) and right-of-way costs furnished by the District. The results of Level II are contained herein and were used as a basis for recommending the most cost-effective mitigation option for each problem location.

Level III: The recommended mitigation options from Level II were then further defined and costs updated for contingencies, engineering, and project administration. "Buy-out" estimates for acquiring parcels within ponding area were also estimated. The results of Level III are contained herein and will serve as the basis for selecting specific problem locations for a pre-design study.

Having performed a tri-level analysis consisting of field surveys, hydrologic analysis, and hydraulic design, the following locations are recommended for pre-design study:

- Grand Avenue at 79th Avenue (10-Year Design Frequency)
- Grand Avenue at 75th Avenue (10-Year Design Frequency)
- Grand Avenue at 73rd Avenue (10-Year Design Frequency)
- Grand Avenue at 67th Avenue (100-Year Design Frequency)
- Grand Avenue at 51st Avenue (10-Year Design Frequency)
- Grand Avenue at 51st Avenue (outfall) (10-Year Design Frequency)
- Grand Avenue at 43rd Avenue (10-Year Design Frequency)
- Grand Avenue at Interstate 17 (5-Year Design Frequency)
- Grand Canal from 67th Avenue to the Agua Fria Freeway (100-Year Design Frequency)
- Grand Canal at 31st Avenue (5-Year Design Frequency)

Any of the locations may be chosen for further evaluation and pre-design study. As a part of that pre-design study, additional analysis will be necessary. This analysis should include a detailed evaluation of the hydrologic and hydraulic design based on current field conditions. In addition, existing utilities should be evaluated to verify location and size. More detailed site specific topographic data, including a field survey of key features, is recommended. Existing drainage facilities, including catch basins, storm drains, channels, etc. should be analyzed to verify inlet capacity, main line conveyance, and backwater effects. Many of the flood control project alternatives include the use of existing storm drains as an outfall. It is recommended that the impacts of adding outfall flow to the existing storm drain systems be evaluated. Adverse impacts to the existing storm drain systems may be mitigated by delaying the release of flows from a proposed basin. The cost analysis should be updated for all modifications to the design concept, including the current unit prices and land costs.

2.0 INTRODUCTION

2.1 Scope of Work

The Maryvale drainage area is located within the cities of Phoenix, Glendale, Peoria, Avondale, and unincorporated areas of Maricopa County and includes approximately 100 square miles. The study area is illustrated in Figure 1 and is bounded on the west by the Agua Fria and New Rivers, from I-10 northerly to Glendale Avenue, and the Agua Fria Freeway from Glendale Avenue to the Arizona Canal Diversion Channel (ACDC); on the north by the ACDC from the Agua Fria Freeway to I-17; on the east by I-17; and on the south by I-10.

There is a history of flooding problems along the Grand Canal, RID Canal, and Grand Avenue/Atchison, Topeka, and Santa Fe Railroad (AT&SFRR). It is the purpose of this study to complete the hydrologic modeling of the study area which will then be used in the evaluation of possible solutions to known flooding problems within the Maryvale ADMS study area and to identify possible flood mitigation options which could alleviate flooding along the corridors of the Grand Avenue/AT&SFRR, the Grand Canal, and the RID Canal. The study included flooding as a result of water ponding above the corridors of the roadway and railroad along Grand Avenue and the two canals. Ponding limits, volumes of water storage, and flood hydrographs overtopping/flowing along the embankments were computed and the limits of ponded water delineated using HEC-1 and topographic mapping.

Field surveys were conducted of hydraulic structures, roads, canal banks, and embankments at known problem areas along the Grand Avenue/AT&SFRR, RID Canal, and the Grand Canal. The results of field surveys are documented in the *Maryvale ADMS Structures and Field Survey Report,* Wood, Patel & Associates, Inc., September 1997. Hydrology was completed for the Maryvale ADMS for the 100-year and 10-year storm frequencies and for the 6-hour and 24-hour storm durations using the 1991 U.S. Army Corps of Engineers' computer program HEC-1, 1991 version and the Drainage Design Manual for Maricopa County, Arizona, Volume I - Hydrology. The results are documented in the

Maryvale ADMS-Hydrology Report, Wood, Patel & Associates, Inc., February 1997 and the *Maryvale ADMS Technical Data Notebook*, Wood, Patel & Associates, Inc., March, 1997. Existing data, mapping, and previous studies were collected and reviewed for appropriate use with this study.

Based on the results of the reservoir routing analysis during the hydrology phase, ponding water limits were delineated at locations along the Grand Avenue/AT&SFRR, RID Canal, and Grand Canal. FEMA delineations were plotted and compared with the ponding limits. Even though these two delineations differ significantly, a detailed hydraulic analysis and floodplain mapping for the District and FEMA approval was not authorized as part of this ADMS.

Finally, the following tri-level analysis was conducted to identify flood problem locations, document the flooding problem, and to formulate flood mitigation options for future planning and design phases:

Level I: Based on the results of hydrology and ponding delineations, a reconnaissance level study was performed to identify flood problem areas and potential flood mitigation options. These options consist of detention basins, channels, and storm drains. The analysis was based on past flood control project experience, "order of magnitude" cost, available funding, current development activities, general land use plans, regulatory floodplain impacts, traffic issues, and park issues. Mitigation options were presented to the District and pertinent cities (Phoenix, Glendale, and Peoria) for review and comment. The results of this analysis are documented in a separate report, *Conceptual Flood Mitigation Options (Level I)*. The Report eliminated options that were not feasible for further more detailed study.

Level II: The short-list of feasible mitigation options from Level I were then further studied at an appraisal level of analysis. The analysis was based on a detailed hydraulic design, potential conflicts with existing major utilities, cost analysis for major drainage elements (earthwork, drains, channels, culverts, pumps, etc) and right-of-way costs furnished by the District. The results of Level II are contained herein and were used as a basis for recommending the most cost-effective mitigation option for each problem location.

Level III: The recommended mitigation options from Level II were then further defined and costs updated for contingencies, engineering, and project administration. "Buy-out" estimates for acquiring parcels within ponding area were also estimated. The results of Level III are contained herein and will serve as the basis for selecting specific problem locations for a pre-design study.

As part of this project, several other reports or documents were prepared by Wood/Patel & Associates, Inc. as listed below:

1. Pilot HEC-1 Study and Hydrology Parameters, February 1996
2. Hydrology - first phase, June 1996
3. Hydrology - overall watershed, August 1996
4. Pre-Final Hydrology Report, November 1996
5. Final Hydrology Report, February 1997
6. Technical Data Notebook, March 1997
7. Floodplain - Valuation Report, June 1997
8. Conceptual Flood Mitigation Options (Level I), July 1997
9. Structures and Field Survey Report, September 1997
10. Floodplain Mitigation Study (draft), October 1997

2.2 Chronology of Previous Studies

Reports of the flooding of agricultural fields and of flow overtopping canal banks date back to the 1940s, when agriculture was essentially the only land use in the Maryvale ADMS study area. Even as late as the 1960s, agriculture was still the primary land use within the study area. In the 1960s, the U.S. Army Corps of Engineers documented, in detail, the storm and flood event of August 16, 1963. During the 1963 storm event, the Corps documented flooding of both residential and commercial properties, primarily along the Grand Canal.

Also in the early 1960s, the District prepared the *Flood Control Survey Report* (District, 1962) and the *Comprehensive Flood Control Program Report* (District, 1963). These studies identified and documented the flood hazards along Grand Avenue and the canal systems. The latter of these two studies documents plans for

several regional flood control facilities, including the ACDC, New River Dam, and the Adobe Dam. Many of the regional flood control facilities identified in the 1963 study were designed and built in the 1970s, 1980s, and early 1990s.

In the late 1980s, the Arizona Department of Transportation evaluated flood hazards and drainage requirements for the future Outer Loop Highway, also called the Agua Fria Freeway (WLB, 1987), and future highway improvements along Grand Avenue (Tudor, 1989). Also in the 1980s, the District prepared the *Glendale-Peoria Area Drainage Master Plan* (Camp Dresser and McKee et. al., 1987). The study evaluated flooding hazards and flood control alternatives for an area located within the study area for the Maryvale ADMS. The flood control alternatives evaluated in this study primarily involved networks of storm drain systems.

In the early 1990s, the District sponsored studies that evaluated various storm drain alternatives along Cactus Road (SFC, 1992), Butler Drive, Northern Avenue, and Orangewood/Glendale Avenue (WPA, 1995). In 1995, the District had flooding hazards and flood control alternatives evaluated for the flooding area along the Grand Canal, between approximately 35th and 67th Avenues (CVL, 1995). This study evaluated storm drain and retention basin alternatives for relieving flooding along the north side of the canal. Several recommended drainage features have already been built. These features include: the Cactus Road and Olive Avenue storm drains and the detention basins adjacent to the Grand Canal at the Maryvale Baseball Park near 52nd Avenue. Additionally, some features are currently under design such as the Northern/Orangewood storm drain system and the Sunset Basin.

The Maryvale ADMS is intended to address the drainage issues within flood prone areas as well as potential mitigation within the study area. Within this study area, there is a complex network of existing drainage facilities. In addition, there are several future flood control systems at various levels of planning and design.

3.0 EXISTING DRAINAGE FACILITIES

3.1 Existing Channel Systems

The ACDC and Skunk Creek define the northern boundary of the study area. The ACDC and Skunk Creek are regional flood control facilities with design capacities greater than the 100-year event. Within the study area, a major flood control channel was built and is maintained by the Arizona Department of Transportation (ADOT) as illustrated in Figure 2. This channel extends along the east side of the Agua Fria Freeway from approximately Greenway Road to Glendale Avenue. It outfalls into New River at several locations and collects both surface and storm drain flow. ADOT has also built a channel facility which parallels I-10 from 27th Avenue to the Agua Fria River as depicted on Figure 2.

3.2 Existing Storm Drain Systems (Phoenix)

As shown in Figure 2, the City of Phoenix has built a complex system of storm drains that conveys stormwater from as far north as Northern Avenue south to the I-10 channel or to the Salt River. Primary components of this system include storm drains along 27th, 35th, 39th, 43rd, 51st, 67th, 83rd, and 91st Avenues. The design capacities for these storm drain systems are generally estimated to be between the 2- and 10-year events.

3.3 Existing Storm Drain Systems (Peoria and Glendale)

There are three major storm drain systems in the northern portion of the study area as shown in Figure 2. The Cactus Road storm drain system currently extends from approximately 67th Avenue west to 83rd Avenue. The Cactus Road storm drain system will be extended to the ADOT channel system along the Agua Fria Freeway. The expected completion date is early 1998. The Olive Avenue storm drain system extends from approximately 51st Avenue west to the Agua Fria Freeway channel system. The Olive Avenue storm drain system contains two surge basins located at approximately 71st Avenue and 83rd Avenue. This system has a 10-year event design capacity. The Peoria Avenue storm drain system extends from approximately Grand Avenue to the Agua Fria Freeway channel system.

3.4 Future Storm Drain Systems

Several storm drain systems were under design and were therefore included in the HEC-1 model for "existing conditions". The decision to include these future storm drain systems was made with District input and concurrence. These future systems include storm drains along Butler Drive, Northern Avenue, and Orangewood/Glendale Avenues as indicated in Figure 2. In addition, the Cactus Road storm drain system was assumed to be completed to the Agua Fria Freeway channel.

The extension of the Agua Fria Freeway from approximately Northern Avenue to I-10 will include a channel along its east side. The channel will intercept runoff and convey it either to New River or to the existing I-10 channel.

4.0 HYDROLOGY

4.1 HEC-1 Modeling Approach

To meet the primary objectives of the hydrologic modeling component of the Maryvale ADMS project, it was essential to develop a HEC-1 modeling approach that is flexible. The HEC-1 modeling was developed during the *Maryvale Area Drainage Master Study - Hydrology* Phase in February 1997. This HEC-1 hydrology study first evaluated the drainage patterns within a 3.8-square-mile pilot study area.

The selected pilot study area is representative of the highly urbanized portion of the total 100-square-mile study area. Detailed evaluation of the topographic mapping and site conditions for the pilot study area indicated that:

- Arterial streets are important conveyors of storm water; however, the capacity of the arterial streets will typically be exceeded during the 10-year event. Stormwater flows will exit typical arterial street alignments as spillover flow down side streets.

- Since the arterial streets are the primary conveyors of stormwater, it is logical to consider the approximately 1-square-mile area bounded by arterial streets as a sub-basin. However, it is important to recognize that stormwater can cross all four sides of the essentially square sub-basin and that the sub-basin does not have a single concentration point. Instead, each sub-basin has a concentration line that extends along the arterial streets along the downstream sides of the essentially square sub-basin.

- Flow patterns within a typical 1-square-mile sub-basin are complex and can vary significantly during the course of a rainfall event. However, flow patterns within the sub-basin are primarily controlled by residential and collector street patterns.

The HEC-1 model for a typical sub-basin included the following standard elements:

- Hydrograph computations using the District methodologies.
- Normal depth channel routings for arterial streets.
- Normal depth composite-channel routings for multiple streets.
- Reservoir routings for ponding areas and regional retention basin systems.
- Combined hydrographs at major street intersections.

However, the uniqueness of the proposed HEC-1 modeling approach lies in its structure and the use of various categories of flow diversions. The ability to model flow diversions flexibly was the key for developing a modeling approach for the study area that meets the project objectives. Flow diversions are used in five distinctly different ways:

1. **Street Capacity Diversions.** Street capacity diversions were used to compute the flow being conveyed by a major/arterial street and the flow that exited the arterial street and entered the adjacent sub-basin via both residential and collector streets.

2. **Street Intersection Diversions.** Street intersection diversions are used to distribute the flow passing through an intersection. Intersection diversion rating curves for arterial streets were based on relative street capacities and the capacity of existing or future storm drain systems.

3. **Sub-basin Diversions.** Sub-basin diversions were used to identify the southerly and westerly components of runoff generated within a sub-basin and the flow entering a sub-basin from adjacent arterial streets. Rating curves for these diversions were based on proportional areas and engineering judgment.

4. **Retention Basin Diversions.** In cases where a portion of a sub-basin drained to a retention basin or system of retention basins, flow diversions were used to divert the volume of water corresponding to the measured capacities of the retention basins. The percentage of the flow rate that could be diverted (i.e., the DQ-record information) corresponded to the percentage of the sub-basin area that drained to the retention basin(s).

5. **Surge Basin Diversions.** The Olive Avenue, Northern Avenue, and Orangewood/Glendale Avenue storm drain systems contained surge basins, as indicated in Figure 2. Flow diversions were used to simulate the diversion of flow from a storm drain system into a surge basin.

The computational sequence of the HEC-1 model had been set up to minimize the number of "hanging" hydrographs and emphasize the east-west streets. Following east-west streets simplified the task of modifying the model to reflect storm drain alternatives that might extend along the east-west streets. Yet, the structure of the model was such that the computational path for the north-south streets was relatively easy to identify and follow.

In addition, the structure of the HEC-1 modeling approach was such that:

- Flow could be routed into and out of a typical 1-square-mile sub-basin across essentially all four sides of the sub-basin.

- Flow could be routed along all four sides of a typical 1-square-mile sub-basin.

- Street intersection, street capacity, and sub-basin diversions could be modified to reflect future or existing storm drain systems, along arterial and collector streets.

- Retention basin diversions could be added and modified to reflect future retention facilities.

The HEC-1 element names are based on section numbers and street names. A detailed description of the element name nomenclature has been documented in Appendix B and in the ID-records of the HEC-1 data sets of the *Maryvale Area Drainage Master Study - Hydrology* dated February, 1997.

Figure 5 "Summary of Conceptual Peak Discharge, 10-Year, 6-Hour Events" and Figure 6 "Summary of Computed Peak Discharge, 100-Year, 6-Hour Events" depict estimated peak flows at all major street intersections throughout the study area.

4.2 HEC-1 Input Data Development

4.2.1 General

The input parameters for the Maryvale ADMS HEC-1 models were measured from or were primarily based on the following sources of data:

- Detailed topographic mapping (i.e., 1" =200' with a contour interval of 1 or 2 feet) prepared by Kenney Aerial Mapping, based on photography flown on March 28, 1994.

- 1990/1991 land use data provided in GIS format by the District.

- Soil type data, based on the Soil Survey of Maricopa County, Arizona: Central Part (SCS, 1997), as provided in GIS format by the District.

- NOAA Atlas II precipitation data as documented in Drainage Design Manual for Maricopa County: Volume I: Hydrology (District, Jan. 1995).

Detailed documentation and computation sheets for the various components of the HEC-1 model are provided in the appendices of the *Maryvale Area Drainage Master Study - Hydrology* and therefore, not repeated here. However, a brief outline is presented about various parameters to familiarize the reader with the complexity of the HEC-1 model.

Hydrology Parameters:

- Precipitation Data
- Sub-basin Parameters
- Sub-basin Diversions
- Arterial and Composite Street Routes
- Retention Basin and Ponding Area Data
- Street Capacity Diversions
- Street Intersection Diversions
- Storm Drain and Surge Basin Data
- Cumulative Area Computations for Hydrograph Combines.

4.2.2 Rainfall Event Parameters

Precipitation Data:

Adjusted point rainfall depths for the 10-year, 6-hour; 100-year, 6-hour; and the 100-year, 24-hour events were computed for the study area.

Rainfall Distributions

- **6-Hour Rainfall Distributions.** The dimensionless storm patterns documented in the Drainage Design Manual for Maricopa County: Volume I Hydrology (District, 1995), were used in this study.

Multiple Versus Single Storm Event

The multiple storm option has been used to model the general "existing conditions."

4.2.3 Sub-basin Parameters

Sub-basin Boundaries

As indicated in Figure 1, the study area encompasses approximately 100 square miles. The study area has been delineated into 141 sub-basins in a manner consistent with the HEC-1 modeling approach described in the *Maryvale Area Drainage Master Study - Hydrology*.

Land Use and Soil Data

The District provided land use and soil map data in GIS format. The land use and soil map data are shown in the *Maryvale Area Drainage Master Study - Hydrology*. GIS software was used to compute the sub-basin areas, the area of each soil unit in each sub-basin, and the area of each land use category in each sub-basin.

Unit Hydrograph

The Clark Unit Hydrograph option in HEC-1 was used for all sub-basins.

Precipitation Losses

The Green-Ampt precipitation loss option was used for all sub-basins.

Time of Concentration Flow Paths

Time of concentration flow path data was determined for each sub-basin using the detailed topographic mapping.

4.2.4 Sub-basin Diversions

Within the study area, the slope of the land is generally from the northeast to the southwest at approximately 0.4 percent. Hence, stormwater flowing within a typical sub-basin is directed and conveyed to the arterial streets along the west and south sides of the sub-basin by residential and collector streets. That is, some of the stormwater is conveyed west to the north-south arterial street by residential and collector streets, while the remainder of the stormwater is conveyed south to the east-west arterial street by residential and collector streets.

Sub-basin diversions are used to separate or divide the hydrograph for the stormwater within a sub-basin into a southerly and a westerly component. The hydrograph for the stormwater within a sub-basin includes runoff generated within a sub-basin and typically the flow entering a sub-basin from the adjacent arterial streets.

Sub-basin diversion data have been computed based on the drainage patterns within each of the sub-basins. The drainage patterns within the sub-basins have been evaluated using the topographic mapping for the study area and site observations.

4.2.5 Arterial and Sub-basin Street Routes

Arterial Street Routes

The Normal-Depth Channel Routing option in HEC-1 is used for arterial street routes. The input data for arterial street routes are based on a typical arterial street section and measured street slopes and reach lengths.

Sub-basin Street Routes

The Normal-Depth Channel Routing option in HEC-1 is used for sub-basin street routes. The input data for sub-basin street routes was based on a composite section and measured street slopes and reach lengths.

4.2.6 Retention Basin and Ponding Area Data

Retention Basin Data

In cases where a portion of a sub-basin drains to a retention basin or system of retention basins, flow diversions are used to divert the volume of water corresponding to the measured capacities of the retention basins. The percentage of the flow rate that can be diverted (i.e., the DQ-record information) corresponds to the percentage of the sub-basin area that drains to the retention basin(s).

Ponding Area Data

During significant rainfall events, stormwater ponds at several locations along the upstream side of the Roosevelt Canal, the Grand Canal, and Grand Avenue and/or the adjacent railroad embankment. Storage volume, ponding elevation, and outfall data were computed based on the detailed topographic mapping and supplemental surveyed spot elevations.

Maryvale Mitigation Area

Within the Maryvale Mitigation Area study limits, the ponding areas have been modeled based primarily on the data documented by CVL (1995); however, this data has been revised to reflect preliminary analyses of the conveyance capacity along the north side of the Grand Canal and additional storm drain capacity computations.

4.2.7 Street Capacity Diversions

Street capacity diversions are used to compute the flow being conveyed by arterial streets and the flow that exits the arterial streets and enters the adjacent sub-basins via both residential and collector streets. Two general cases of street capacity diversions have been evaluated. The typical case (Case "1") occurs when flow exits the arterial street as spillover flow into the side streets. Along most arterial streets, the side streets have been designed with a high point or grade break near the intersection. This prevents stormwater flowing in the gutter of the arterial from being directly conveyed into the side street. However, a special case, that occurs at several locations is when stormwater can exit the arterial street directly into the side street. In this case, normal depth calculations are used to develop rating data for both the arterial and side street(s). Spreadsheets have been used to compute the rating curves for the street capacity diversions based on easily measured physical parameters and future/existing storm drain system capacities.

4.2.8 Street Intersection Diversions

Street intersection diversions are used to distribute the flow passing through an intersection. Intersection diversion rating curves for arterial streets are based on relative street capacities and the capacity of existing or future storm drain systems. Two general types of street intersections have been evaluated. Type A--Arterial Street Intersections are the typical type of arterial street intersections within the study area. The characteristics of a Type A intersection are listed as follows.

- Continuous pavement crowns in both directions; that is, valley gutters are **not** used to direct stormwater through the intersection.

- Street slopes in the vicinity of the intersection are relatively mild (i.e., less than 1%).

- The intersection is subject to low velocity inundation.

The special case, Type B--Arterial Street Intersections, refers to the condition where the pavement crown is continuous in only one direction through the intersection. In this case, the intersection diversion is based on normal depth and weir flow computations.

4.2.9 Storm Drain Systems

4.2.9.1 Existing Storm Drain Systems within the City of Phoenix

As shown schematically in Figure 2, the City of Phoenix has a complex system of storm drains that conveys stormwater from as far north as Northern Avenue south to the Salt River. Primary components of this system include storm drains along 27th, 35th, 39th, 43rd, 51st, 67th, 75th, 83rd, and 91st Avenues. The design capacities for these storm drain systems are generally estimated to be between the 2-and 10-year event.

The capacities of the storm drain systems located within the City of Phoenix have been estimated based on pipe slopes and diameters, assuming pipe full conditions.

4.2.9.2 Existing Storm Drain Systems within the Cities of Peoria and Glendale

There are three major storm drain systems in the northern portion of the study area, as shown schematically in Figure 2. The Cactus Road storm drain system currently extends from approximately 67th Avenue west to 83rd Avenue. This storm

drain system will be extended to the ADOT channel system along the east side of the Agua Fria Freeway, with an expected completion date of July, 1997. The Olive Avenue storm drain system extends from approximately 51st Avenue west to the Agua Fria Freeway Channel System. The Olive Avenue storm drain system contains two surge basins located at approximately 71st Avenue and 83rd Avenue. This storm drain system has a 10-year event design capacity. The Peoria Avenue storm drain system extends from approximately Grand Avenue to the Agua Fria Freeway channel system.

The Peoria Avenue, Cactus Road, and Olive Avenue storm drain systems have been incorporated into the HEC-1 model by modification of the appropriate street intersection and street capacity diversion rating curves. The Cactus Road storm drain system has been modeled assuming the system is complete and outfalls to the Agua Fria Freeway Channel. Storm drain capacity data for these systems are based on the capacities given in the design reports for these storm drain systems.

4.2.9.3 Future Storm Drain Systems Included in "Existing Conditions"

Several future storm drain systems were included in the HEC-1 model for "existing conditions." These future systems include:

- The storm drain systems evaluated and proposed in the "Northern/Orangewood Storm Drain Project: Concept/Routing Study FCD #94-12" by Wood, Patel & Associates, Inc. (1996). The study proposed systems along Butler Drive, Northern Avenue, and Orangewood/Glendale Avenues, as indicated in Figure 2.

- Extension and completion of the Cactus Road storm drain system. The Cactus Road storm drain system will be extended to the ADOT channel system along the east side of the Agua Fria Freeway, with an expected completion in early 1998.

4.2.10 Cumulative Area Computations for Hydrograph Combined

When hydrographs generated from diverts are combined, HEC-1 requires a drainage area specified on the HC-record. This area is used to compute an interpolated hydrograph for the "combined hydrograph," based on the data given in the JD-records (HEC-1,1990).

For this study, areas have been computed for each combine node based on the total area of all the sub-basins located upstream of the combine node. These "Cumulative Area Computations" list the areas and names for all of the upstream sub-basins for each combine node.

The drainage area specified for each of the combine nodes represents the maximum drainage area that may contribute flow to the combine node. It is recognized that a combine node may only receive a small fraction or none of the runoff hydrograph for some of the upstream sub-basins.

5.0 FLOOD PRONE AREAS IDENTIFICATION

Flood prone areas have been defined by FEMA floodplain maps and also by the Maryvale Area Drainage Master Study. Both the floodplain maps and the Maryvale ADMS map of the flooding areas are illustrated on Figure 7. The flooding limits, prepared by FEMA, were delineated using approximate methods and are generally more extensive than those identified by the ADMS. The identification of flood prone areas (only ponding areas) by the ADMS as shown on Figure 4 was completed using detailed methods. The flood prone areas are described below.

5.1 Grand Avenue Study Area

The areas adjacent to the northeast side of Grand Avenue have historically been subject to repeated flooding, as evidenced by numerous reports to the cities and the county. The flooding is not caused directly by Grand Avenue but rather by the Atchison Topeka and Santa Fe Railroad (AT&SFRR) which parallels the Grand Avenue alignment and which is elevated several feet above natural ground. Runoff that reaches Grand Avenue ponds behind the railroad and inundates the neighborhoods. The entire study corridor of Grand Avenue from 83rd Avenue to the north to I-17 to the south has drainage concerns. Several ponding areas are identified all along the corridor. The corridor is also one of the oldest areas of development dating back to the early 1920's. As a result, the entire corridor is essentially all developed. With easy access of railroad and highway, this area has also attracted industrial and commercial developments.

5.1.1 FEMA Designated Flood Prone Areas

The Flood Insurance Rate Map (FIRM) panels that cover Grand Avenue within the study limits are: Panel 1630F, 1645E, and 2130. Ponding area RES26E near Grand Avenue & I-17 is the only ponding area from the ADMS that is not shown within a FEMA designated flood prone area, as indicated on the FIRM panels. The designation (RES26E) was used for identifying the reservoir routine in the HEC-1 model. The numerals 26 stand for the Section and "E" gives the easterly location. This and other ponding areas are depicted on Figure 4. Similar designations have been cited throughout this report.

5.1.2 Maryvale ADMS

Seven ponding areas were defined along Grand Avenue by the Maryvale ADMS, as shown on Figure 4.

The first ponding area, RES26E, covers an area bounded by Black Canyon Highway (I-17) on the east, Grand Avenue on the southwest, and approximately Earll Drive on the north. Runoff reaches this area and is trapped by I-17 and the AT&SFRR which parallels Grand Avenue.

The second area, RES8, lies adjacent to grand Avenue at the northwest side of the 51st Avenue and Bethany Home Road intersection.

Area three, RES6, is bounded by Northern Avenue on the north, Grand Avenue on the southwest, and approximately 63rd Avenue on the west. However, it inundates 63rd Avenue approximately 1000 feet north of Grand Avenue.

The fourth area, RES36, is south of Olive Avenue along the northeast side of Grand Avenue.

The fifth area, RES26S is bounded by Olive Avenue on the south, Mountain View Road on the north, Grand Avenue on the southwest, and 75th Avenue on the east.

Area six, RES26N, lies north of Mountain View Road along Grand Avenue, south of Peoria Avenue.

Finally, the seventh area, RES22, is a small area along Grand Avenue, lying north of the Peoria Avenue and 83rd Avenue intersection.

5.2 Grand Canal Study Area

Like the Grand Avenue study area, the Grand Canal study area has been subject to repeated flooding as well. The Grand Canal is an irrigation conveyance channel with banks that are raised several feet above adjacent ground in some locations.

The Grand Canal corridor from 83rd Avenue to I-17 is subject to ponding on the north side of the canal bank. The north bank is about 2 to 4 feet elevated above natural ground, causing runoff to pond up or be diverted along the canal alignment often inundating several neighborhoods.

5.2.1 FEMA Designated Flood Prone Areas

The FIRM panels that cover Grand Canal within the study limits are: Panel 1620, 1640D, 2105D, 2110D, and 2130. Ponding areas RES8N, RES8S, RES9, and RES10 are from the Maryvale ADMS and are not shown within a FEMA designated flood prone area as indicated on the FIRM panels.

5.2.2 Maryvale ADMS

The Maryvale ADMS identified 13 ponding areas along the Grand Canal, as shown on Figure 4.

The first, RES26T, lies at the northwest side of the intersection of the Grand Canal and Grand Avenue.

The second through the sixth areas, PA43, PA47, PA51, PA55, and PA59 are contiguous along the north side of the Canal from approximately 36th Avenue to 59th Avenue.

The seventh area, PA63 inundates Indian School Road at its intersection with the Grand Canal and an area south of Indian School Road.

RES24N, the eighth area, is bounded by 67th Avenue on the east, Camelback Road on the north, and the Grand Canal on the southwest.

Area nine, RES14E, lies south of Bethany Home Road along the Canal.

The tenth area, RES10, is bounded by 87th Avenue on the east, the Grand Canal on the south, 91st Avenue on the west and Rovey Avenue on the north. This ponding area appears to be a regional detention area for the subdivision to the north.

Area eleven, RES9, is at the northeast side of the intersection of 99th Avenue and the Canal.

RES8S, the twelfth area, lies along the north side of the Grand Canal between 99th Avenue and the Roosevelt Irrigation Canal. The ponding is caused by the raised banks of the canal.

The last area, RES8N, lies along the northeast side of the irrigation canal bank immediately upstream of the outfall to New River.

5.3 I-10 Channel Study Area

The Interstate 10 (I-10), also known as the Papago Freeway study area differs from the others in that it was not originally identified as a problem area. The original assumption regarding the freeway was that the existing channel along the north side would intercept all runoff reaching it.

5.3.1 FEMA Designated Flood Prone Areas

I-10, within the study boundary, has not been added to the FIRM panels. Therefore, no flood prone areas are identified with respect to I-10.

5.3.2 Maryvale ADMS

During the development of the ADMS, the section of I-10 channel between 83rd and 94th Avenues was identified as having insufficient capacity to convey the 100-year runoff that gets to it. However, this condition is existing and the overflow is not significant. The District, therefore, decided not to include the I-10 channel for any flood mitigation option study.

5.4 Agua Fria Freeway Study Area

The Agua Fria Freeway (SR 101) is not a part of this study. However, the proposed construction of the section of freeway between Glendale Avenue and I-10 will have a major influence on drainage in the western part of the study area. A channel along the east side of the freeway will intercept runoff that impacts the Grand Canal from 99th Avenue west to its outlet to New River. Intercepting this runoff should reduce or eliminate ponding areas RES9, RES8S, RES8N.

South of Bethany Home Road, another channel is proposed which will collect flow and direct it south to discharge into the existing I-10 channel. At the confluence of the AFF and I-10 channels, an off-line detention basin is proposed by ADOT. The basin will be designed to take the 100-year peak flows in excess of the I-10 channel capacity. This approach, in turn, will reduce the outflow into the existing I-10 channel such that it will be contained within its existing banks all the way to the Agua Fria River.

This portion of work is being managed by DMJM, consultant to ADOT. The AFF channel off-line basin system is planned to be operational by the year 2003.

This system will also intercept runoff that causes ponding along the Roosevelt Irrigation District (RID) Canal (ponding areas RES33, RES32E, RES29S, and RES29W).

5.5 Roosevelt Irrigation District Canal Study Area

The raised banks of the Canal create ponding along its upstream side. The ponding has not created much public comment because it occurs in areas where there is little development. As previously mentioned, the proposed AFF channel and detention basin will mitigate these flood prone areas.

5.5.1 FEMA Designated Flood Prone Areas

The FIRM panel that covers the RID Canal within the study limits is: Panel 2085. Ponding area RES29W is the only ponding area from the ADMS that is now shown within a FEMA designated flood prone area, as indicated on the FIRM panels.

5.5.2 Maryvale ADMS

The Maryvale ADMS showed that runoff produces four ponding areas along the RID Canal, as shown in Figure 4.

The first, RES33, is along the north side of the Canal as it parallels McDowell Road between 91st and 99th Avenues.

The second, RES32E, lies within Holy Cross Cemetery in an area where the canal switches from a westerly alignment to a northerly one. It is south of Thomas Road between the 100th Avenue alignment and the northerly canal alignment.

RES29S, the third area, covers an area bounded by Thomas Road on the south, the 100th Avenue alignment on the east, the RID Canal on the west, and the Osborn alignment on the north.

The fourth area, RES29W, lies in an area where the canal changes from a westerly alignment to a northerly one. It covers an area east of the RID Canal which lies along the east side of 107th Avenue and north of the Canal at approximately the Osborn Road alignment.

6.0 PROPOSED FLOOD MITIGATION OPTIONS (LEVEL I ANALYSIS)

6.1 Design Elements/Mitigation

Based on the results of hydrology and ponding delineations, a reconnaissance level study was performed to identify flood problem areas and potential flood mitigation options. These options consist of detention basins, channels, and storm drains. The analysis was based on past flood control project experience, "order of magnitude" cost, available funding, current development activities, general land use plans, regulatory floodplain impacts, traffic issues, and park issues. Mitigation options were presented to the District and pertinent cities (Phoenix, Glendale, and Peoria) for review and comment. The results of this analysis are documented in a separate report, *Conceptual Flood Mitigation Options (Level I)*. The Report eliminated options that were not feasible for further detailed study.

The following is a brief summary of the options considered in the Level I Analysis:

Grand Avenue

- **At 83rd Avenue** - Four options were studied and none were recommended for Level II Analysis.
- **At 79th Avenue** - Two options were studied and the least cost option was recommended for Level II Analysis.
- **At 75th Avenue** - Two options were studied and the least cost option was recommended for Level II Analysis.
- **At 73rd Avenue** - Two options were studied and both options were recommended for Level II Analysis.
- **At 67th Avenue** - One option was studied and recommended for Level II Analysis.
- **At 51st Avenue** - Twelve options were studied and six were recommended Level II Analysis.

- **I-17 Interchange** - Six options were studied and three were recommended for Level II Analysis.
- **At 43rd Avenue** - Eight options were studied and one was recommended for Level II Analysis.

Grand Canal

- **Grand Canal Diversion Channel (I-17 to New River)** - One option was studied but not recommended for Level II Analysis.
- **From 67th Avenue to 87th Avenue** - Eleven options were studied and eight were recommended for Level II Analysis.
- **87th Avenue to New River** - One option was studied and recommended for Level II Analysis.
- **At 31st Avenue** - Nine options were studied and one was recommended for Level II Analysis.

7.0 OPTIONS COMPARISON/EVALUATION (LEVEL II ANALYSIS)

7.1 Selection of Feasible Options

The Level I options were evaluated on a reconnaissance basis. These options were then presented to the District and the local municipalities for their review and input. They were reviewed with respect to cost constraints, the current development activities, general land use plans, drainage master plans, possible impacts on the FEMA regulatory floodplain maps, traffic issues, and park/recreational master plans. Several options were designated for further investigation based on this input. The designated options were further appraised for engineering feasibility and costs in what is being referred to as the Level II analysis.

Existing record data on all major utilities such as sewer, storm drain, and irrigation were collected from the pertinent city or county agencies. That data was used to evaluate any utility conflict in the design of drainage facilities. Preliminary hydraulic analysis was performed to insure the hydraulic feasibility of each option. A cost analysis was performed for all major elements such as earthwork, storm drains, pumping facility, open channel, and culvert crossings. Costs of rights-of-way were estimated based on land prices furnished by the District. If existing homes or businesses had to be bought, estimates of real estate acquisition were made including relocating costs per input from the District.

Preliminary plan view maps for all Level II options are provided in the Appendix as Figure 8. A preliminary cost estimate is provided for each Level II option in the Appendix.

7.1.1 Cost Estimates

While it is necessary to consider and evaluate many different factors when comparing each of the options, the overall cost of each is often of primary importance. The cost estimates developed at this stage were based on approximate construction and land acquisition costs with appropriate

contingency factors applied. These cost estimates should only be used for comparison purposes. Land acquisition costs include relocation costs, where applicable.

- **Construction Costs**

  Construction cost estimates for each alternative were prepared based upon bid prices from past public works projects. In establishing these unit prices, consideration was given to the magnitude of the project and any economies of scale that might be anticipated.

- **Land Costs**

  Private land acquisition costs were provided by District staff based on current County Assessor's maps and ownership sheets. Where land acquisition involves moving residents, relocation costs were also included. For those aspects of the options which lie within publicly held property, no land acquisition costs were assumed.

- **Demolition Costs**

  Where existing homes will be razed, the cost of demolition was included in the construction costs.

7.2 Grand Avenue Study Area

The Grand Avenue study area encompasses the ponding problems which are caused by the elevated railroad tracks located adjacent to Grand Avenue. As mentioned in Section 6.2, eight mitigation areas were designated for Level I study. However, only seven of these areas have options that are being evaluated to a Level II study. The Grand Avenue at 83rd Avenue mitigation area did not have a solution that warranted Level II consideration. The following subsections describe the Level II options and analysis.

7.2.1 Grand Avenue at 79th Avenue (RES26N)

A large undeveloped parcel north of Grand Avenue is within the ponding area. The remainder of the ponding area covers homes, businesses, and a school yard. A 10-year detention option was selected for the Level II analysis.

7.2.1.1 Mitigation Option 1, 10-Year

This option consists of a single detention basin sized to contain the 10-year runoff volume. The basin is proposed to be on the northeast corner of Peoria and 81st Avenues (see Figure 8, Sheet 1). The proposed storage basin would be constructed on currently vacant property. The 10-year peak flow rate is 312 cfs with a volume of 43 acre-feet. The detention basin will store the entire 43 acre-feet. Outflow is provided by the use of an ungated 36-inch outlet pipe which will connect to the existing 36-inch storm drain located in Peoria Avenue. Refer to Table 2.01 for the preliminary cost analysis.

7.2.2 Grand Avenue at 75th Avenue (RES26S)

The availability of vacant land within or near the ponding area is limited and the inflow runoff volumes are large. Therefore, the only option evaluated at Level II is a 10-year detention option.

7.2.2.1 Mitigation Option 1, 10-Year

This option consists of two detention basins sized to contain the 10-year runoff volume. One basin is proposed to be north of Grand Avenue and south of Mountain View Road while the second basin is proposed to be south of Grand Avenue (see Figure 8, Sheet 2). The two basin system would be hydraulically connected via a proposed 60-inch pipe crossing under Grand Avenue. Both proposed storage basins would be constructed on currently vacant property. The 10-year peak flow rate is 595 cfs with a volume of 197 acre-feet and the storage basin will store the entire 197 acre-feet. Outflow is provided through an ungated new 42-inch outlet pipe which will connect to the existing 96-inch storm drain located in Olive Avenue near 78th Avenue. Refer to Table 2.02 for the preliminary cost analysis.

7.2.3 Grand Avenue at 73rd Avenue (RES36)

The entire ponding area is currently vacant farmland. Therefore, the options evaluated in this study area entail the use of this property as a storage basin. The stored volume would be discharged to the existing Olive Avenue storm drain.

7.2.3.1 Mitigation Option 1, 100-Year

This option consists of a surge basin sized to contain the peak of the 100-year runoff hydrograph. The basin is proposed to be on the southwest corner of 71st and Olive Avenues on property that is currently vacant (see Figure 8, Sheet 3). The 100-year peak flow rate is 2535 cfs with a volume of 495 acre-feet. The proposed basin will store 313 acre-feet with a 392 cfs bypass. Outflow is provided through an ungated new 42-inch outlet pipe which will connect to the existing 78-inch storm drain located in Olive Avenue. Refer to Table 2.03 for the preliminary cost analysis.

7.2.3.2 Mitigation Option 1, 10-Year

This option consists of a detention basin similar to the one described in Mitigation Option 1, 100-Year (see Figure 8, Sheet 4). The area required for the 10-year basin is less than half of the size required for the 100-year surge basin. The 10-year peak flow rate is 1,045 cfs with a volume of 227 acre-feet. The proposed basin will store 68 acre-feet with a bypass of 392 cfs. Outflow is provided through an ungated new 42-inch outlet pipe which will connect to the existing 78-inch storm drain located in Olive Avenue. Refer to Table 2.04 for the preliminary cost analysis.

7.2.4 Grand Avenue at 67th Avenue (RES6)

Under a separate contract with the District, Wood/Patel will be developing construction plans for a 10-year storm drain system and surge basin in this area. The only alternative evaluated in this study area entails the use and

enlargement of this basin as a surge basin. The stored volume would be discharged to the storm drain being designed in Grand Avenue.

7.2.4.1 Mitigation Option 1, 100-Year

This option entails enlarging the Northern/Orangewood surge basin which will be under design by Wood/Patel as part of the Northern/Orangewood storm drain project (see Figure 8, Sheet 5). The current design is for a 10-year basin and storm drain outfall to the ADOT Agua Fria Freeway channel. The proposed basin would be enlarged from the 10-year storm event to contain the additional volume generated by the 100-year storm event. The 100-year peak flow rate is 2,888 cfs with a volume of 570 acre-feet. The surge basin will store 533 acre-feet with 110 cfs bypass. The bypass flow rate is maintained at the current design to ensure that the outfall system will not be adversely impacted. A 100-year basin would be deeper than the proposed 10-year basin and therefore, would require a pump station to drain the bottom 5 feet of the basin. The cost to increase the basin from a 10-year design to a 100-year design is shown on Table 2.05.

7.2.5 Grand Avenue at 51st Avenue

The ponding area is mostly developed with business and industrial uses. There are only a few parcels of vacant land available on the north side of Grand Avenue. The only 100-year option considered in the Level I analysis did not progress to a Level II analysis, largely due to cost. The remaining options being considered for Level II analysis are all 10-year designs.

To simplify the option evaluation, the area was studied in two parts. A collection system and an outfall system. These systems could then be combined to make an overall option. The collection system options (4, 5, and 6) collects storm runoff from the 51st Avenue and Grand Avenue

ponding area and then convey the stormwater to the intersection of 55th Avenue and Bethany Home Road. The outfall options (7, 8, and 9) begin at that intersection and terminate at the Bethany Home Road outfall channel near 83rd Avenue.

7.2.5.1 Mitigation Option 4, 10-Year

This option consists of a storm drain in 47th Avenue from Maryland Avenue south to Bethany Home Road, then west to the intersection of 51st and Grand Avenues (see Figure 8, Sheet 6). At this point, a junction structure connects to another proposed storm drain in Grand Avenue. The Grand Avenue storm drain would begin 1,500 feet southeast of Maryland Avenue and terminate at the intersection of 51st and Grand Avenues. The junction structure hydraulically connects the collection system to the surge basin and outfall storm drain. The proposed surge basin is located on a vacant parcel on the southeast corner of 51st Avenue and Bethany Home Road (northeast of Grand Avenue). The 10-year peak inflow rate is 560 cfs with a volume of 113 acre-feet. The surge basin will store 37 acre-feet with 225 cfs bypass. Flows intercepted by these storm drains would be conveyed to the Intersection of 55th Avenue and Bethany Home Road. At this point a second conveyance system would intercept flows in Maryland Avenue from 51st to 55th Avenue where it would cross under Grand Avenue. A surge basin would be located approximately 500 feet south of Maryland Avenue on the west side of 55th Avenue. The 10-year peak flow rate is 353 cfs with a volume of 105 acre-feet. The surge basin will store 36 acre-feet with 150 cfs bypass. Bypass flows would continue south via a proposed 60-inch storm drain to the intersection of 55th Avenue and Bethany Home Road where it would connect to the proposed Bethany Home Road storm drain system. The peak flow at the

intersection of 55th and Grand Avenues is 375 cfs. Storm flows would by conveyed to the proposed Bethany Home Road outfall channel via the proposed Bethany Home Road Storm Drain Option 8 or 9. Refer to Table 2.06 for the preliminary cost analysis.

7.2.5.2 Mitigation Option 5, 10-Year

This option consists of a storm drain in 51st Avenue from Maryland Avenue south to Bethany Home Road and a storm drain in Grand Avenue from Maryland Avenue to Bethany Home Road (see Figure 8, Sheet 7). At this point, a junction structure connects to another proposed storm drain in Bethany Home Road which conveys storm flows west to 55th Avenue. The 10-year peak flow rate in the 51st Avenue storm drain is 405 cfs while the Grand Avenue storm drain peak flow is 266 cfs. The peak flow rate at the intersection of 51st Avenue and Bethany Home Road is 510 cfs. This system will release 585 cfs at the system outfall, 55th Avenue and Bethany Home Road. This system requires outfall option 7. Refer to Table 2.07 for the preliminary cost analysis.

7.2.5.3 Mitigation Option 6, 10-Year

This option is similar to the above option 5 with the exception of a proposed surge basin located at the vacant parcel on the southeast corner of 51st Avenue and Bethany Home Road, northeast of Grand Avenue (see Figure 8, Sheet 8). The 10-year peak flow rate in the 51st Avenue storm drain is 405 cfs while the Grand Avenue storm drain peak flow is 266 cfs. The peak flow rate at the intersection of 51st Avenue and Bethany Home Road is 510 cfs. The junction structure will bypass 120 cfs and surge 80 acre-feet of runoff volume into the basin. This system outlets 340 cfs at the intersection of 55th Avenue & Bethany Home Road. This system requires outfall option 8 or 9. Refer to Table 2.08 for the preliminary cost analysis.

7.2.5.4 Mitigation Option 7, 10-Year

This option begins at the intersection of 55th Avenue and Bethany Home Road and is the outfall to option 5 listed above (see Figure 8, Sheet 9). The Bethany Home Road storm drain detailed in this option discharges storm flows to the Bethany Home Road Outfall Channel. The 10-year peak flow rate at the intersection of 55th Avenue and Bethany Home Road is 585 cfs. The outfall discharge at the Bethany Home Road outfall channel is 980 cfs. Refer to Table 2.09 for the preliminary cost analysis.

7.2.5.5 Mitigation Option 8, 10-Year

This option begins at the intersection of 55th Avenue and Bethany Home Road (see Figure 8, Sheet 10) and is one of two alternative outfalls to option 4 or 6 listed above. The Bethany Home Road storm drain detailed in this option discharges storm flows to the Bethany Home Road outfall channel. This option allows a reduced diameter storm drain pipe for the entire Bethany Home Road storm drain system from Grand Avenue to the Grand Canal Diversion Channel. The 10-year peak flow rate at the intersection of 55th Avenue and Bethany Home Road is 340 cfs. An estimated pipe size of 84-inch is required to convey the full 10-year storm runoff. The outfall discharge to the Bethany Home Road outfall channel is 840 cfs. Refer to Table 2.10 for a preliminary cost analysis.

7.2.5.6 Mitigation Option 9, 10-Year

This option begins at the intersection of 55th Avenue and Bethany Home Road (see Figure 8, Sheet 11) and is one of two alternative outfalls to option 4 or 6 listed above. The Bethany Home Road storm drain detailed in this option discharges storm flows to the Bethany Home Road outfall channel. This option allows a reduced diameter storm drain pipe for the entire Bethany Home Road storm drain system. A surge basin is proposed at the northwest corner of Bethany Home Road and

71st Avenue. This surge basin is used in conjunction with the upstream basins (options 4 or 6). The 10-year peak flow rate at the intersection of 71st Avenue and Bethany Home Road is 645 cfs with a volume of 157 acre-feet. The surge basin will store 88 acre-feet with 100 cfs of bypass. Refer to Table 2.11 for a preliminary cost analysis.

7.2.6 Grand Avenue at 43rd Avenue (no ponding in existing condition)

Currently, the area is mostly developed with only small parcels of vacant land available on the north side of Grand Avenue. However, vacant land is available in a industrial park located on the southwest corner of 43rd Avenue and Camelback Road. Therefore, the alternative evaluated in this study area entail the use of industrial zoned property.

7.2.6.1 Mitigation Option 4, 10-Year

This option consists of a storm drain in 43rd Avenue from Missouri Avenue to Grand Avenue (see Figure 8, Sheet 12). In addition, a storm drain is required in Grand Avenue from Missouri Avenue to 39th Avenue. Storm flows intercepted by these storm drains would be conveyed to the intersection of 43rd Avenue and Camelback Road where the storm flows would be conveyed under Grand Avenue southward 200 feet to a junction structure. The junction structure would connect the proposed storm drain to the existing storm drain in 43rd Avenue. Flows in excess of the existing downstream storm drain capacity would be diverted and stored in a proposed surge basin located on the southwest corner of 43rd Avenue and Camelback Road. The 10-year peak flow rate is 708 cfs with a volume of 188 acre-feet. The surge basin will store 38 acre-feet with 410 cfs bypass. Outflow is discharged to both existing storm drains located in 39th and 43rd Avenues which ultimately discharge to the Salt River to the south. Refer to Table 2.12 for a preliminary cost analysis.

7.2.7 Grand Avenue at I-17 (RES26E)

Currently, the area is mostly developed with only small parcels of vacant land. Therefore, the alternatives evaluated in this study area entail the demolition of existing homes and local businesses to store the entire volume of stormwater impacting the area for various frequency storms.

7.2.7.1 Mitigation Option 2, 100-Year

This option consists of two detention basins sized to contain the entire 100-year runoff volume. One basin is proposed to be on the north side of Thomas while the second basin is proposed to be on the south side (see Figure 8, Sheet 13). The two basin system would be hydraulically connected via a proposed culvert under Thomas Road. Flood mitigation of this area involves acquiring right-of-way for the basins by demolition of residences on both sides of Verde Lane, Catalina Drive and Avalon Drive, located north of Thomas Road between I-17 and 27th Avenue, as well as all businesses on the north side of Thomas Road between I-17 and 27th Avenue, and all businesses on the south side of Thomas Road between the triangle section bounded by Grand Avenue, I-17, and Thomas Road. The 100-year peak flow rate is 3,323 cfs with a volume of 610 acre-feet. This option requires a pump station to drain the detention basin system. Outflow is discharged to the existing 60-inch storm drain located in 27th Avenue which ultimately discharges to the Salt River to the south. Refer to Table 2.13 for a preliminary cost analysis.

7.2.7.2 Mitigation Option 2, 10-Year

This option consists of two detention basins sized to contain the entire 10-year runoff volume similar to Option 2, 100-year (see Figure 8, Sheet 14). The two basin system would be hydraulically connected via a proposed culvert under Thomas Road.

Flood mitigation of this area involves acquisition of right-of-way for the basins by demolition of residences on both sides of Verde Lane located north of Thomas Road between I-17 and 27th Avenue as well as all businesses on the north side of Thomas Road between I-17 and 27th Avenue, and all businesses on the south side of Thomas Road between the triangle section bounded by Grand Avenue, I-17, and Thomas Road. The 10-year peak flow rate is 1416 cfs with a volume of 278 acre-feet. This option requires a pump station to drain both basins. Outflow is discharged to the existing 60-inch storm drain located in 27th Avenue which ultimately discharges to the Salt River to the south. Refer to Table 2.14 for a preliminary cost analysis.

7.2.7.3 Mitigation Option 1, 5-Year

This option consists of one detention basin sized to contain the entire 5-year runoff volume. The basin is proposed to be on the north side of Thomas Road (see Figure 8, Sheet 15). Flood mitigation of this area involves acquisition of right-of-way for the basins by demolition of residences on both sides of Verde Lane located north of Thomas Road between I-17 and 27th Avenue as well as all businesses on the north side of Thomas Road between I-17 and 27th Avenue. The 5-year peak flow rate is 953 cfs with a volume of 184 acre-feet. This option requires a pump station to drain the detention basin system. Outflow is discharged to the existing 60-inch storm drain located in 27th Avenue which ultimately discharges to the Salt River to the south. Refer to Table 2.15 for a preliminary cost analysis.

7.3 Grand Canal Study Area

The Grand Canal cuts off the historic flow path of flood water and causes ponding to occur on the upslope (north) side of the canal. The most efficient method to resolve this conflict is to construct a drainage system along the north side of the canal to safely convey the flood water to an outfall. The whole reach was evaluated in Level I as a channel from Interstate 17 to New River. This option,

known as the Grand Canal Diversion Channel (GCDC) did not warrant Level II consideration due to the extreme cost. Additionally, the upper reach of the Grand Canal from 35th Avenue to 67th Avenue has already been studied under separate contract by the District and therefore, did not warrant Level II consideration.

7.3.1 87th Avenue to New River

As stated previously, the flood mitigation considerations in this outfall reach will be unique due to the proposed Intergovernmental Agreement (IGA) between ADOT and the District. At this stage, the only design considered is with the proposed Agua Fria Freeway and its proposed AFF outfall channel along the Bethany Home Road alignment to New River. The proposed channel design for this reach consists of a trapezoidal concrete lined channel. The 100-year flow rate at 87th Avenue is 3,530 cfs and the outfall flow rate at New River is 5,280 cfs.

7.3.2 67th Avenue to 87th Avenue

It has been decided that the cost of extending the Bethany Home Road Outfall Channel from 67th Avenue to I-17 is significantly greater than the benefit gained. However, constructing a channel from 87th Avenue to 67th Avenue provides many benefits in addition to a reduced stormwater ponding area. These benefits include a positive outfall as well as a reduced flooding potential downstream (south side) of the canal.

Three potential 100-year solutions to alleviate the flooding problems caused by Grand Canal were analyzed at this level. All options will outfall to the AFF outfall channel. In order to obtain adequate right-of-way for the channel, two options entail the condemnation, purchase, and demolition of 63 existing homes. The third option requires the acquisition of 9 more existing residences for the proposed on-line basin. All three options require an additional purchase of land on the upslope (north) side of Grand Canal. The City of Glendale recently acquired a drainage easement along the proposed Bethany Home Road Outfall Channel between 83rd and 75th Avenues.

Five potential 10-year solutions to alleviate the flooding problems caused by Grand Canal were analyzed at this level. All options will outfall to the AFF outfall channel at 87th Avenue. During a 100-year event, stormwater will overtop the Grand Canal including the 10-year mitigation measured proposed with these options; thus, the existing Flood Insurance Rate Map (FIRM) will not change significantly. Four 10-year options entail the condemnation, purchase, and demolition of 63 existing homes. The fifth option requires the acquisition of 9 more existing residences for a proposed on-line basin. All five options require an additional purchase of land on the upslope (north) side of Grand Canal. As mentioned above, the City of Glendale recently acquired access to some of this land via a drainage easement.

7.3.2.1 Mitigation Option 1, 100-year (Without Camelback Road storm drain)

This option assumes that the entire 100-year flow reaching the Grand Canal will be intercepted by the proposed channel (see Figure 8, Sheet 16). The channel was evaluated to account for the proposed 10-year Bethany Home Road storm drain which outlets to the proposed Bethany Home Road outfall channel just upstream of 83rd Avenue. The purpose of the 10-year storm drain is to alleviate the ponding water problem at Grand Avenue and 51st Avenue.

Mitigation for this reach entails constructing a rectangular concrete lined channel to convey the entire 100-year runoff which arrives at the Grand Canal. The option outfalls to the AFF outfall reach which ultimately carries the flow to New River just west of 107th Avenue and Bethany Home Road. Peak flow values vary from 1,280 cfs at 67th Avenue to 1,620 cfs at 75th Avenue to 2,860 cfs at 83rd Avenue and 3,530 cfs at 87th Avenue. Refer to Table 2.16 for a preliminary cost analysis.

7.3.2.2 Mitigation Option 2, 100-year (With Camelback Road storm drain)

This option is similar to Option 1, 100-Year. However, it includes a proposed storm drain in Camelback Road (see Figure 8, Sheet 17). The purpose of the two mile proposed storm drain is to intercept the 10-year runoff reaching Camelback Road between 75th and 59th Avenues, which in turn, reduces the flow in the proposed Bethany Home Road outfall channel upstream of Camelback Road. Due to existing utility conflicts in Camelback Road, the storm drain would need to drain to the Bethany Home Road outfall channel upstream of the proposed culvert under Camelback Road. This creates a hydraulic backwater effect that negates the intended reduction in the proposed channel base width. Flow rates vary from 880 cfs at 67th Avenue to 970 cfs at 75th Avenue to 2,860 cfs at 83rd Avenue and 3,530 cfs at 87th Avenue. Refer to Table 2.17 for a preliminary cost analysis.

7.3.2.3 Mitigation Option 4, 100-year (On-line detention basin north of Grand Canal between 67th and 73rd Avenues)

An on-line detention basin is proposed to pass 540 cfs through 2 - 6 x 3 foot box culverts and detain approximately 85 acre-feet of runoff. The basin is approximately 5000 feet long and 120 feet wide paralleling Grand Canal between 67th and 73rd Avenues (see Figure 8, Sheet 18). A concrete lined rectangular channel is proposed to convey the outflow from the on-line basin at 73rd Avenue to 87th Avenue. The 100-year flow rate at 67th Avenue is 1,280 cfs inflow with 330 acre-feet of volume. The on-line basin attenuates the peak inflow to 540 cfs at 73rd Avenue, 800 cfs at 75th Avenue, 2,260 cfs at 83rd Avenue and 2,880 cfs at 87th Avenue. Refer to Table 2.18 for the preliminary cost analysis.

7.3.2.4 Mitigation Option 1, 10-year (No supplemental storm drains)

Mitigation for this reach entails constructing a rectangular concrete lined channel to convey the entire 10-year runoff which arrives at Grand Canal (see Figure 8, Sheet 19). The AFF outfall channel conveys the collected flow from 87th Avenue to New River just west of 107th Avenue. Flow rates vary from 483 cfs at 67th Avenue, 640 cfs at 75th Avenue, 870 cfs at 83rd Avenue, and 1,100 cfs at 87th Avenue. Refer to Table 2.19 for the preliminary cost analysis.

7.3.2.5 Mitigation Option 2, 10-year (With Bethany Home Road storm drain)

This option is similar to Option 1, 10-Year. However, the concrete lined rectangular channel was designed to account for the proposed 10-year Bethany Home Road storm drain which outlets to the proposed channel just upstream of 83rd Avenue (see Figure 8, Sheet 20). The purpose of the 10-year storm drain is to reduce the ponding water problem at Grand Avenue and 51st Avenue. Flow rates vary from 483 cfs at 60th Avenue to 640 cfs at 75th Avenue to 870 cfs at 83rd Avenue and 1,100 cfs at 87th Avenue. Refer to Table 2.20 for the preliminary cost analysis.

7.3.2.6 Mitigation Option 3, 10-year (With supplemental Camelback Road storm drain)

The channel is proposed to be a concrete lined rectangular channel for the 10-year storm with a supplemental 10-year storm drain in Camelback Road (see Figure 8, Sheet 21). This option is similar in purpose and constraints to Option 2, 100-Year. Flow rates vary from 80 cfs at 67th Avenue to 80 cfs at 75th Avenue to 870 cfs at 83rd Avenue and 1,100 cfs at 87th Avenue. Refer to Table 2.21 for the preliminary cost analysis.

7.3.2.7 Mitigation Option 4, 10-year (With both Bethany Home Road and Camelback Road storm drains)

Mitigation for this option entails utilizing both the Bethany Home Road and Camelback Road storm drain system along with a concrete lined rectangular channel (see Figure 8, Sheet 22). As stated earlier, the Camelback Road storm drain was intended to reduce the Bethany Home Road outfall channel size upstream of Camelback Road. However, it was found not to be fully effective with respect to this goal. Flow rates vary from 80 cfs at 67th Avenue to 80 cfs at 75th Avenue to 870 cfs at 83rd Avenue and 1,100 cfs at 87th Avenue. Refer to Table 2.22 for the preliminary cost analysis.

7.3.2.8 Mitigation Option 6, 10-year (Off-line detention basin between 67th and 71st Avenues)

An off-line detention basin is designed to bypass 120 cfs and detain approximately 65 acre-feet of runoff into a proposed off-line basin. The basin is approximately 4,00 feet long and 120 feet wide paralleling the Grand Canal between 67th and 73rd Avenues (see Figure 8, Sheet 23). The Bethany Home Road Outfall Channel is a concrete lined rectangular channel which will outfalls to the proposed AFF outfall channel at 87th Avenue. The 10-year flow rate at 67th Avenue is 483 cfs inflow with 120 cfs in the Bethany Home Road Outfall Channel, 275 cfs at 75th Avenue, 500 cfs at 83rd Avenue, and 740 cfs at 87th Avenue. Refer to Table 2.23 for the preliminary cost analysis.

7.3.3 Grand Canal at 31st Avenue (RES26T)

The ponding area at this location is entirely developed as commercial and industrial uses with no vacant land available. Therefore, the options evaluated in this study area entail the demolition of existing businesses to store the required volume of water impacting the area. The only option feasible is for the 5-year storm.

7.3.3.1 Mitigation Option 1, 5-Year

This option consists of two detention basins sized to contain the runoff from a 5-year storm. One basin is proposed to be on the north side of Weldon Avenue while the second basin is proposed to be on the south side (see Figure 8, Sheet 24). The two basin system would be hydraulically connected via a proposed culvert under Weldon Avenue. Flood mitigation relief of this area involves acquisition of right-of-way for the basins by demolition of businesses between the Grand Canal and Weldon Avenue from Grand Avenue to 30th Avenue as well as the businesses bounded by Clarendon, Weldon, 32nd Avenue and 30th Avenue. The 5-year peak flow rate is 1,138 cfs with a volume of 272 acre-feet. The surge basin will store 152 acre-feet with 250 cfs bypass. Outflow is discharged through a new 72-inch pipe which will connect to the existing 72-inch storm drain located in 30th Avenue. Refer to Table 2.24 for the preliminary cost analysis.

8.0 SELECTED OPTIONS

8.1 Selection of Recommended Options

Results of the Level II analysis were used to select a single option at each mitigation area for further consideration in the Level III analysis. The selection was primarily based on the overall cost of improvements and engineering feasibility. In most cases, the most economical option was selected.

The Level III analysis was performed to refine the Level II analysis. The items refined were typically the preliminary design, costs, and rights-of-way requirements. If needed, a detailed hydrology evaluation was carried out to refine the peak flow and volume parameters required for a conveyance or detention system. Refinements were also made to the hydraulic analysis. The cost estimate was updated to reflect the selected conveyance/detention basin system and all major elements to support its functioning. Contingencies were applied to the estimated costs to account for engineering, construction, administration, fluctuating unit prices and other items.

Preliminary plan and profile exhibits for these selected options are provided in the Appendix as Figure 9. They show horizontal and vertical alignment, major utilities, required right-of-way, and various other features for the selected conveyance system. Land costs were provided by the District for right-of-way acquisition estimates. A cost estimate is provided for each selected option included in this section. Quantities of materials and unit costs used for the estimated costs are provided in Tables 4.01 through 4.10.

8.2 Grand Avenue Study Area

The entire study corridor of Grand Avenue from 83rd Avenue to the north to I-17 to the south has drainage concerns. The corridor is also one of the oldest areas of development going back to the early 1920's. As a result, the entire corridor is essentially all developed. With easy access of railroad and highway, this area has also attracted industrial and commercial developments.

Our study concluded that most mitigation options required a land/business acquisition of expensive established properties and most drainage conveyance systems will be built in intense traffic and utility conflict areas. Most mitigation costs came out relatively high making most of the options not cost-effective.

8.2.1 Grand Avenue at 79th Avenue

The selected alternative for this area is mitigation option 1, 10-year. It was determined in the Level II Analysis that the improvement cost of resolving the 100-year flooding at this location is cost prohibitive. Therefore, 10-year mitigation measures were pursued. It has been determined that during the 10-year storm a peak flow rate of 312 cfs and a runoff volume of 47 acre-feet concentrate near the south east corner of the intersection at 83rd Avenue and Peoria Avenue along Grand Avenue. An earthen lined on-line detention basin is proposed to contain the 10-year volume. The side slopes of the basin are 4:1 (H:V) and the water surface is expected to pond to elevation 1139, an average of 5 feet deep. The existing 36 inch storm drain in Peoria Avenue provides sufficient conveyance to drain the proposed detention basin. Refer to Figure 9, Sheet 1 for the preliminary drainage system plan.

8.2.1.1 Mitigation Costs

The 10-year mitigation measures for this option is estimated to cost $1.8 million (see Table 4.01). It has been estimated that it will cost $3.1 million to purchase the properties within the FEMA designated 100-year floodplain. The Maryvale ADMS found the limits of the 100-year ponding to be larger than the recorded FEMA floodplain boundary and the cost to buy out properties within the ADMS ponding area is estimated to be $8.5 million.

8.2.1.2 Recommendation

Based upon the review of implementation cost for flood mitigation versus the cost of acquisition of properties within the floodplain, it is apparent that the buy out of the floodplain properties is cost prohibitive.

If the 10-year mitigation option is implemented, it will not remove the properties from the floodplain. It will, however, create a reduction in the floodplain and reduce the flooding potential from more frequent storms significantly both in the ponding areas as well as immediately downstream properties.

This option is therefore recommended for pre-design study.

8.2.2 Grand Avenue at 75th Avenue

The selected alternative for this area is mitigation option 1, 10-year. It was determined during Level II Analysis that the cost of mitigating the 100-year flood at this location was too expensive. Therefore, a 10-year solution is presented hereafter. It has been determined that during the 10-year storm a peak flow rate of 595 cfs and a runoff volume of 197 acre-feet concentrate near the south east corner of the intersection at 79th Avenue and Mountain View Road along Grand Avenue. Therefore, an earthen lined on-line detention basin is proposed to intercept the entire 10-year runoff volume. Due to the limited open space available at this location, two storage basins are proposed. Both basins are triangular in shape and will be connected by a 60-inch equalizer pipe under Grand Avenue. The proposed 10-year ponding depth in the basin system is expected to average 15 feet at an elevation of 1130. The basin side slopes are 4:1 (H:V). The detention basin system will drain to the south and a proposed 42-inch pipe will convey the stormwater to the existing 78-inch storm drain in Olive Avenue. Refer to Figure 9, Sheets 2 and 3 for the preliminary drainage system plan.

8.2.2.1 Mitigation Costs

The 10-year mitigation measures for this option are estimated to cost $6.8 million (see Table 4.02). It has been estimated that it will cost $14.5 million to purchase the properties within the FEMA floodplain. The Maryvale ADMS found the limits of the 100-year ponding to be smaller than the recorded FEMA floodplain boundary, thus the cost to buyout properties within the ADMS ponded area is estimated to be $6.2 million.

8.2.2.2 Recommendations

Based upon the review of implementation cost for the flood mitigation versus the cost of acquisition of properties within the floodplain, it is apparent that the buy out of the floodplain properties is cost prohibitive.

If the 10-year mitigation option is implemented, it will not remove the properties from the floodplain. It will, however, create a reduction in the floodplain and reduce the flooding potential from more frequent storms significantly both in the ponding areas as well as immediately downstream properties.

This option is therefore recommended for pre-design study.

8.2.3 Grand Avenue at 73rd Avenue

The selected alternative for this area is **mitigation option 1, 10-year**. It was determined during Level II Analysis that the cost of resolving the 100-year flooding at this location not economically feasible. Therefore, 10-year mitigation measures were pursued. It has been determined that during the 10-year storm a peak flow rate of 1,045 cfs and a runoff volume of 227 acre-feet concentrate near the south east corner of the intersection at 75th Avenue and Olive Avenue along Grand Avenue. The existing 78-inch storm drain in Olive Avenue will intercept and bypass 392 cfs. To accommodate the flow interception, a surge basin is proposed to contain the excess surge volume of 68 acre-feet. The proposed 10-year water surface is expected to pond to elevation 1034 at an average depth of 15 feet. The basin is proposed to be earthen lined with 4:1 (H:V) side slopes. Refer to Figure 9, Sheet 4 for the preliminary drainage system plan.

8.2.3.1 Mitigation Costs

The 10-year mitigation measures for this option will cost $1.7 million (see Table 4.03). It has been estimated that it will cost $1.0 million to purchase the properties within the FEMA

floodplain. The Maryvale ADMS found the limits of the 100-year ponding to be larger than the recorded FEMA boundary and the cost to buyout properties within the ADMS ponding area is estimated to be $2.5 million.

8.2.3.2 Recommendation

Based upon the review of implementation cost for the flood mitigation versus the cost of acquisition of properties within the floodplain, it is apparent that the buy out of the floodplain properties is cost prohibitive.

If the 10-year mitigation option is implemented, it will not remove the properties from the floodplain. It will, however, create a reduction in the floodplain and reduce the flooding potential from more frequent storms significantly both in the ponding areas as well as immediately downstream properties.

This option is therefore recommended for pre-design study.

8.2.4 Grand Avenue at 67th Avenue

The selected alternative for this area is **mitigation option 1, 100-year**. This option involves enlarging and deepening the proposed Northern/Orangewood 10-year surge basin to contain the 100-year storm. It has been determined that during the 100-year storm, a peak flow rate of 2,888 cfs and a runoff volume of 570 acre-feet concentrate near the southeast corner of the intersection at 67th Avenue and Northern Avenue along Grand Avenue. The proposed basin will intercept the stormwater and allow 110 cfs to by-pass through the proposed 10-year Northern/Orangewood storm drain which outfalls to the proposed AFF channel. The basin only needs to store 495 acre-feet due to the surge basin concept. A pump station will be required to drain the bottom 5 feet of New River basin since the invert of the outfall pipe will be about 5 feet higher than the basin bottom elevation. Refer to Figure 9, Sheet 5 for the preliminary drainage system.

8.2.4.1 Mitigation Costs

The 100-year mitigation measures for this option will add an additional $2.9 million (see Table 4.04) to the cost of the 10-year design. It has been estimated that it will cost $19.2 million to purchase the properties within the FEMA designated 100-year ponding area. The Maryvale ADMS found the limits of the 100-year ponding to be smaller than the recorded FEMA floodplain boundary, thus the cost to buyout properties within the ADMS ponded area is estimated to be $6.4 million.

8.2.4.2 Recommendation

Based upon the review of implementation cost for the flood mitigation versus the cost of acquisition of properties within the floodplain, it is apparent that the buy out of the floodplain properties is cost prohibitive.

If the 100-year mitigation option is implemented, it will remove the properties from the floodplain and create a reduction in the floodplain and reduce the flooding potential from more frequent storms significantly both in the ponding areas as well as immediately downstream properties.

This option is therefore recommended for pre-design study.

8.2.5 Grand Avenue at 51st Avenue

The selected alternative for this area is a combination of two options; **mitigation option 6, 10-year** for the collection system and **mitigation option 8, 10-year** to convey and outlet stormwater from Bethany Home Road and 51st Avenue to 83rd Avenue. This option also requires the construction of the Bethany Home Road Outfall Channel. Mitigation for the 10-year storm involves collecting 220 cfs at the intersection of Grand Avenue and Maryland Avenue and conveying it southeasterly in a proposed storm drain along Grand Avenue to the intersection of Bethany Home Road and Grand Avenue. The 51st Avenue trunk line will pick up 297 cfs at Maryland Avenue and 51st Avenue. An additional 111 cfs will

be intercepted by the system just east of the intersection of Bethany Home Road and Grand Avenue. All three intercepted flows are combined at this intersection to total 510 cfs. A surge basin is proposed which will reduce this flow rate by storing 80 acre-feet and allowing 120 cfs to by-pass to the proposed Bethany Home Road storm drain. The proposed basin is to be earthen lined with 4:1 side slopes. The 10-year water surface is expected to pond to elevation 1144. The Bethany Home Road Storm drain will follow the Bethany Home Road alignment and outfall to the Bethany Home Road Outfall Channel at 83rd Avenue. The storm drain flows will increase as a result of drainage contribution from local subareas. The storm drain flows are estimated to be 120 cfs at Grand Avenue, 340 cfs at 55th Avenue, 372 cfs at 59th Avenue, 463 cfs at 63rd Avenue, 515 cfs at 67th Avenue, 643 cfs at 71st Avenue, 714 cfs at 75th Avenue, 805 cfs at 79th Avenue, and 837 cfs at the 83rd Avenue outlet near the Bethany Home Road outfall channel. Figure 9, Sheets 6 through 22 depicts the preliminary drainage system plan.

8.2.5.1 Mitigation Costs

The 10-year mitigation measures for this option is estimated to be $12.2 million (see Table 4.05 and 4.06), including both the collection and outfall systems (options 6 and 8). There is not a FEMA designated floodplain for this location. The Maryvale ADMS found that there is ponding in this vicinity and the cost to buyout properties within the ADMS ponded area is estimated to be $7.3 million.

8.2.5.2 Recommendation

Both the implementation cost for drainage improvements and the buy out costs for the floodplain properties are excessive.

For that reason, this option is not recommended for pre-design study.

8.2.6 Grand Avenue at 43rd Avenue

The selected alternative for this area is **mitigation option 4, 10-year**. This option may warrant interagency participation. Also, it should be noted that if option 6, 10-year for 51st Avenue and Grand Avenue is built, the flooding problems at Grand Avenue and 43rd Avenue will be reduced. This area also differs from the rest of the ADMS problem areas since stormwater does not pond at this location, however, a sheet flow of 708 cfs crosses 43rd Avenue for the 10-year storm.

Mitigation measures for the 10-year storm include a proposed storm drain paralleling Grand Avenue to intercept flows upstream of the intersection with 43rd Avenue and Camelback Road. A storm drain will also pick up 10-year flows at 43rd Avenue and Missouri Avenue. Both storm drain systems will combine at the intersection of 43rd Avenue and Camelback Road along Grand Avenue. The 10-year combined inflow is estimated to be 708 cfs. A surge basin is proposed at the southwest corner of 43rd Avenue and Camelback Road. The system will by-pass 410 cfs and surge 38 acre-feet of storm runoff into the basin. The surge basin 10-year water surface elevation is estimated to be 1134.5. The basin will be earthen lined with 4:1 (H:V) side slopes. For proper downstream conveyance, the 410 cfs by-pass will have to be split into the existing storm drain in 43rd Avenue and a proposed storm drain lateral paralleling Grand Avenue to connect to the existing storm drain in 39th Avenue. The 43rd Avenue storm drain outlets to the I-10 channel, and the 39th Avenue Storm drain outlets to the I-10 Interceptor Channel and ultimately to the Agua Fria River. Figure 9, Sheets 23 through 29 depict the preliminary drainage system plan.

8.2.6.1 Mitigation Costs

The 10-year mitigation measures for this option is estimated to cost $4.5 million (see Table 4.07). Since flooding does not pond in this area, the buyout of flooded areas is not considered.

8.2.6.2 Recommendation

Since this area is not in the FEMA defined flood zone, implementing this option does not have any impact on the flood insurance requirements by the properties in this area.

The runoff potential in this area is still significant which adversely influences the traffic corridors of Grand Avenue, Camelback Road, and 43rd Avenue. It is recommended that this option be considered for pre-design study by multi-agencies, such as ADOT, the District, local city participation, etc.

8.2.7 Grand Avenue at I-17

The selected alternative for this area is **mitigation option 1, 5-year**. It was determined during Level II Analysis that both the 100- and 10-year solutions are cost prohibitive, thus a 5-year option was evaluated. Mitigation for the 5-year storm involves construction of a detention basin to contain the entire 5-year runoff volume for the 953 cfs peak inflow. A 184 acre-feet detention basin is proposed north of Thomas Road and west of I-17 and will pond to an elevation of 1095. The basin is proposed as an earthen lined basin with 4:1 side slopes, and will intercept the 5-year runoff before it starts to pond against I-17 and the railroad embankment along Grand Avenue. The basin will drain to the existing storm drain in 27th Avenue. A pump station will be needed to drain the bottom 20 feet of the basin. Refer to Figure 9, Sheet 30 for the Preliminary Drainage System Plan.

8.2.7.1 Mitigation Costs at Grand Avenue and I-17

The 5-year mitigation measures for this option is estimated to cost $7.8 million (see Table 4.08). There is not a FEMA designated 100-year ponding area, however, the Maryvale ADMS determined that ponding does occur at this location. The cost to buyout properties within the ADMS ponded area is estimated to be $15.7 million.

8.2.7.2 Recommendation

Based upon the review of implementation cost for the flood mitigation versus the cost of acquisition of properties within the floodplain, it is apparent that the buy out of the floodplain properties is cost prohibitive.

If the 5-year mitigation option is implemented, it will not remove the properties from the floodplain. It will, however, create a reduction in the floodplain and reduce the flooding potential from more frequent storms significantly both in the ponding areas as well as immediately downstream properties.

This option is therefore recommended for pre-design study.

8.3 Grand Canal Study Area

The Grand Canal study area downstream of 67th Avenue was separated into two parts for the Level I and Level II analyses. This division occurred at 87th Avenue due to ADOT proposing to build the AFF outfall channel from 87th Avenue to New River. However, subsequent to the completion of the Level I and Level II analyses, Wood/Patel learned about ADOT's decision to end the AFF outfall channel at the Agua Fria Freeway corridor at approximately 97th Avenue. Therefore, Level III plans and cost estimates account for the division of the AFF and cannot be directly compared to the Level II information.

8.3.1 Agua Fria Freeway to New River (AFF Outfall Channel)

As previously mentioned, the District is in the process of entering into an IGA with ADOT to buy capacity in the AFF outfall channel. This would provide conveyance for the Bethany Home Road outfall channel to New River.

8.3.2 67th Avenue to the Agua Fria Freeway

The selected alternative for this option is **mitigation Option 4, 100-year**. This option continues the Bethany Home Road Outfall Channel upstream from the proposed Agua Fria Freeway alignment to 67th Avenue. Mitigation for the 100-year storm involves constructing an on-line detention

basin north of Grand Canal from 67th Avenue to 73rd Avenue. This basin is sized to attenuate the 100-year peak inflow of 1,280 cfs near 67th Avenue to 540 cfs. The detention basin is proposed as an earthen lined basin with side slopes of 4:1 (H:V). The basin will detain the peak storage of 84 acre-feet at elevation 1094. The basin is provided with an outlet consisting of a 2 barrel 6 foot x 3 foot box culvert with the inlet invert set at elevation 1083. This box culvert has been sized based on inlet control and, therefore, final design may require a larger culvert if the outlet hydraulics control.

The channel downstream of 73rd Avenue is sized to convey 540 cfs plus the 100-year runoff generated from the local drainage subarea at each downstream point. The flow rates estimated for preliminary design are 540 cfs at 73rd Avenue, 800 cfs at 75th Avenue, 1,545 cfs at 79th Avenue, 2,260 cfs at 83rd Avenue, 2,280 cfs at 91st Avenue, and 3,240 cfs upstream of the confluence with the proposed AFF channel at 97th Avenue. Refer to Figure 9, Sheets 31 through 43 for the preliminary drainage system plans.

The Bethany Home Road storm drain (options 6 and 8, 10-year for the Grand Avenue at 51st Avenue vicinity) is proposed to outfall to this reach at 83rd Avenue for the purpose of this study. It is assumed that the flow rates shown above will not change if the storm drain system is constructed. The flows upstream of 83rd Avenue will be slightly reduced, but not significant enough to affect preliminary design of the Bethany Home Road Outfall Channel. The same logic also applies to the flows downstream of 83rd Avenue already include the possibility of a 10-year storm drain outfall.

8.3.2.1 Mitigation Costs

The 100-year mitigation measures for this option is estimated to cost $21.2 million (see Table 4.09). It has been estimated that it will cost $49.2 million to purchase the properties within the FEMA designated floodplain. The Maryvale ADMS found the limits of the 100-year ponding to be smaller than the recorded FEMA boundary, thus the cost to buyout properties within the ADMS ponding areas is estimated to be $34.7 million.

8.3.2.2 Recommendation

The implementation costs for the 100-year flood is significantly lower than the buy out costs for the properties within the floodplain areas. Moreover, by implementing this option, the 100-year floodplain boundary can be either partially or completely removed and thereby positively impacting the properties in the flood zone. This option will also reduce all possible overflows across Grand Canal and thus, any flood potential to the properties immediately downstream (south) of the south bank is eliminated.

As a side benefit, this option can provide a lineal trail/bikepath along the Grand Canal corridor, thus enhancing the recreational benefits.

This option looks promising, therefore, it is strongly recommended that this option be recommended for pre-design study.

8.3.3 Grand Canal at 31st Avenue

The selected alternative for this option is **mitigation option 1, 5-year**. It was determined during Level II analysis that the cost of mitigating either the 100-year or the 10-year storm at this location is excessive. Therefore, a 5-year solution was pursued. The 5-year storm generates 1,138 cfs and 272 acre-feet of runoff volume at this location. The existing 72-inch storm drain in 31st Avenue will convey 250 cfs, thus a surge basin is proposed to surge 152 acre-feet of runoff volume and by-pass 250 cfs. Due to available parcels of land, a two basin system with an equalizer pipe is proposed. An earthen basin is proposed with 4:1 (H:V) side slopes. It is expected that the depth of water in the basin will average 15 feet deep at a water surface elevation of 1112. Figure 9, Sheet 44 depicts the preliminary drainage system plan.

8.3.3.1 Mitigation Costs

The 5-year mitigation measures for this option is estimated to cost $9.4 million (see Table 4.10). The cost to purchase the properties within the FEMA designated 100-year ponding area was not calculated. The cost to buyout properties within the ADMS ponding areas is estimated to be $2.0 million.

8.3.3.2 Recommendations

Based upon the review of implementation cost for the flood mitigation versus the cost of acquisition of properties within the floodplain, it is apparent that the buy out of the floodplain properties is cost prohibitive.

If the 10-year mitigation option is implemented, it will not remove the properties from the floodplain. It will, however, create a reduction in the floodplain and reduce the flooding potential from more frequent storms significantly both in the ponding areas as well as immediately downstream properties.

This option is therefore recommended for pre-design study.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The purpose of the Maryvale ADMS was to identify problem locations along the Grand Avenue/AT&SFRR, Grand Canal, Interstate 10, Agua Fria Freeway, and RID Canal, and to evaluate potential mitigation options that would mitigate flooding problems.

Grand Avenue and Grand Canal were selected for further study. The selection was made by the District because the study areas are highly urbanized and there have been numerous complaints from area residents for the flooding problem. The existence of poor drainage also has caused traffic problems in the area.

The drainage corridors associated with I-10 and the proposed Agua Fria Freeway are managed by ADOT. ADOT has built a drainage channel along I-10 and enhancements to drainage improvements are being considered for the outfall portion of the channel. The Agua Fria Freeway corridor is being designed to manage the 100-year storm event. The design is expected to be completed within the next two years. For these reasons, these two corridors were not evaluated as part of this Study.

The RID Canal corridor is currently agricultural land without any significant development. The ponding areas created by the raised canal banks are anticipated to be reduced or eliminated as a result of the planned drainage diversion by the AFF channel. For these reasons, the RID Canal corridor was not considered for pre-design study.

Having performed a tri-level analysis consisting of field surveys, hydrologic analysis, and hydraulic design, the following locations are recommended for pre-design study:

- Grand Avenue at 79th Avenue (10-Year Design Frequency)
- Grand Avenue at 75th Avenue (10-Year Design Frequency)
- Grand Avenue at 73rd Avenue (10-Year Design Frequency)
- Grand Avenue at 67th Avenue (100-Year Design Frequency)
- Grand Avenue at 51st Avenue (10-Year Design Frequency)
- Grand Avenue at 51st Avenue (outfall) (10-Year Design Frequency)
- Grand Avenue at 43rd Avenue (10-Year Design Frequency)

- Grand Avenue at Interstate 17 (5-Year Design Frequency)
- Grand Canal from 67th Avenue to the Agua Fria Freeway (100-Year Design Frequency)
- Grand Canal at 31st Avenue (5-Year Design Frequency)

Any of the locations may be chosen for further evaluation and pre-design study. As a part of that pre-design study, additional analysis will be necessary. This analysis should include a detailed evaluation of the hydrologic and hydraulic design based on current field conditions. In addition, existing utilities should be evaluated to verify location and size. More detailed site specific topographic data, including a field survey of key features, is recommended. Existing drainage facilities, including catch basins, storm drains, channels, etc. should be analyzed to verify inlet capacity, main line conveyance, and backwater effects. Many of the flood control project alternatives include the use of existing storm drains as an outfall. It is recommended that the impacts of adding outfall flow to the existing storm drain systems be evaluated. Adverse impacts to the existing storm drain systems may be mitigated by delaying the release of flows from a proposed basin. The cost analysis should be updated for all modifications to the design concept, including the current unit prices and land costs.

10.0 REFERENCES

Wood, Patel & Associates, Inc. and CH2M Hill, *Maryvale Area Drainage Master Study - Hydrology,* Flood Control District of Maricopa County, February 1997.

Camp Dresser and McKee Inc. and James M. Montgomery Consulting Engineers, Inc., *Glendale-Peoria Area Drainage Master Plan*, Flood Control District of Maricopa County, May 1987.

Coe and Van Loo Consultants, Inc., *Maryvale Area, Flooding Mitigation Project, Phase I, FCD #93-34, Pre-Design Report,* Flood Control District of Maricopa County, January 1996.

Flood Control District of Maricopa County, *Flood Control Survey Report*, 1962

Flood Control District of Maricopa County, *Comprehensive Flood Control Program Report,* 1963.

Hydrologic Engineering Center (HEC), *HEC-1 Flood Hydrograph Package, User's Manual*, US Army Corps of Engineers, September 1990.

Lee L.L., Note from L.L. Lee to Mr. H.J. Lawson Regarding the *Desert Flood of August 3, 1943*, August 28, 1943.

Stanley Franzoy Corey (60th Avenue to the Agua Fria Freeway), Flood Control District of Maricopa County, June 1992.

WLB Group, Inc., *Offsite Drainage Concept Study, Part A - Offsite Hydrology, Outer Loop Highway (Buckeye Road to Northern Avenue*, Prepared for the Arizona Department of Transportation, Revised December 1987.

Wood, Patel & Associates, *Northern/Orangewood Storm Drain Project: Concept/Routing Study: FCD #94-12*, March 1996, Flood Control District of Maricopa County.

Boyle Engineering Corp., July, 1998, *Olive Avenue Storm Drain, 60th Avenue to the Outer Loop Freeway, Detention Basin Alternatives.*

Flood Control District of Maricopa County, June 1, 1992. *Hydrologic Design Manual for Maricopa County.*

Kenney Aerial Mapping, Inc., 1991. *Topographic Maps*, Scale 1" = 400', contour interval = 2 feet; prepared for Arizona Canal Diversion Channel Area Drainage Master Study, Phase I.

Kenney Aerial Mapping, Inc., 1994. *Topographic Maps*, Scale 1" = 200' contour interval = 2 feet.

Camp, Dresser & McKee, Inc., *Glendale-Peoria Area Drainage Master Plan*, May 1987.

City of Phoenix, *Stormwater Flooding Report*, July 23 and 24, 1994.

Flood Control District of Maricopa County, *After Action Report-Flash Flood of July 23-24, 1992.*

Flood Control District of Maricopa County, *Drainage Design Manual of Maricopa County, Arizona, Volume II - Hydraulics,* November 1991.

Flood Control District of Maricopa County, *Maryvale-Flooding History*, August 1987.

Flood Control District of Maricopa County, *Maryvale Area Flooding Mitigation Project, Scope of Work - Contract FCD 93-34*, March 9, 1995.

Evans, Parker, *The Erosion of Buried Cables*, Dayton, Ohio, Ohio Bell Telephone Company, 1970.

APPENDICES

APPENDIX A

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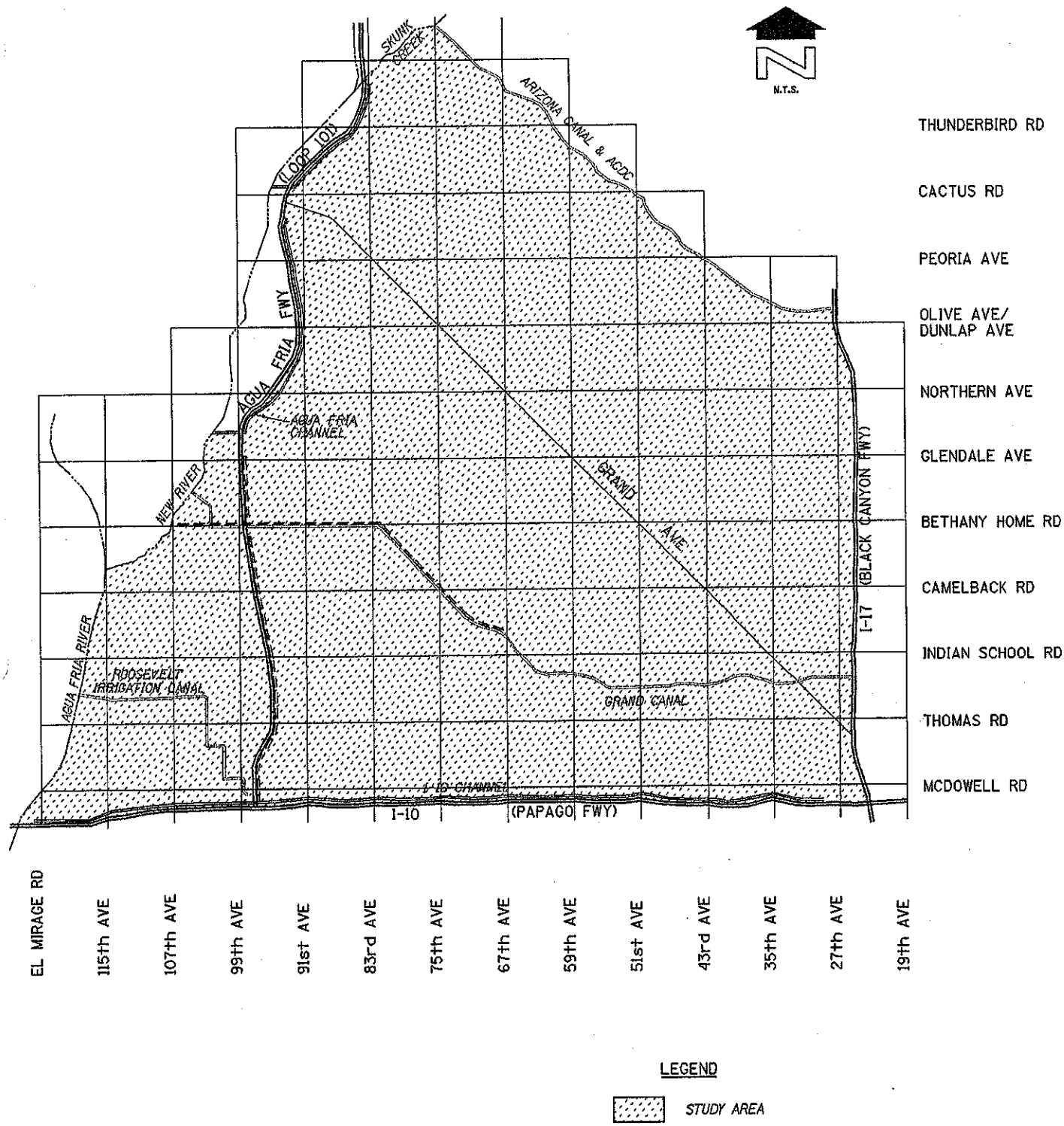

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

STUDY AREA MAP

MARYVALE AREA DRAINAGE MASTER STUDY

FIGURE 1

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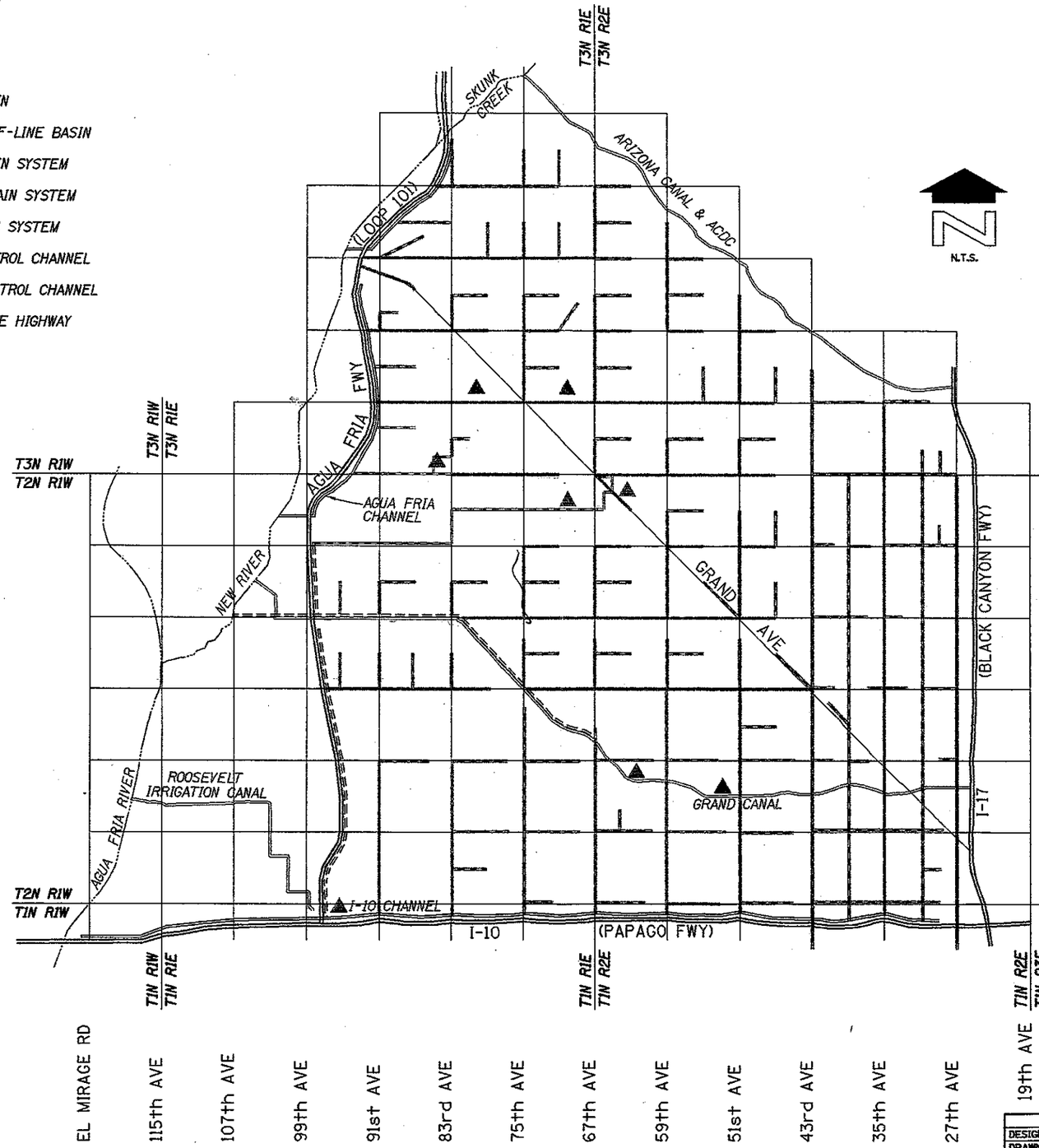
LEGEND

- EXISTING SURGE BASIN
- PROPOSED SURGE/OFF-LINE BASIN
- EXISTING STORM DRAIN SYSTEM
- PROPOSED STORM DRAIN SYSTEM
- FUTURE STORM DRAIN SYSTEM
- EXISTING FLOOD CONTROL CHANNEL
- PROPOSED FLOOD CONTROL CHANNEL
- INTERSTATE OR STATE HIGHWAY



N.T.S.

THUNDERBIRD RD

CACTUS RD

PEORIA AVE

OLIVE AVE/DUNLAP AVE

NORTHERN AVE

GLENDALE AVE

BETHANY HOME RD

CAMELBACK RD

INDIAN SCHOOL RD

THOMAS RD

MCDOWELL RD

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

EXISTING & PROPOSED
STORM DRAIN FACILITIES

MARYVALE AREA DRAINAGE MASTER STUDY

FIGURE 2

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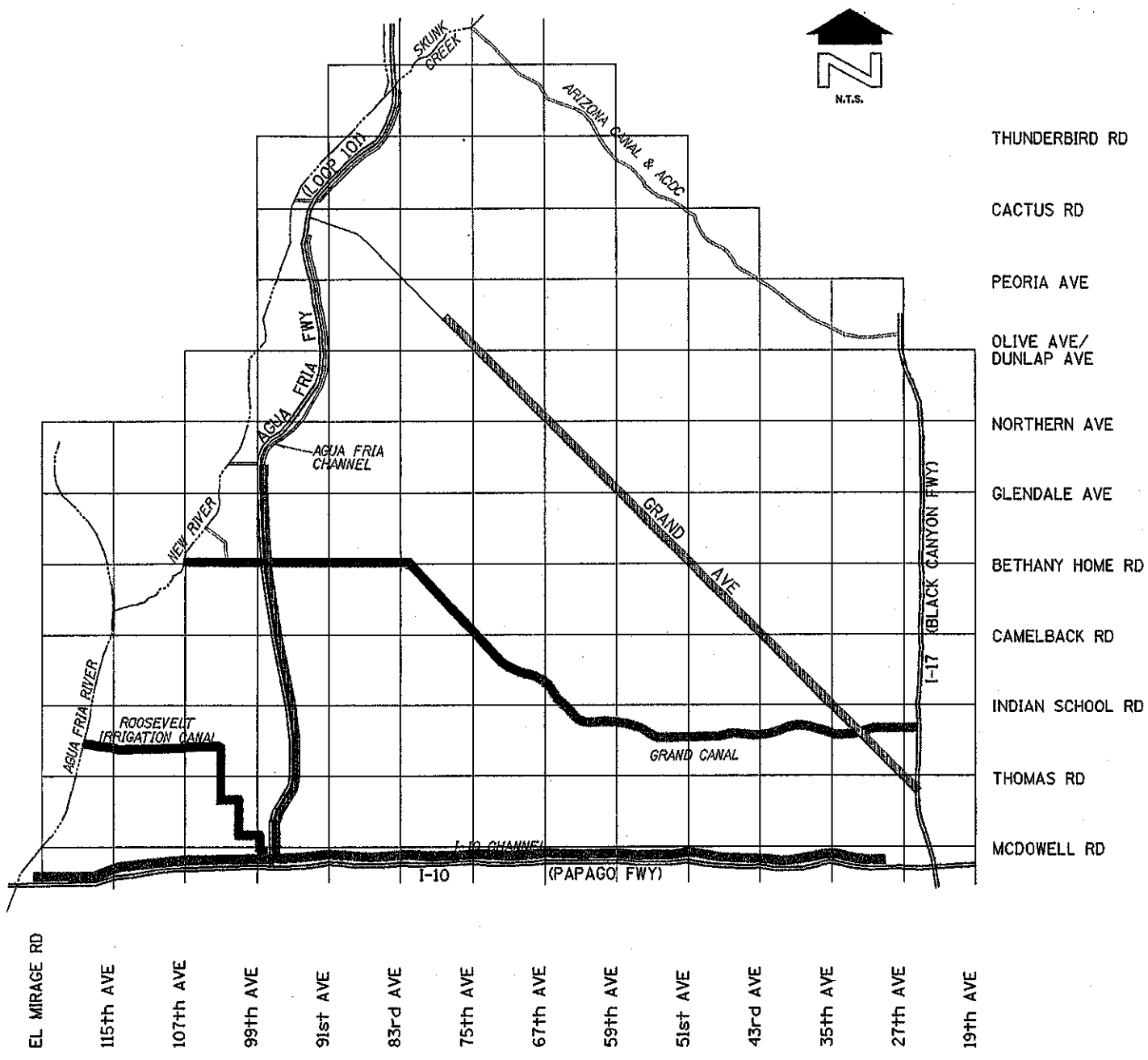

LEGEND

- STUDY LOCATION
- EXISTING FLOOD CONTROL CHANNEL
- PROPOSED FLOOD CONTROL CHANNEL
- INTERSTATE OR STATE HIGHWAY

	NAME	DATE
DESIGN	J. MOODY	9/97
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOODPLAIN MITIGATION
STUDY LOCATIONS

MARYVALE AREA DRAINAGE MASTER STUDY | FIGURE 3

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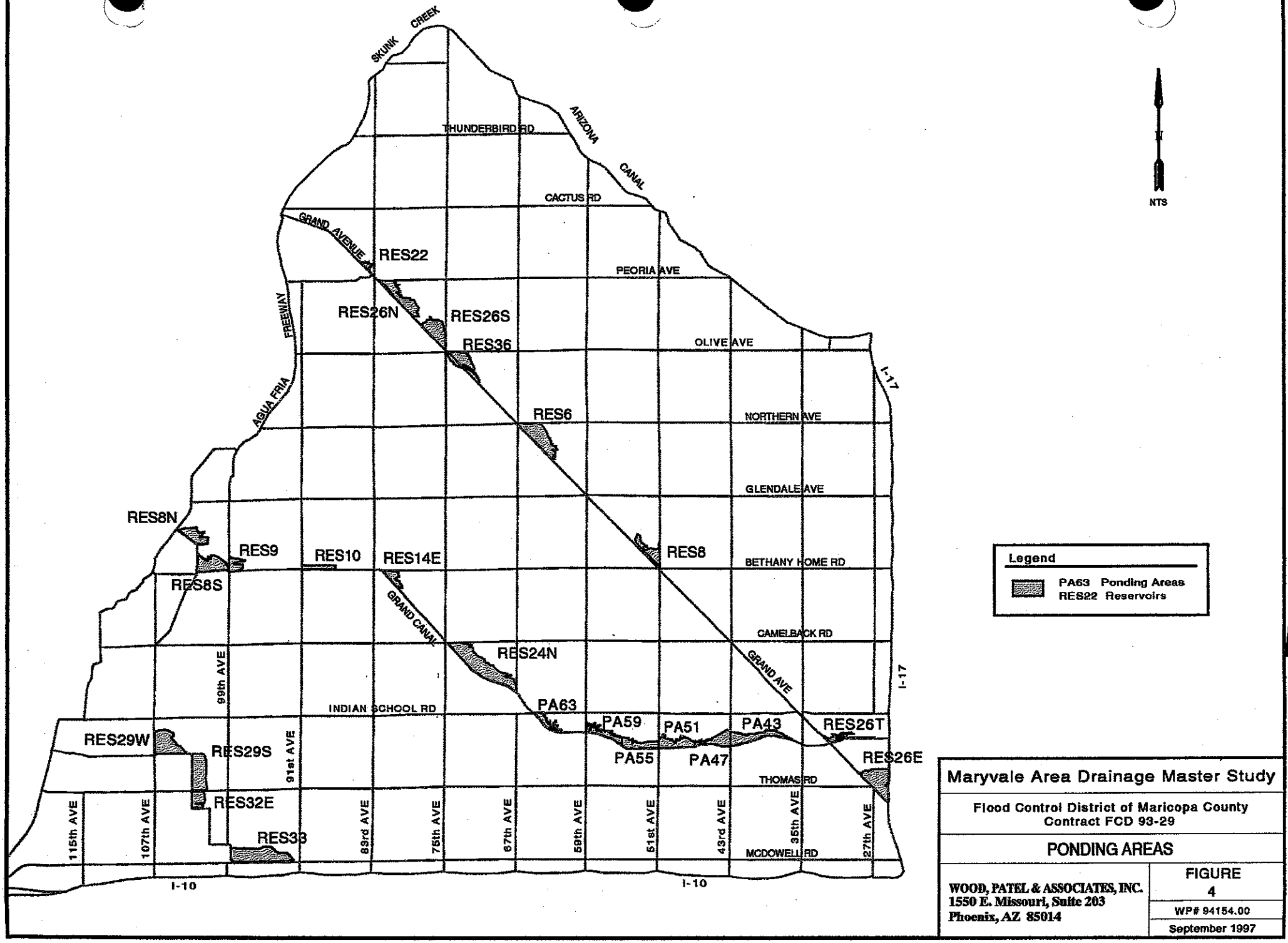

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS

WOOD, PATEL & ASSOCIATES, INC.
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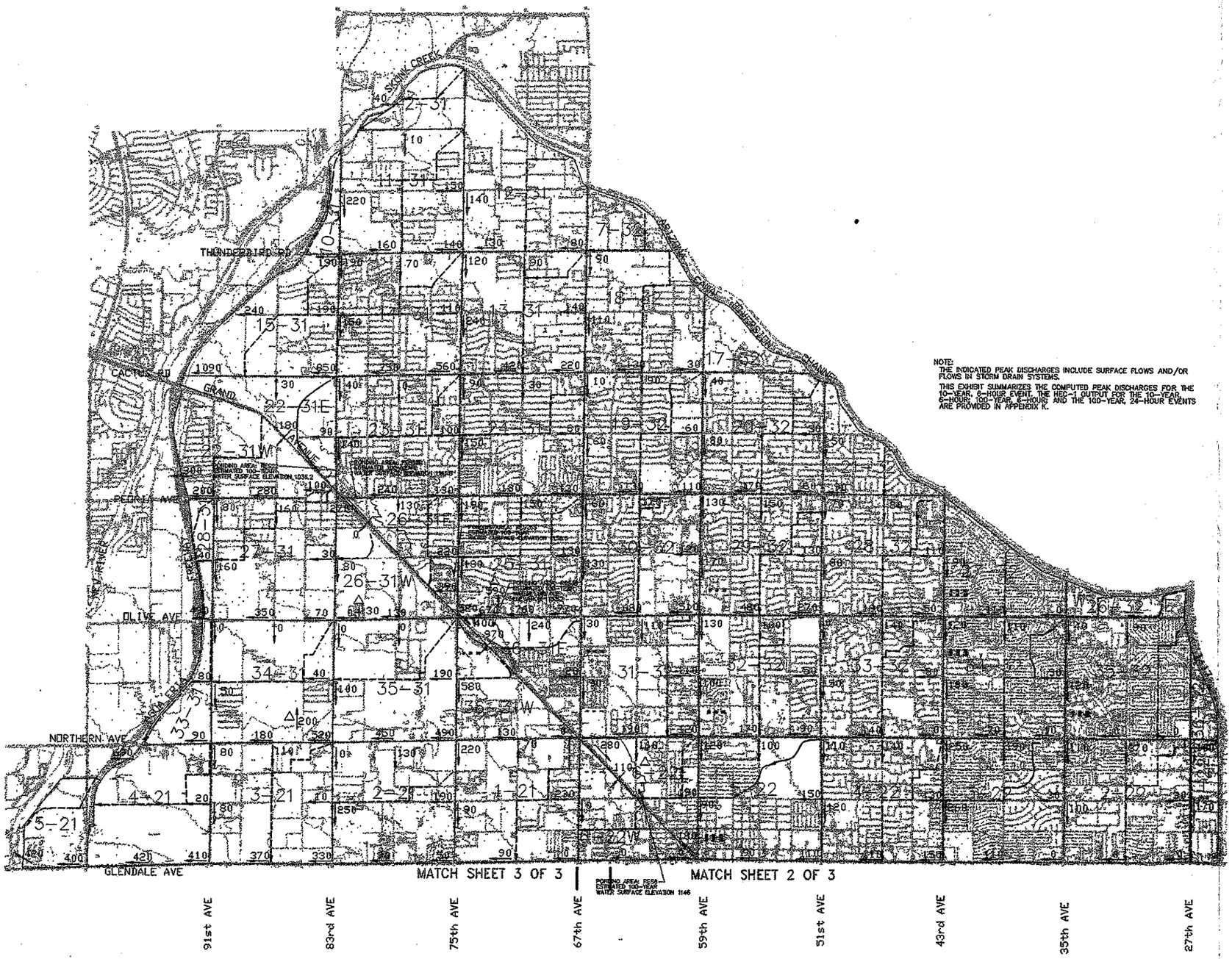
FIGURE 4

WP# 94154.00

September 1997



NOTE:
THE INDICATED PEAK DISCHARGES INCLUDE SURFACE FLOWS AND/OR FLOWS IN STORM DRAIN SYSTEMS.

THIS EXHIBIT SUMMARIZES THE COMPUTED PEAK DISCHARGES FOR THE 10-YEAR, 6-HOUR EVENT. THE HEC-1 OUTPUT FOR THE 10-YEAR, 6-HOUR, 100-YEAR, 6-HOUR, AND THE 100-YEAR, 24-HOUR EVENTS ARE PROVIDED IN APPENDIX K.

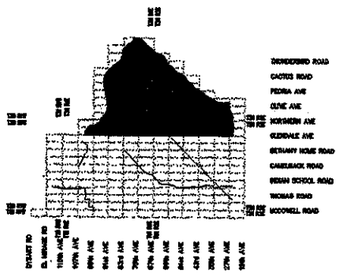
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE
AREA DRAINAGE MASTER STUDY
"FCD CONTRACT # 93-29"

LEGEND

- ROAD/PAVEMENT
- RAILROAD
- 1110 INDEX CONTOUR
- 15-32 DRAINAGE SUB-BASIN BOUNDARY
- 15-32 SUB-BASIN I.D. NO.
- 100 COMPUTED PEAK DISCHARGE 10-YEAR 6-HOUR EVENT
- SURGE BASIN
- PONDING AREA

INDEX MAP



0 2000' 4000' 6000'
SCALE: 1" = 2000'

FIGURE 5
SUMMARY OF COMPUTED PEAK DISCHARGES: 10-YEAR 6-HOUR EVENT

CH2MHILL | WOOD / PATEL

	BY	DATE
DESIGN	-	-
DESIGN CHK.	-	-
PLANS	-	-
PLANS CHK.	DMD	OCT 96

SUBMITTED BY: DATE: OCT 96

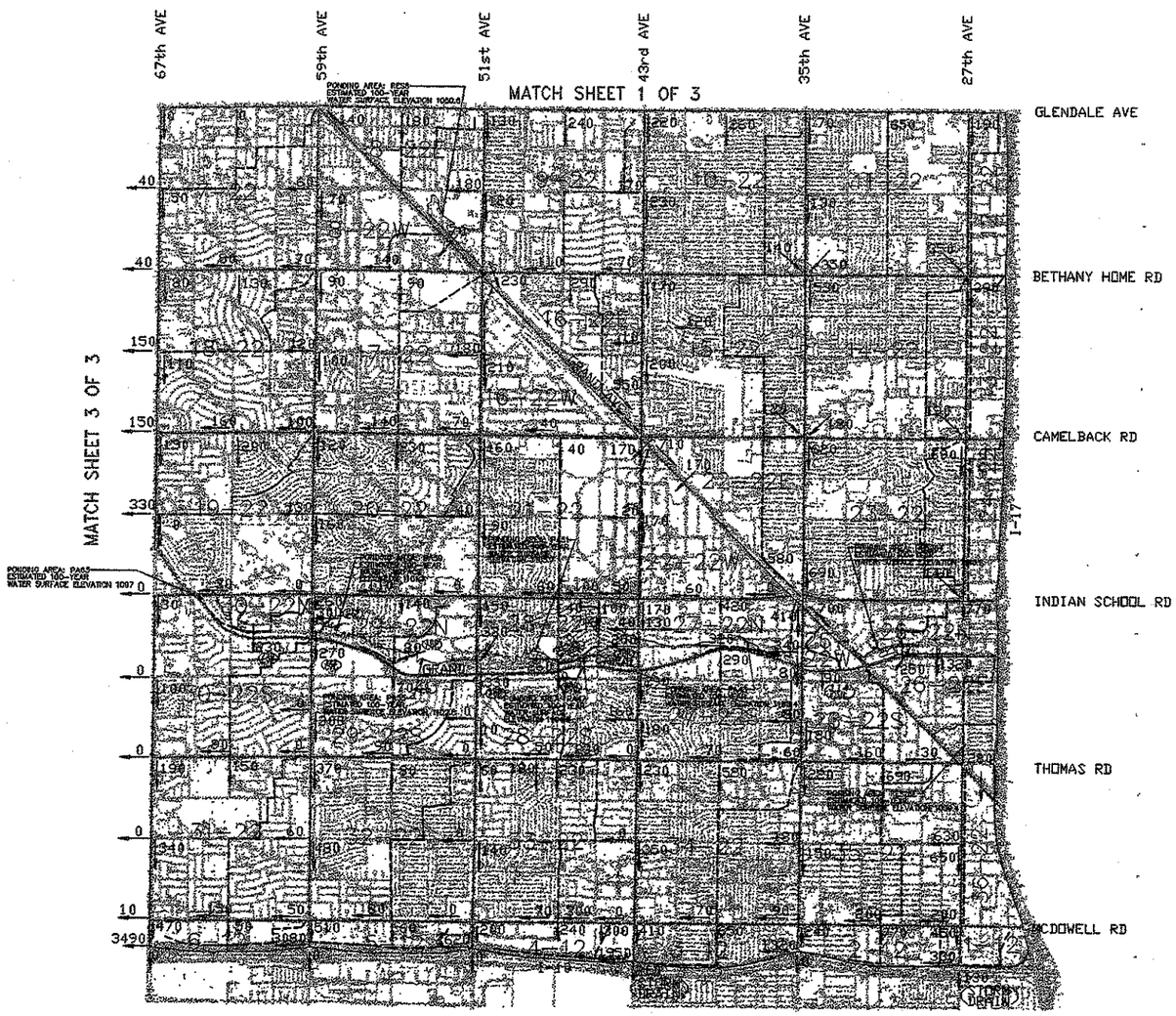
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3



NOTE:
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THIS EXHIBIT SUMMARIZES THE COMPUTED PEAK DISCHARGES FOR THE 10-YEAR, 6-HOUR EVENT. THE HEC-1 OUTPUT FOR THE 10-YEAR, 6-HOUR; 100-YEAR, 6-HOUR; AND THE 100-YEAR, 24-HOUR EVENTS ARE PROVIDED IN APPENDIX K.

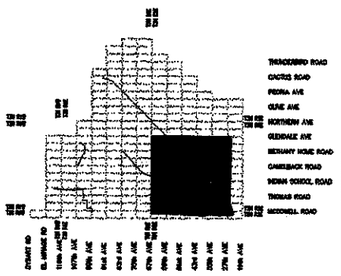
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE
AREA DRAINAGE MASTER STUDY
"FCD CONTRACT # 93-29"

LEGEND

- ROAD/PAVEMENT
- RAILROAD
- 1110 INDEX CONTOUR
- 16-32 DRAINAGE SUB-BASIN BOUNDARY
- 16-32 SUB-BASIN I.D. NO.
- 100 COMPUTED PEAK DISCHARGE 10-YEAR 6-HOUR EVENT
- PONDING AREA

INDEX MAP



N

0 2000' 4000' 6000'
SCALE: 1" = 2000'

FIGURE 5
SUMMARY OF COMPUTED PEAK DISCHARGES: 10-YEAR 6-HOUR EVENT

CH2MHILL | WOOD / PATEL

	BY	DATE
DESIGN	--	--
DESIGN CHK.	--	--
PLANS	--	--
PLANS CHK.	DWD	OCT 96

SUBMITTED BY: DATE: OCT 96

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

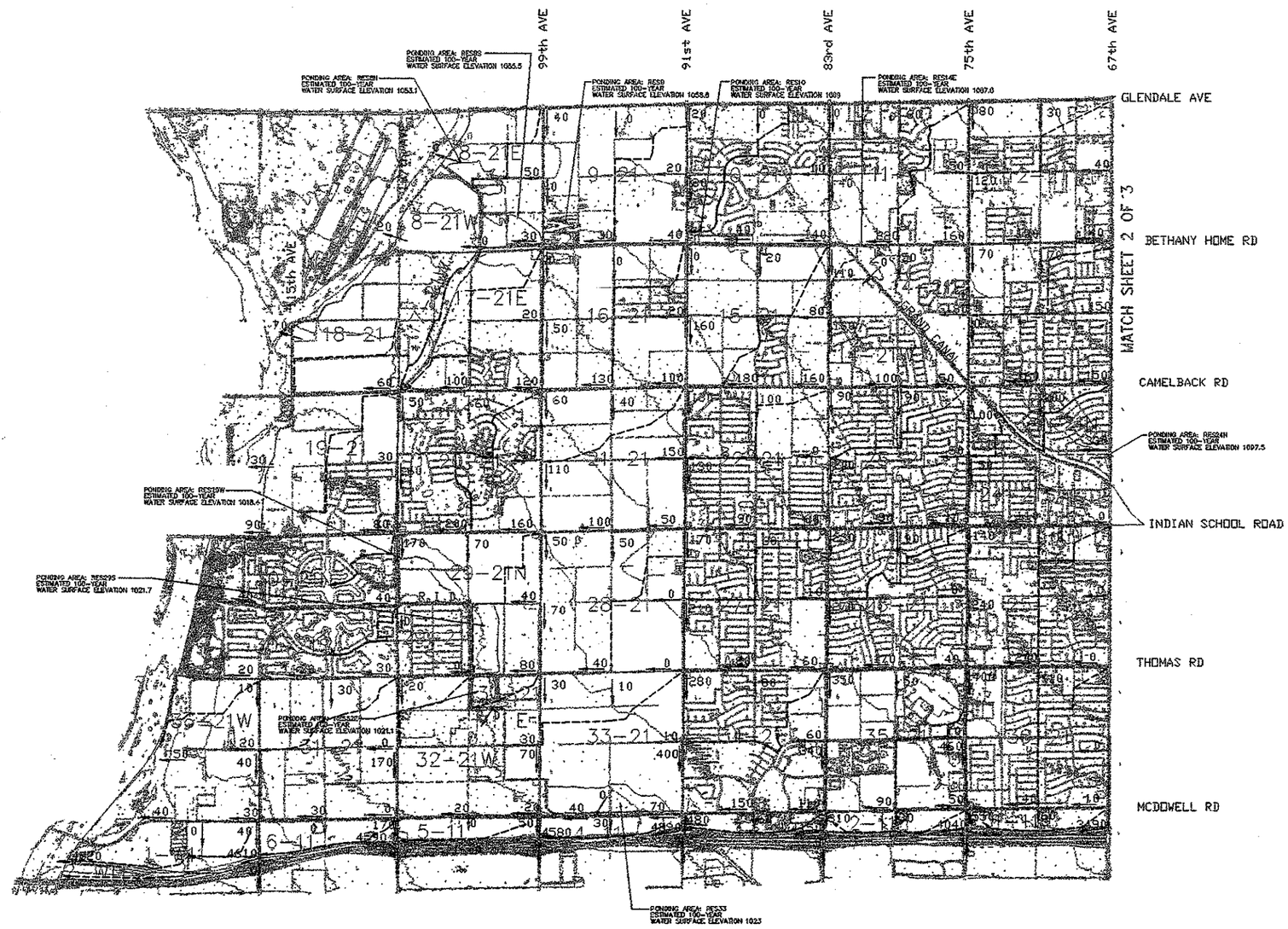
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 2 OF 3

MATCH SHEET 1 OF 3



NOTE:
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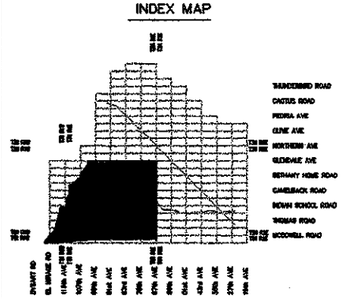
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE
AREA DRAINAGE MASTER STUDY
"FCD CONTRACT # 93-29"

LEGEND

- ROAD/PAVEMENT
- RAILROAD
- INDEX CONTOUR
- 16-32 DRAINAGE SUB-BASIN BOUNDARY
- 16-32 SUB-BASIN I.D. NO.
- 100 COMPUTED PEAK DISCHARGE 10-YEAR 6-HOUR EVENT
- PONDING AREA

INDEX MAP



N

0 2000' 4000' 6000'
SCALE: 1" = 2000'

FIGURE 5
SUMMARY OF COMPUTED PEAK DISCHARGES: 10-YEAR 6-HOUR EVENT

CH2MHILL | WOOD / PATEL

	BY	DATE
DESIGN	–	–
DESIGN CHK.	–	–
PLANS	–	–
PLANS CHK.	DWD	OCT 96

SUBMITTED BY: DATE: OCT 96

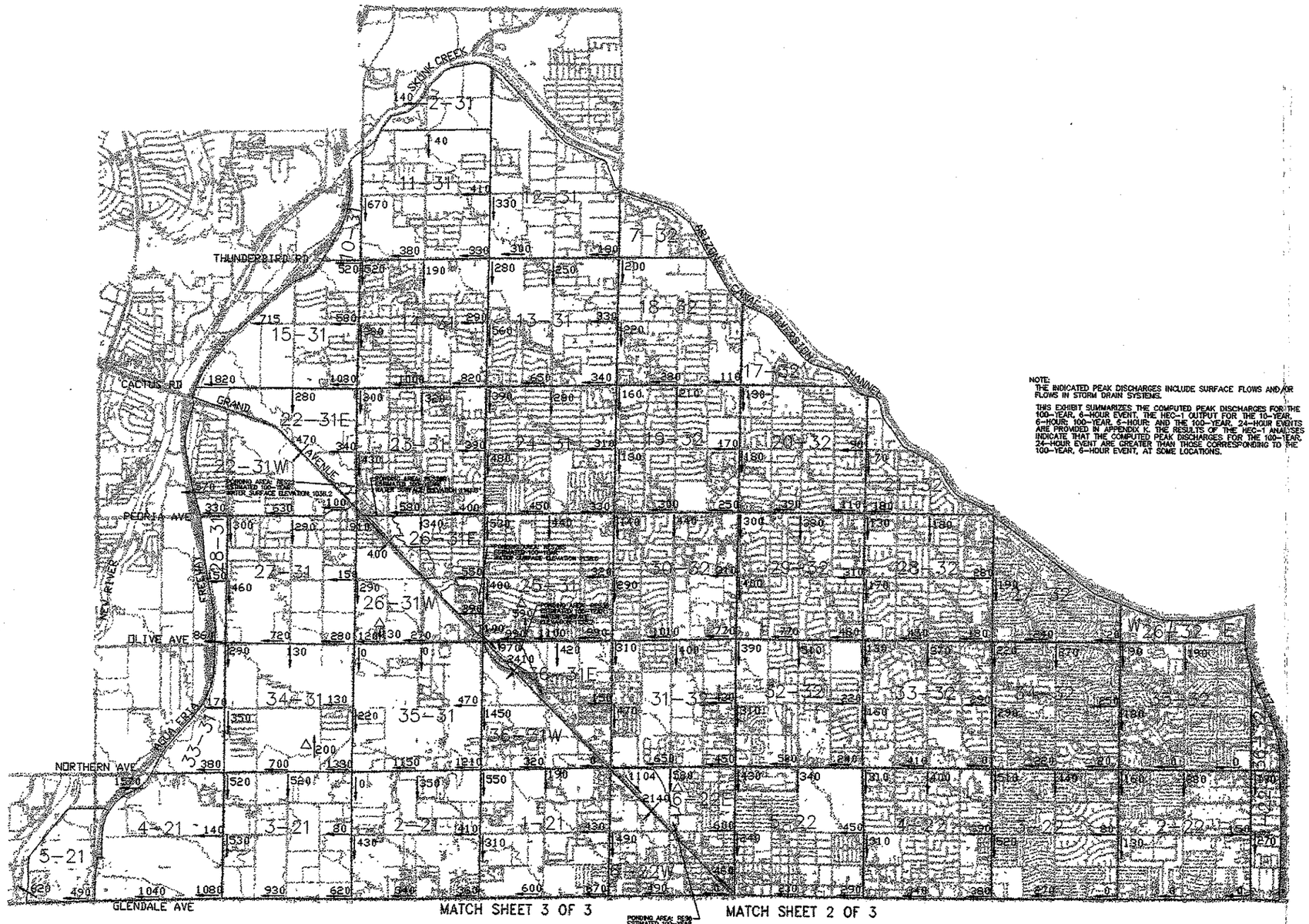
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3



NOTE:
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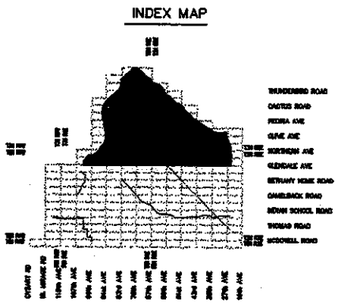
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE
AREA DRAINAGE MASTER STUDY
"FCD CONTRACT # 93-29"

LEGEND

- ROAD/PAVEMENT
- RAILROAD
- 1110 INDEX CONTOUR
- 16-32 DRAINAGE SUB-BASIN BOUNDARY
- 16-32 SUB-BASIN I.D. NO.
- 100 COMPUTED PEAK DISCHARGE 100-YEAR 6-HOUR EVENT
- SURGE BASIN
- PONDING AREA

INDEX MAP



N

0 2000' 4000' 8000'
SCALE: 1" = 2000'

FIGURE 6
SUMMARY OF COMPUTED PEAK DISCHARGES:
100-YEAR 6-HOUR EVENT

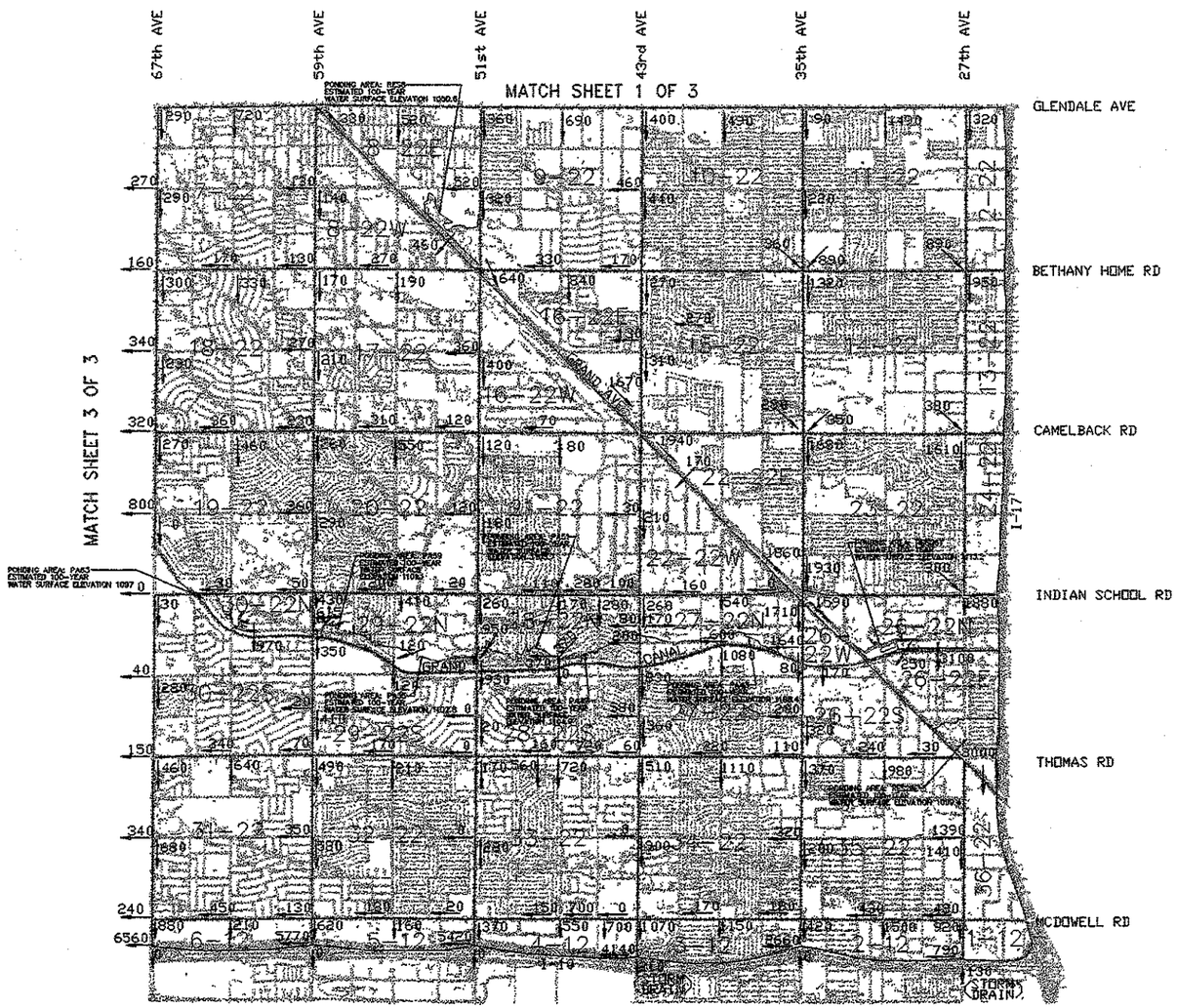
CH2MHILL | WOOD / PATEL

	BY	DATE
DESIGN	-	-
DESIGN CHK.	-	-
PLANS	-	-
PLANS CHK.	DWD	OCT 96

SUBMITTED BY:
DATE: OCT 96

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3



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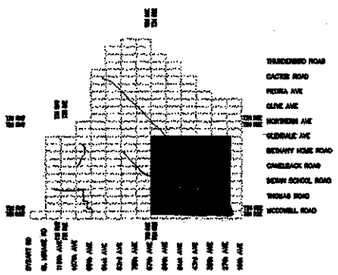
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE
AREA DRAINAGE MASTER STUDY
"FCD CONTRACT # 93-29"

LEGEND

- ROAD/PAVEMENT
- RAILROAD
- INDEX CONTOUR
- 16-32 DRAINAGE SUB-BASIN BOUNDARY
- 16-32 SUB-BASIN I.D. NO.
- 100 COMPUTED PEAK DISCHARGE 100-YEAR 6-HOUR EVENT
- PONDING AREA

INDEX MAP



N

0 2000' 4000' 6000'
SCALE: 1" = 2000'

FIGURE 6
SUMMARY OF COMPUTED PEAK DISCHARGES:
100-YEAR 6-HOUR EVENT

CH2MHILL | WOOD / PATEL

	BY	DATE
DESIGN	--	--
DESIGN CHK.	--	--
PLANS	--	--
PLANS CHK.	DWD	OCT 96
SUBMITTED BY:		DATE: OCT 96

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

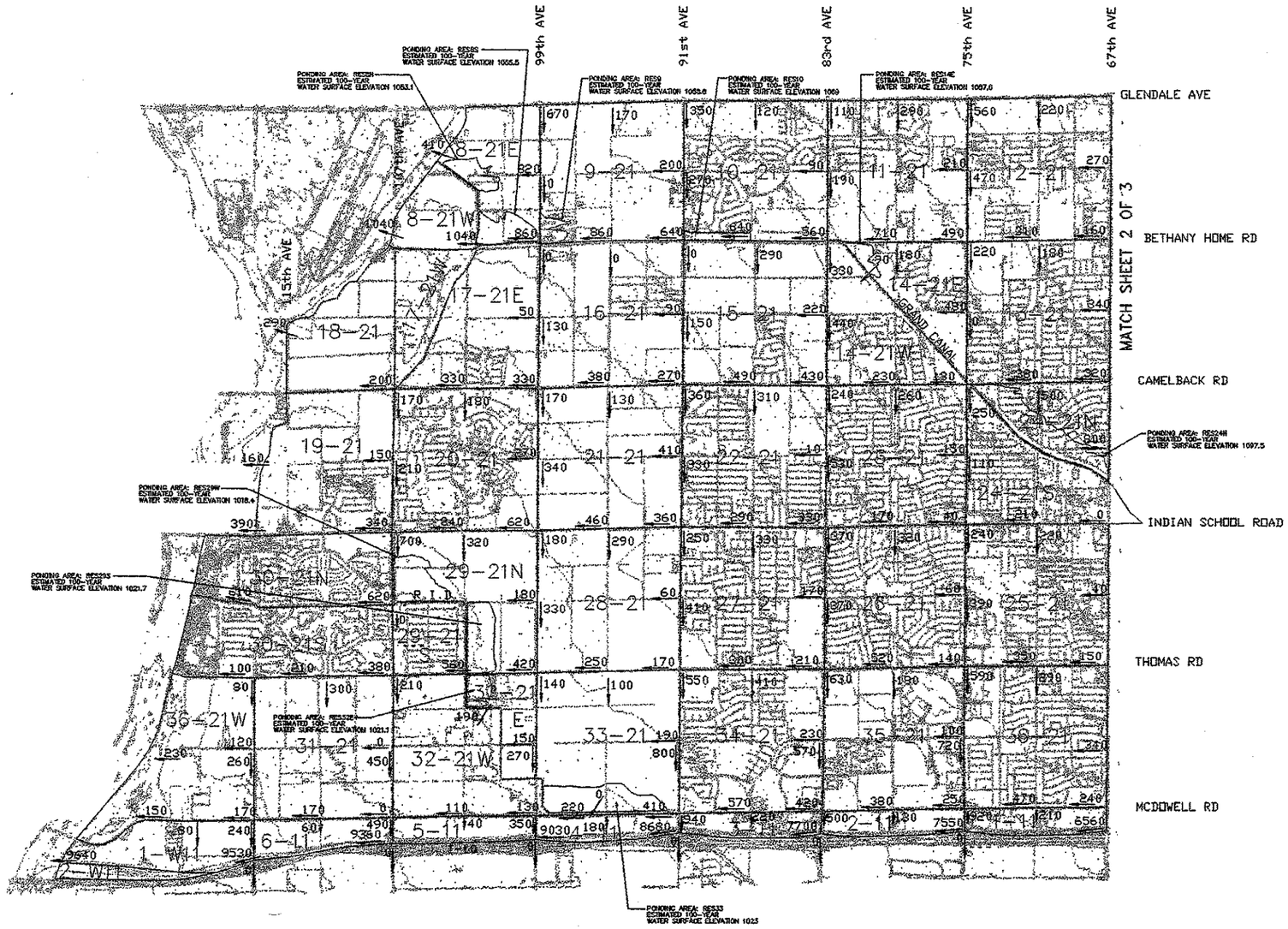
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 2 OF 3

MATCH SHEET 1 OF 3



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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE
AREA DRAINAGE MASTER STUDY
"FCD CONTRACT # 93-29"

LEGEND

- ROAD/PAVEMENT
- RAILROAD
- 1110 INDEX CONTOUR
- 15-32 DRAINAGE SUB-BASIN BOUNDARY
- 15-32 SUB-BASIN I.D. NO.
- 100 COMPUTED PEAK DISCHARGE 100-YEAR 6-HOUR EVENT
- PONDING AREA

INDEX MAP

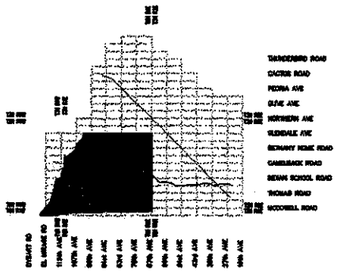


FIGURE 6
SUMMARY OF COMPUTED PEAK DISCHARGES:
100-YEAR 6-HOUR EVENT

CH2MHILL | WOOD / PATEL

	BY	DATE
DESIGN	--	--
DESIGN CHK.	--	--
PLANS	--	--
PLANS CHK.	DWD	OCT 96
SUBMITTED BY:		DATE: OCT 96

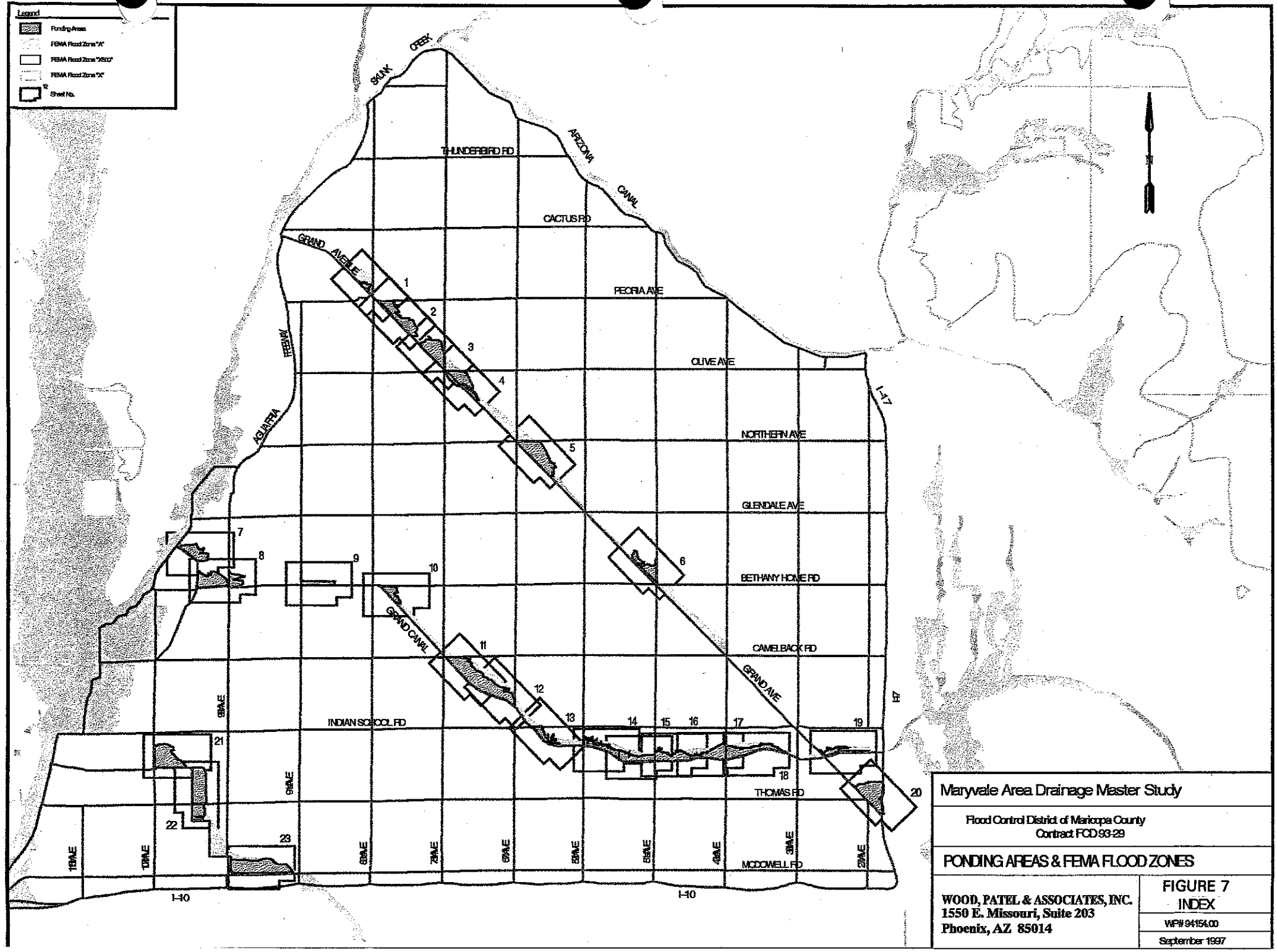
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3



Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
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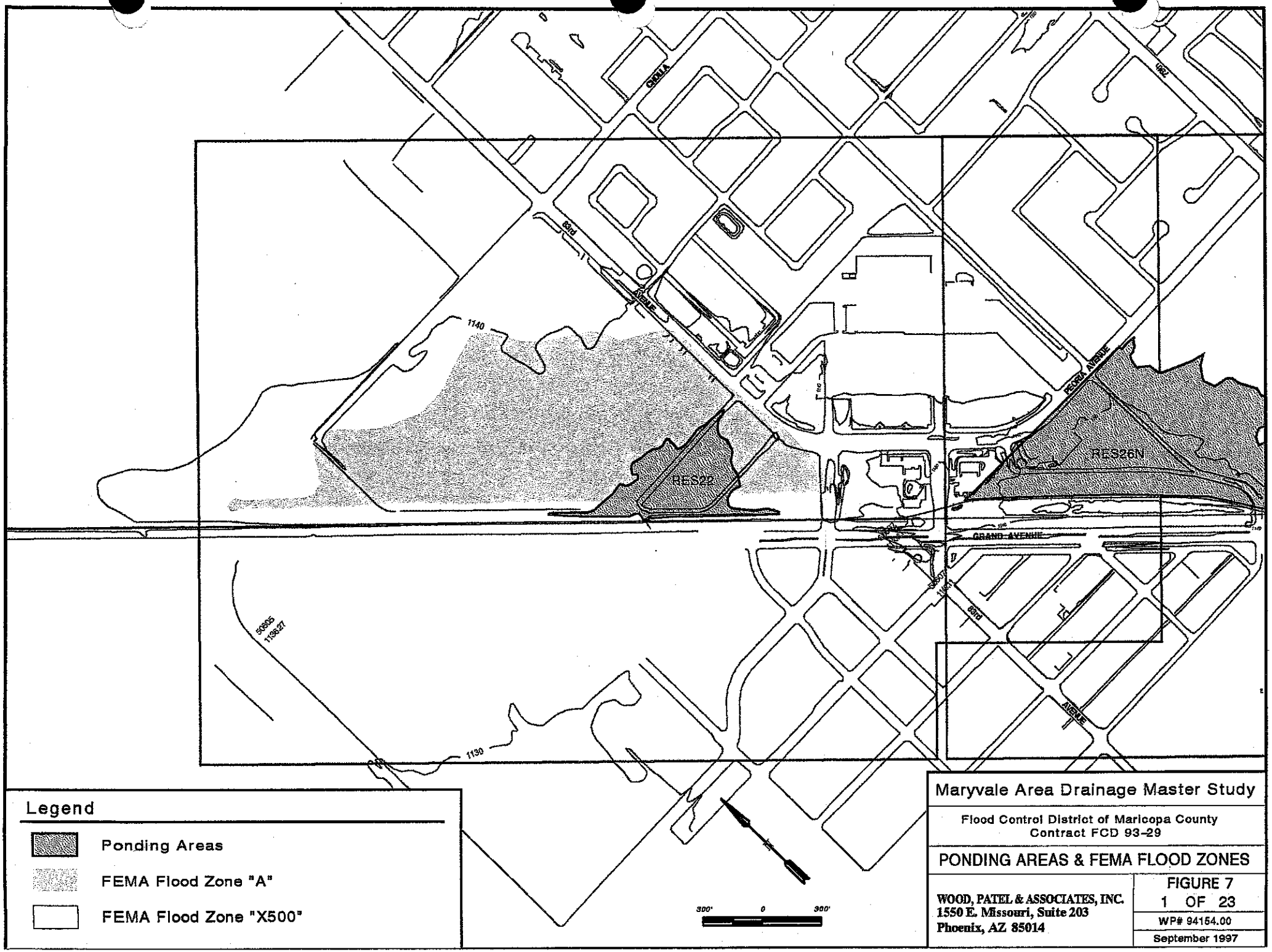

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
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Phoenix, AZ 85014

FIGURE 7
1 OF 23
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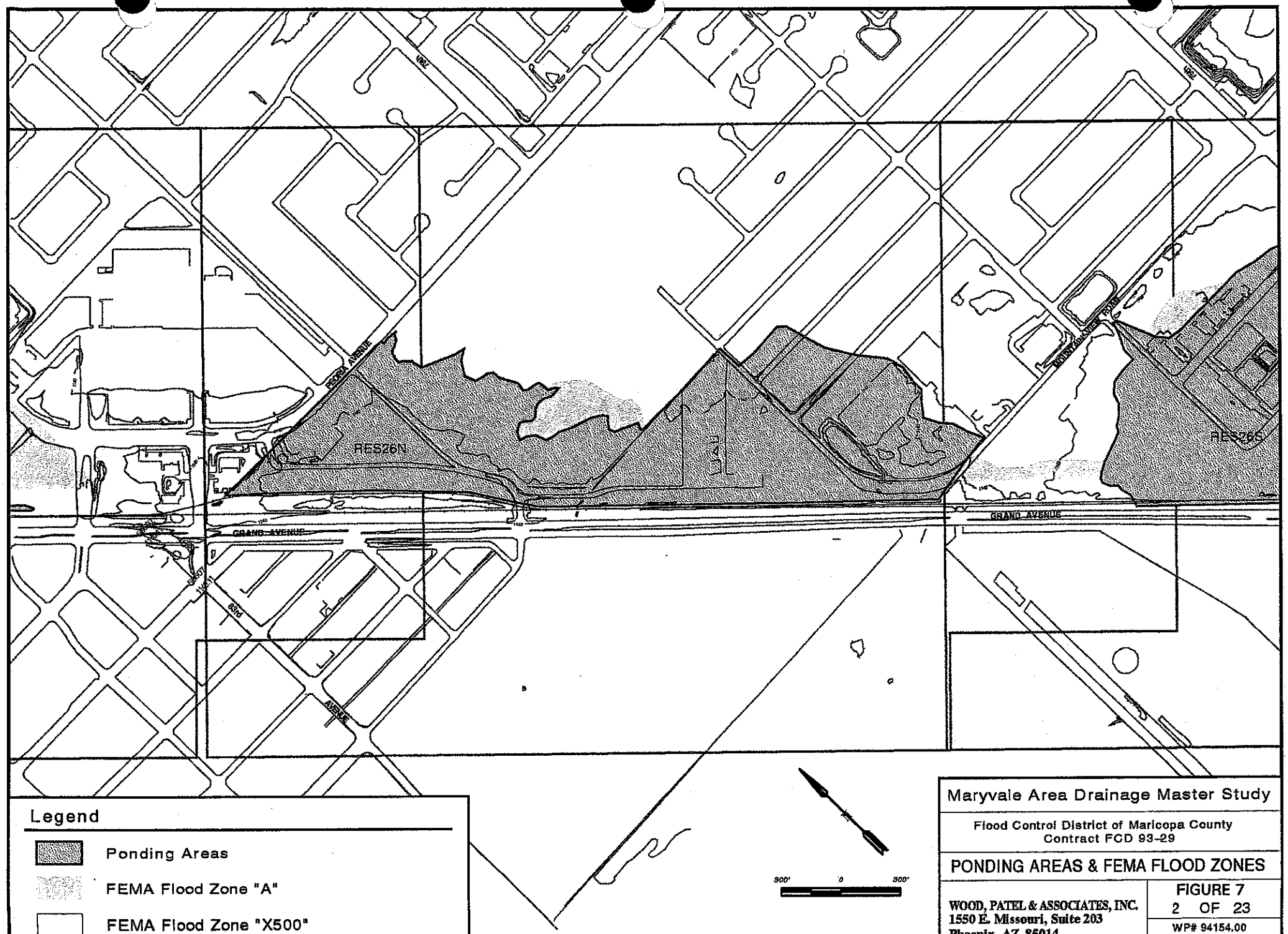

Legend

- Ponding Areas
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- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

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Phoenix, AZ 85014

FIGURE 7
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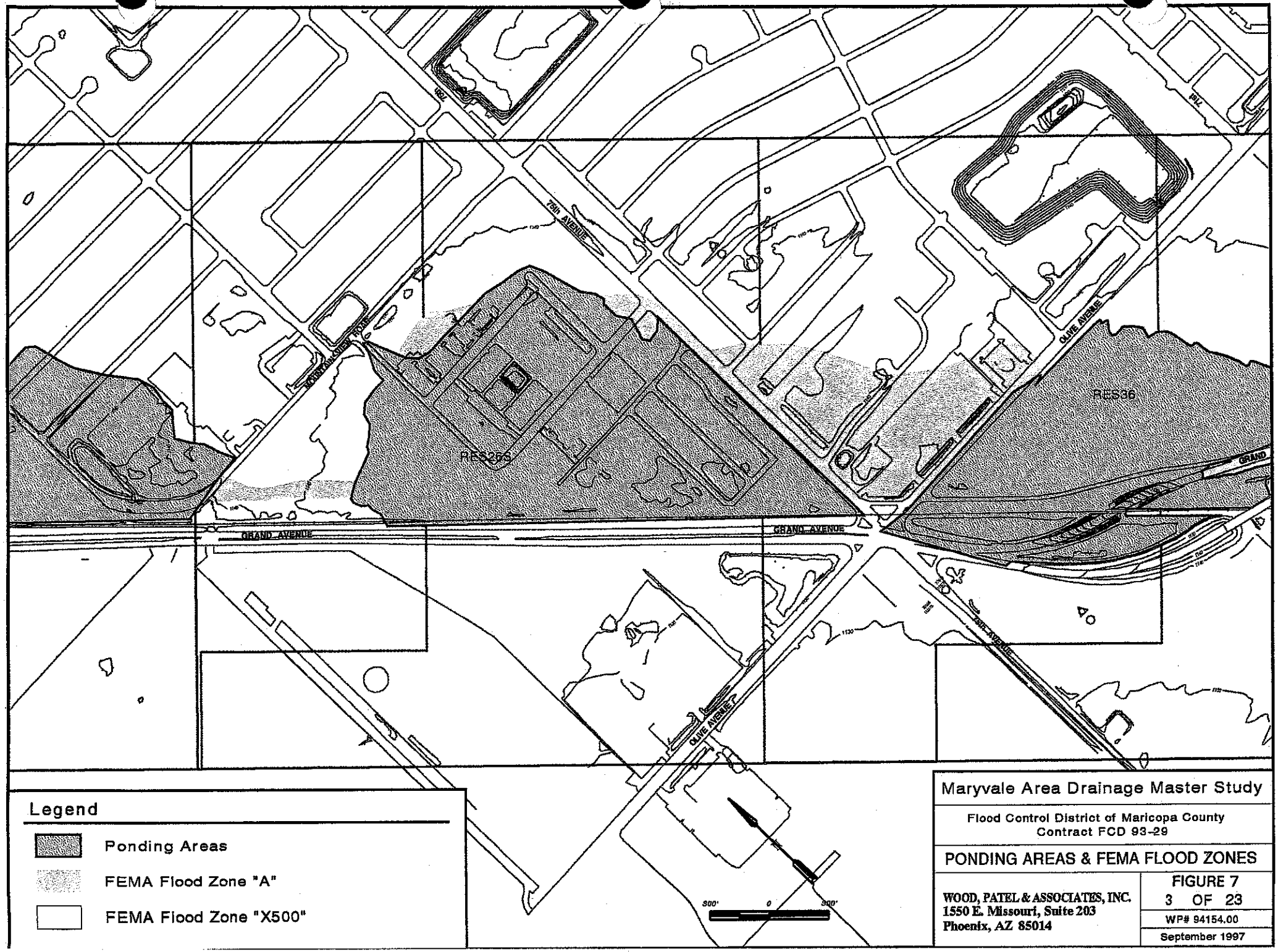

Legend

- Ponding Areas
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- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
3 OF 23
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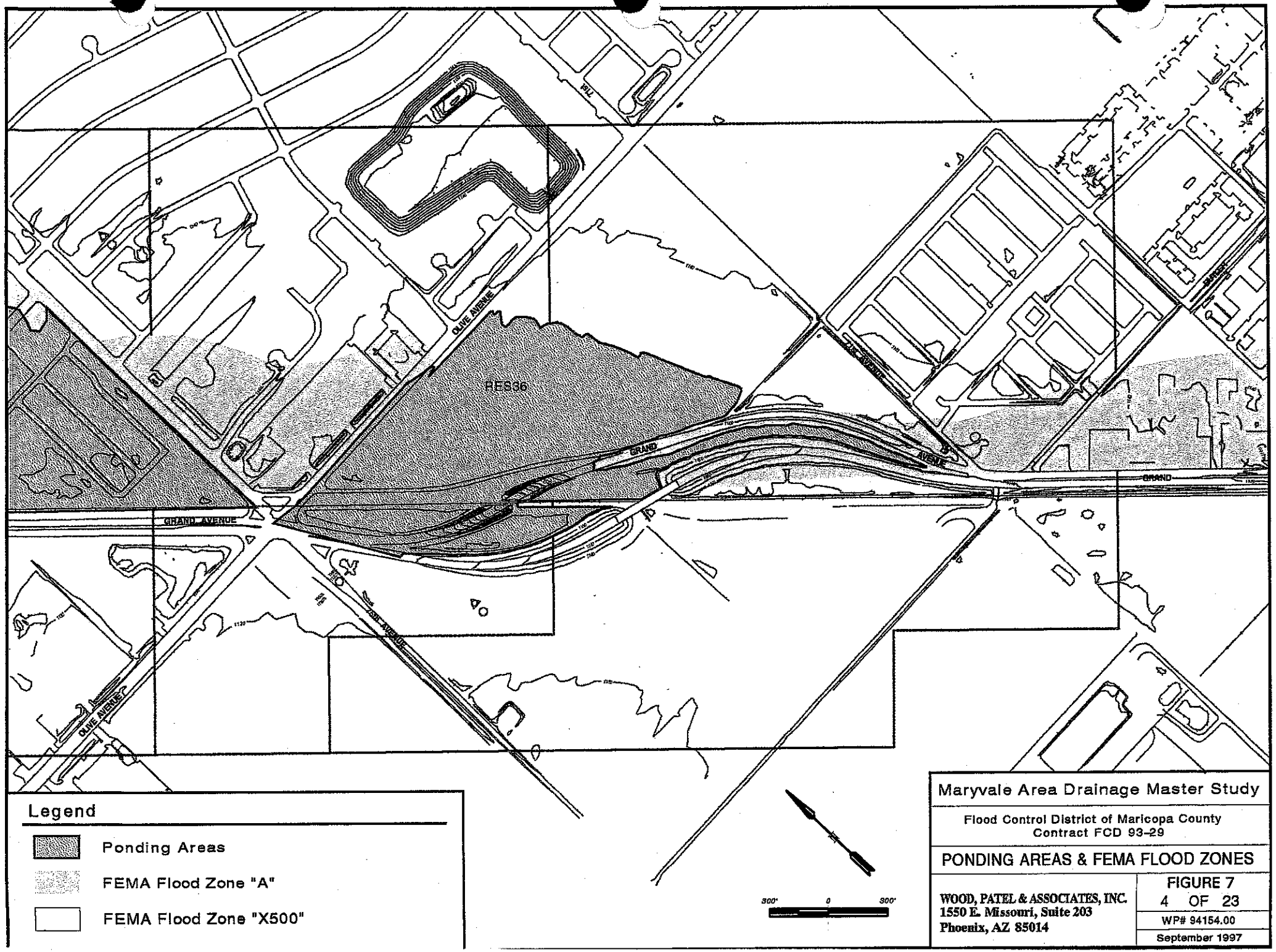
September 1997



Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
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Phoenix, AZ 85014

FIGURE 7
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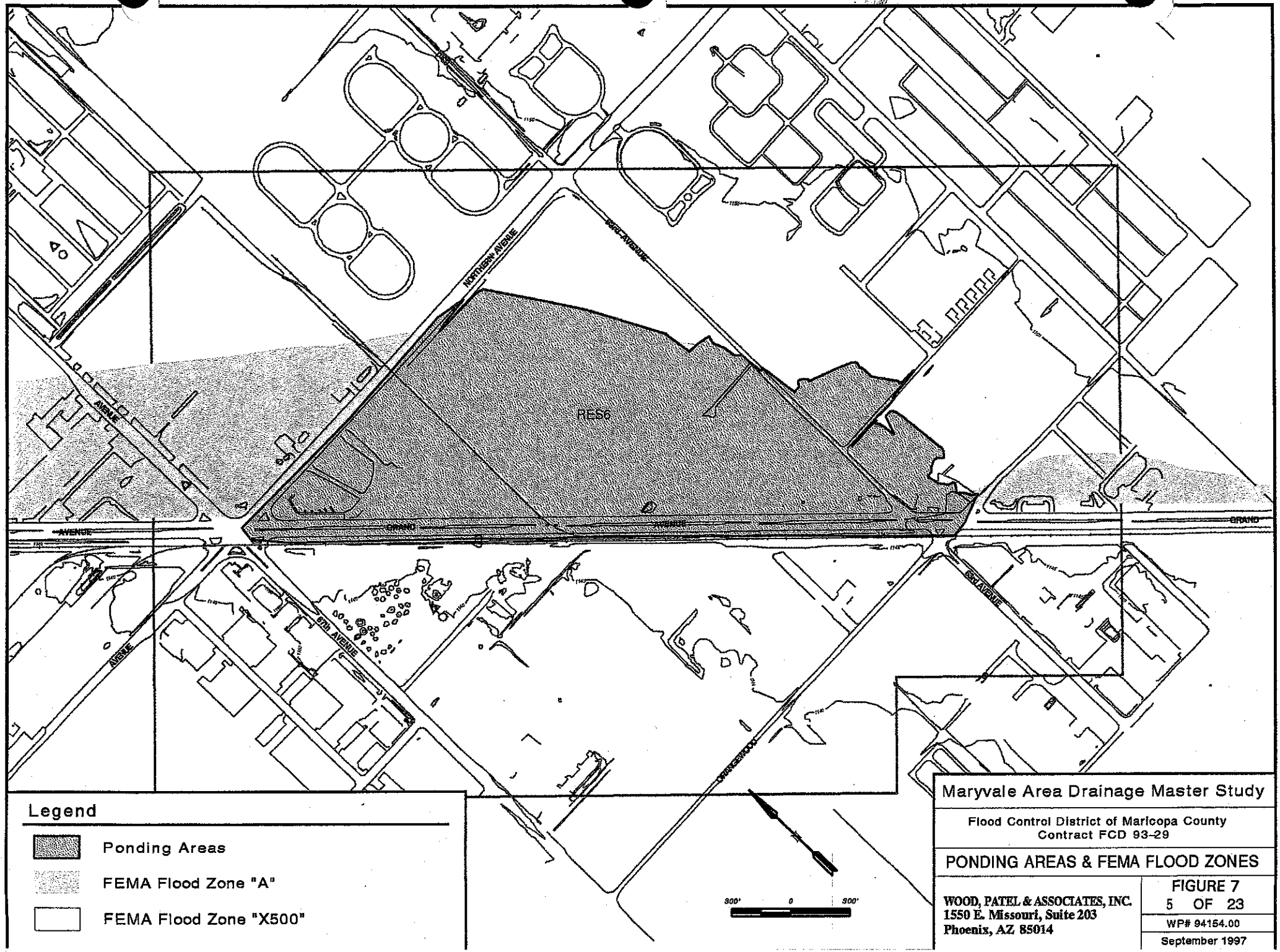

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

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Phoenix, AZ 85014

FIGURE 7
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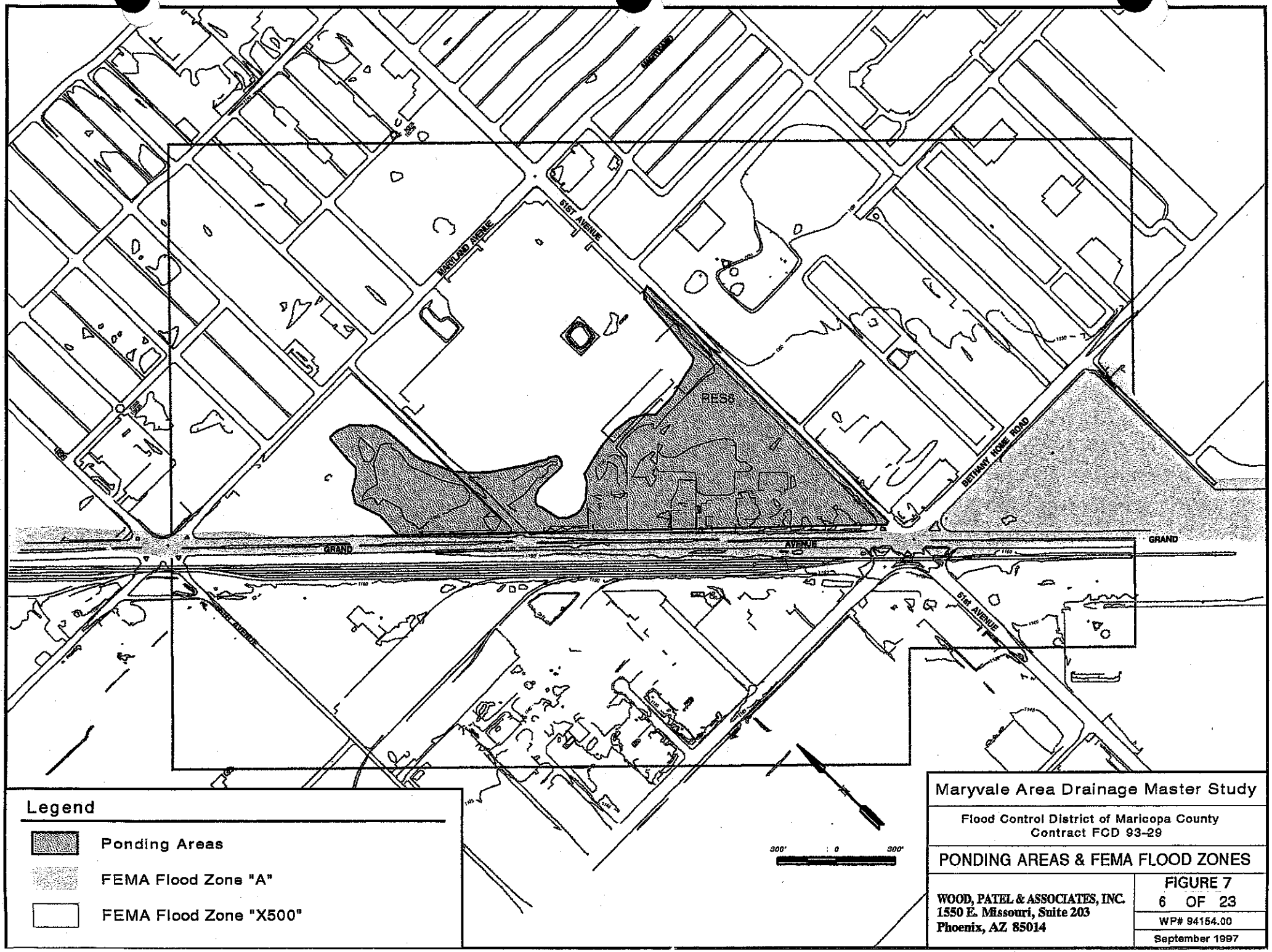

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
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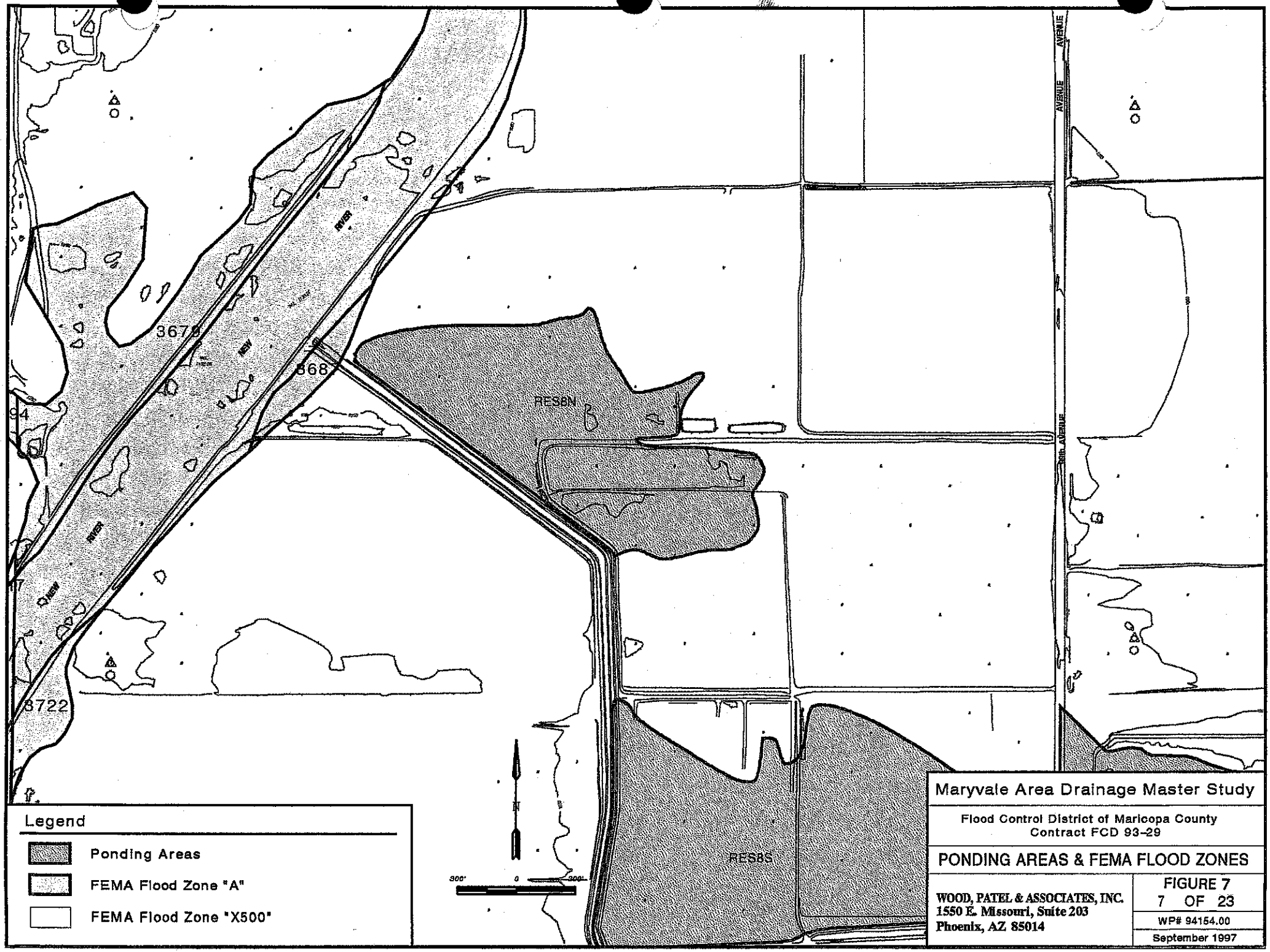

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

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Phoenix, AZ 85014

FIGURE 7
7 OF 23

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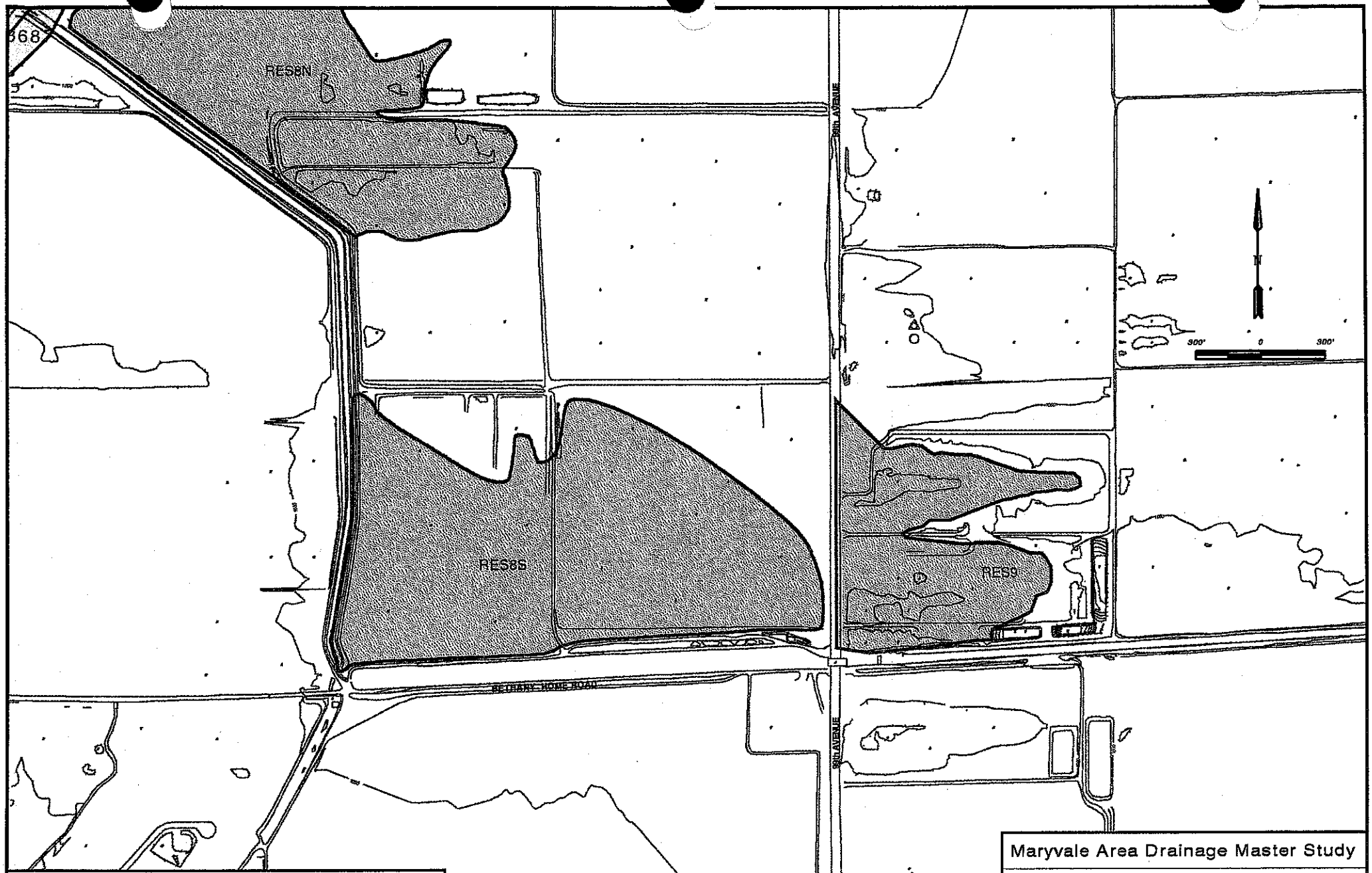

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

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Phoenix, AZ 85014

FIGURE 7
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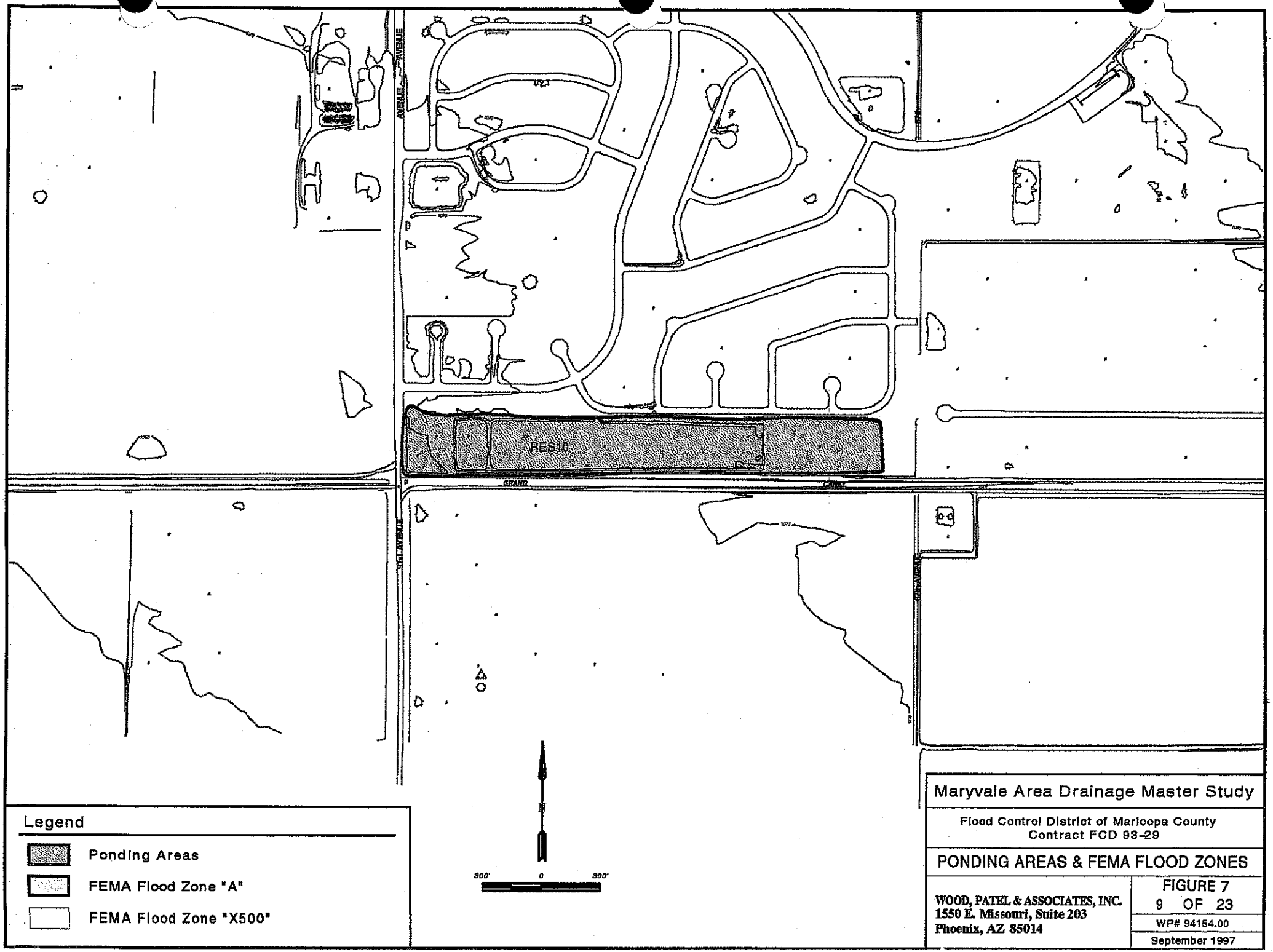

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
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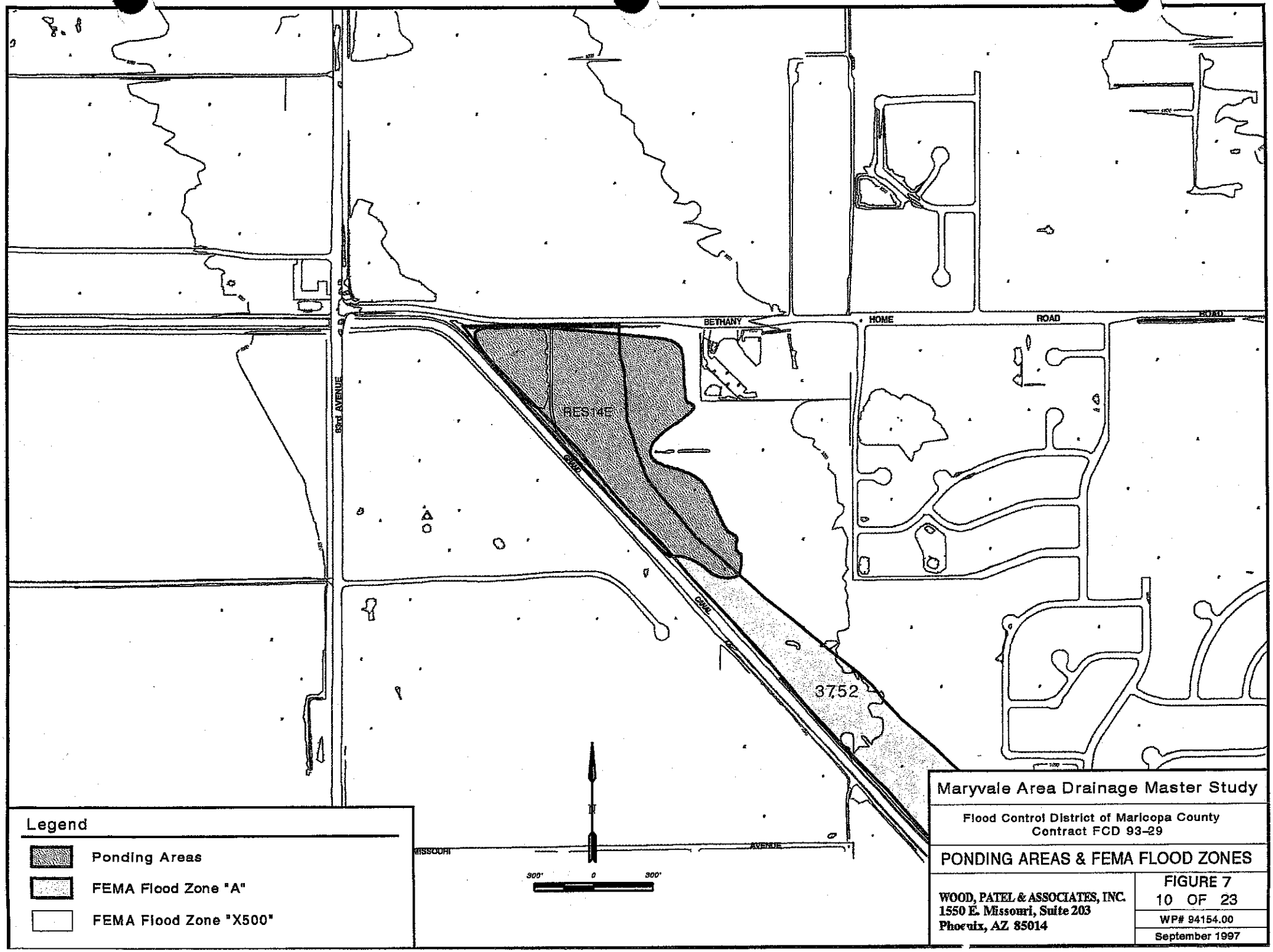

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
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Phoenix, AZ 85014

FIGURE 7
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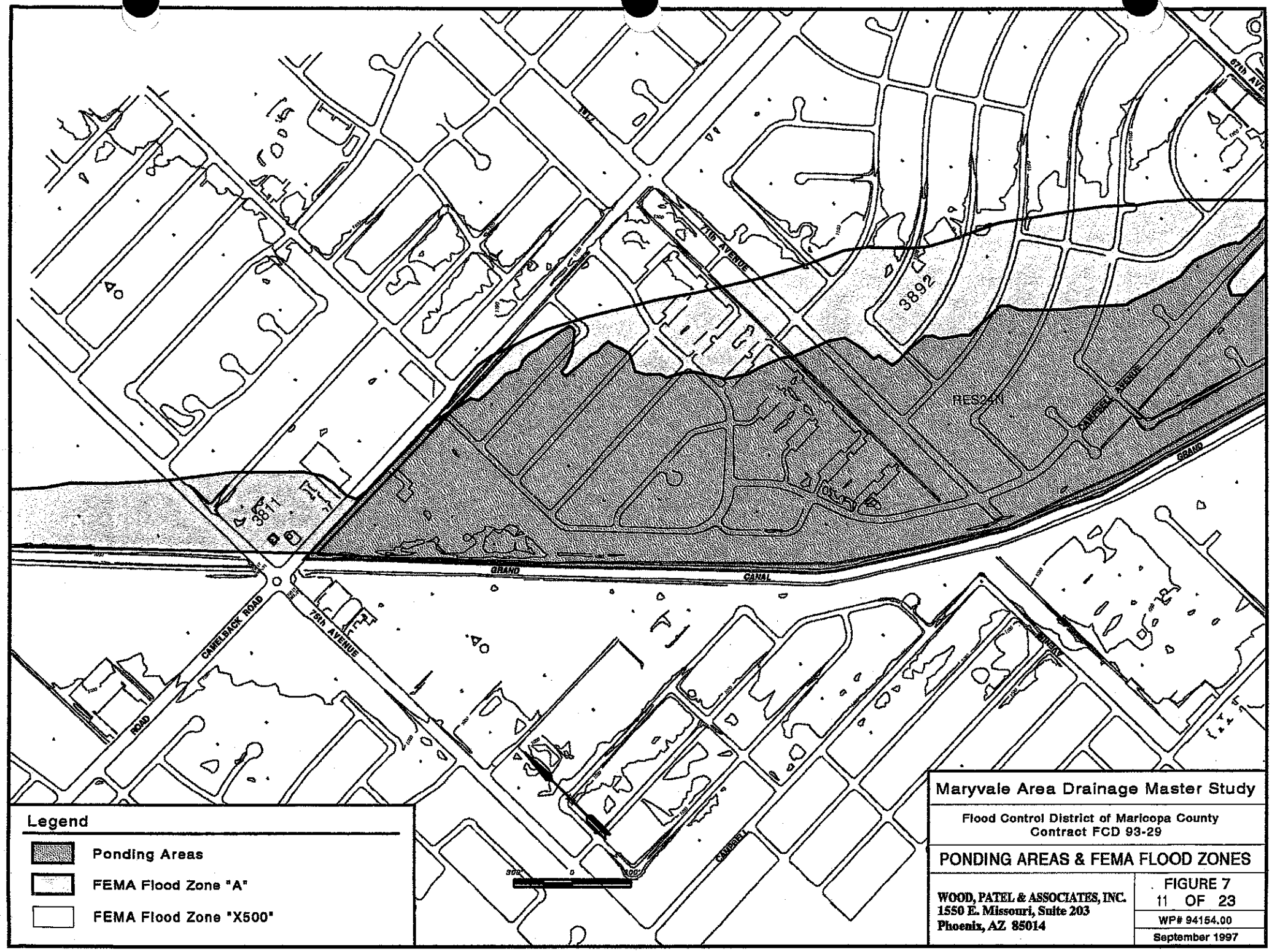

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
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FIGURE 7
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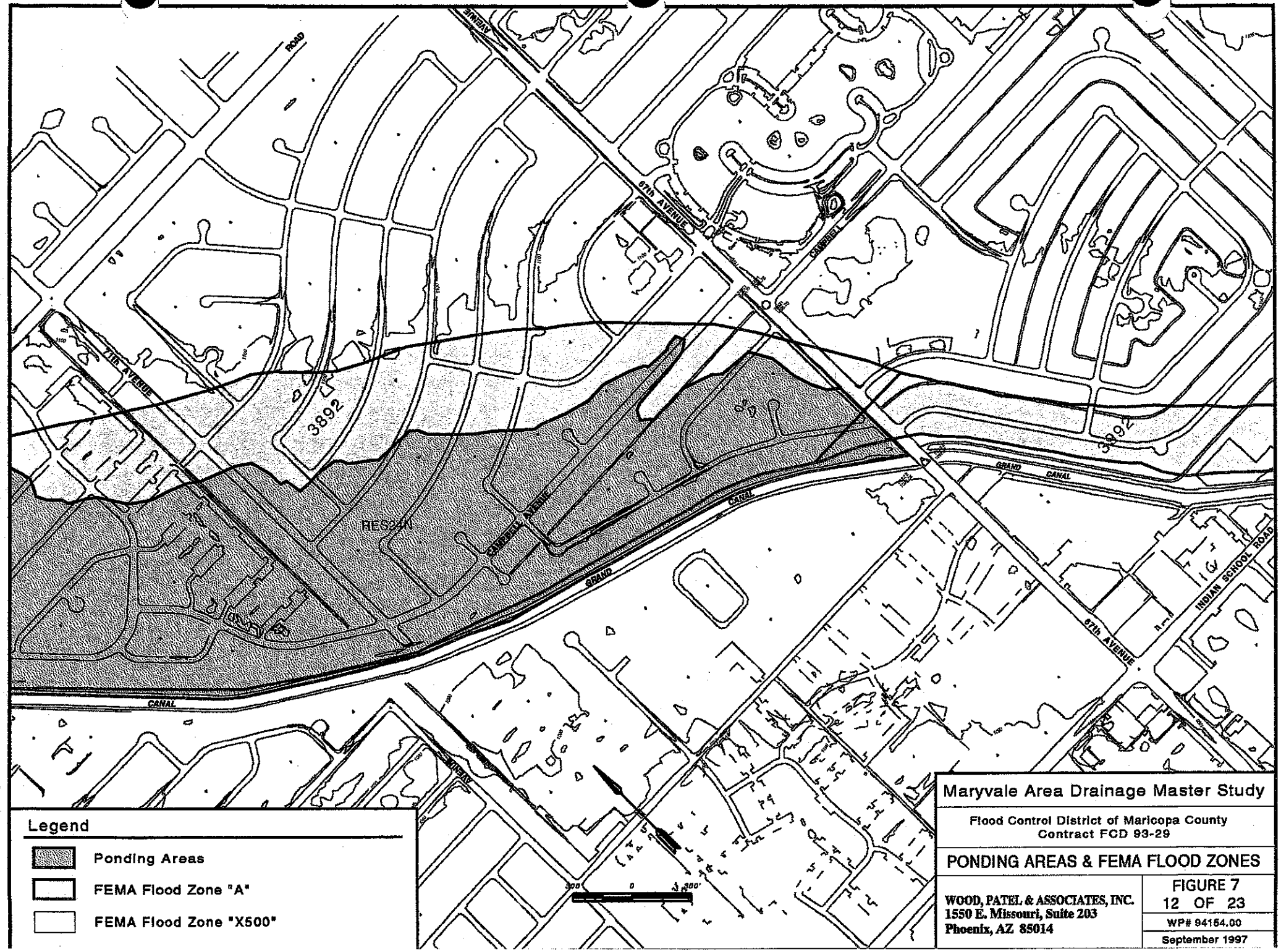

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

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Phoenix, AZ 85014

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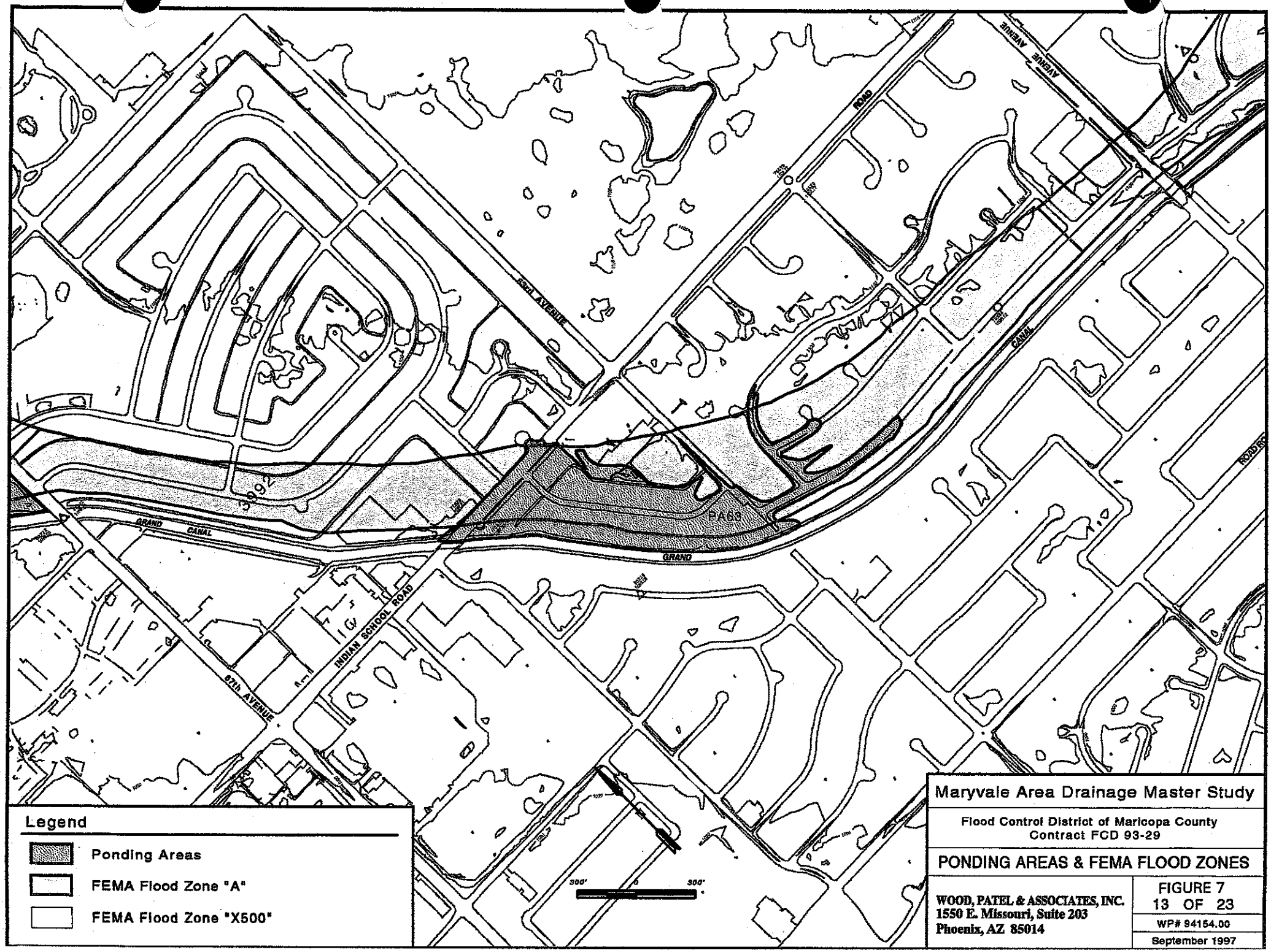

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

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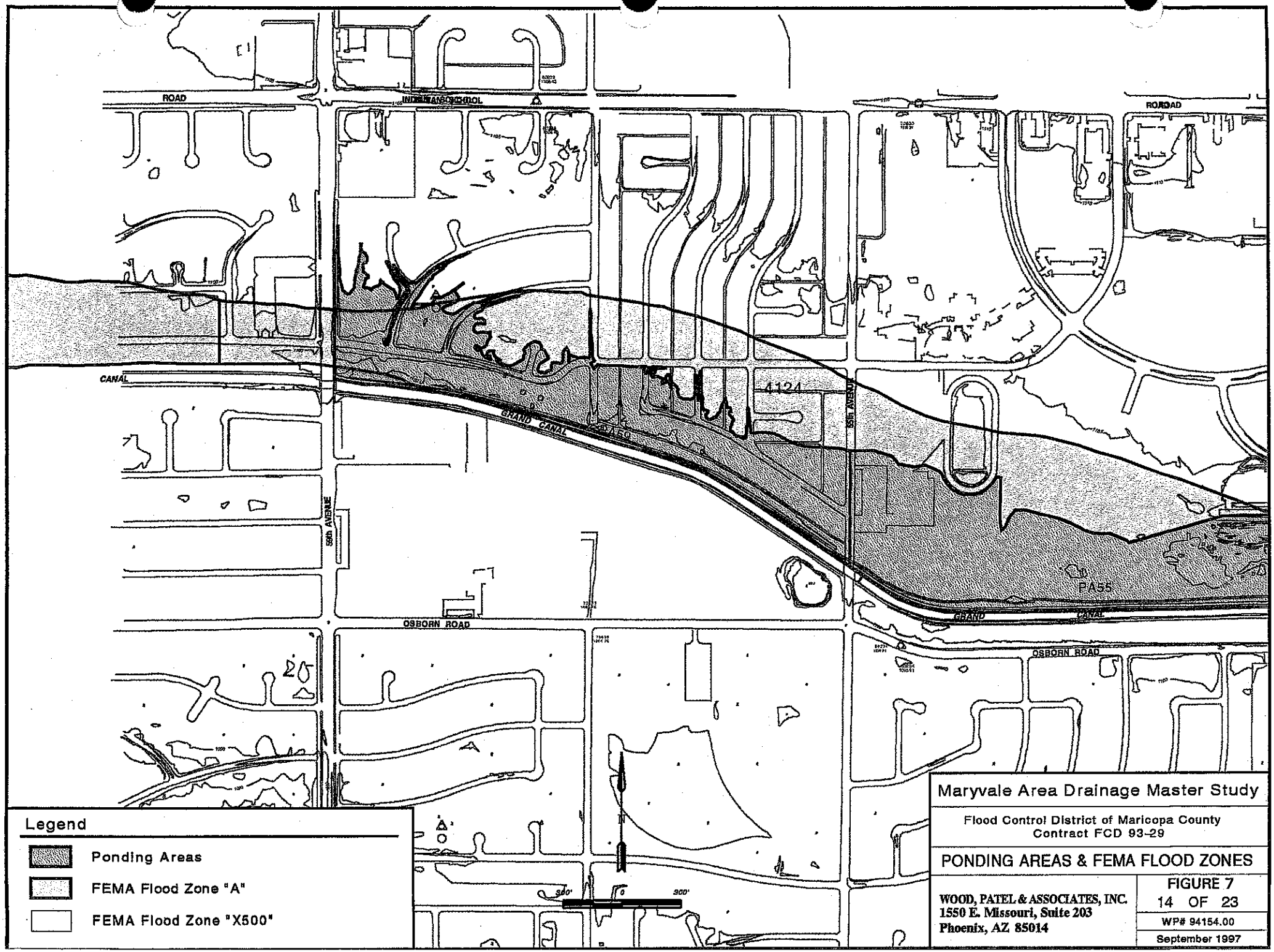

Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

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Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
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Phoenix, AZ 85014

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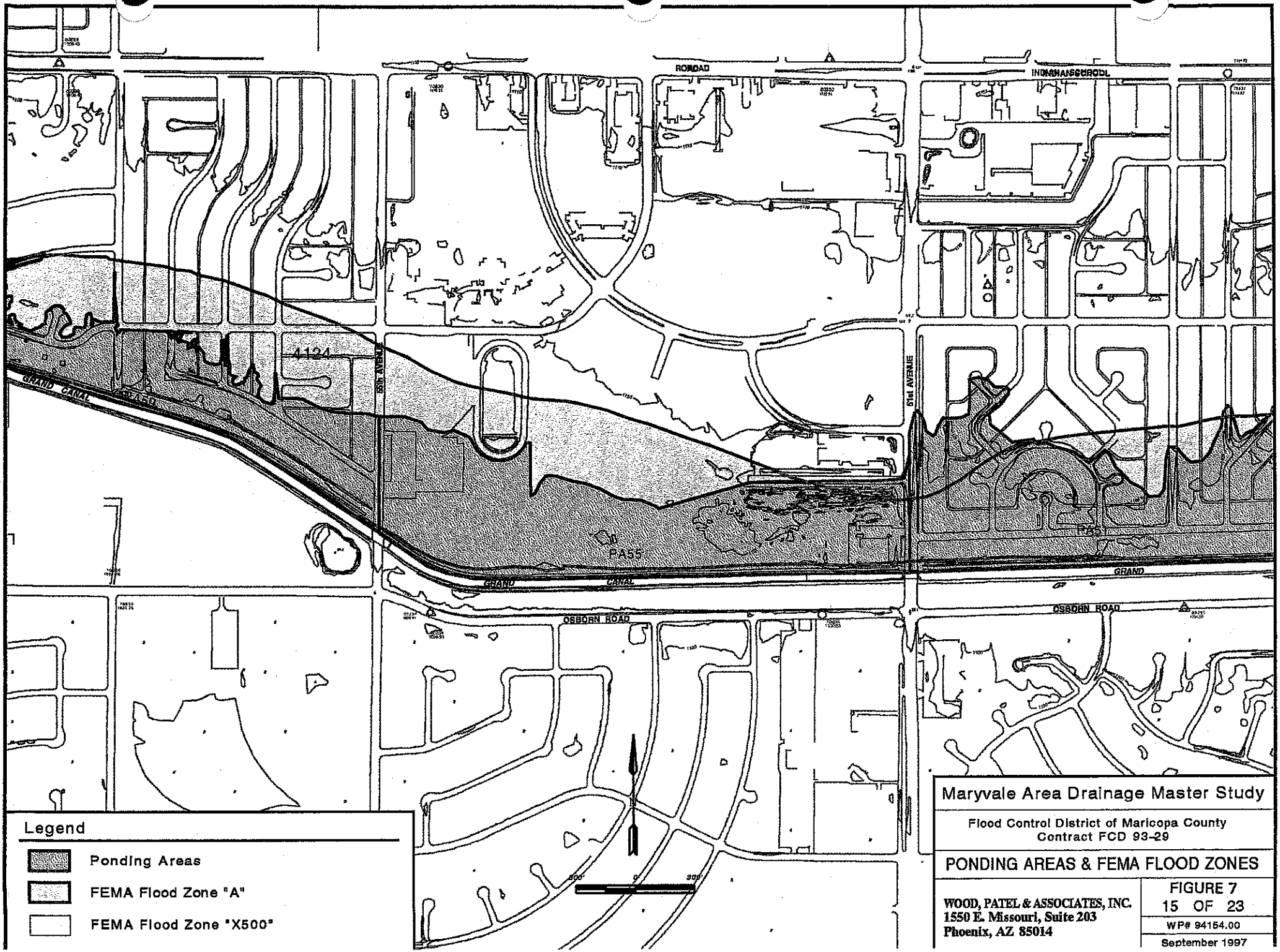
ROAD
INDIAN SCHOOL
4124
GRAND CANAL
61st AVENUE
PA55
GRAND CANAL
OSBORN ROAD
OSBORN ROAD
GRAND
Legend
Ponding Areas
FEMA Flood Zone "A"
FEMA Flood Zone "X500"
Maryvale Area Drainage Master Study
Flood Control District of Maricopa County
Contract FCD 93-29
PONDING AREAS & FEMA FLOOD ZONES
WOOD, PATEL & ASSOCIATES, INC.
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Phoenix, AZ 85014
FIGURE 7
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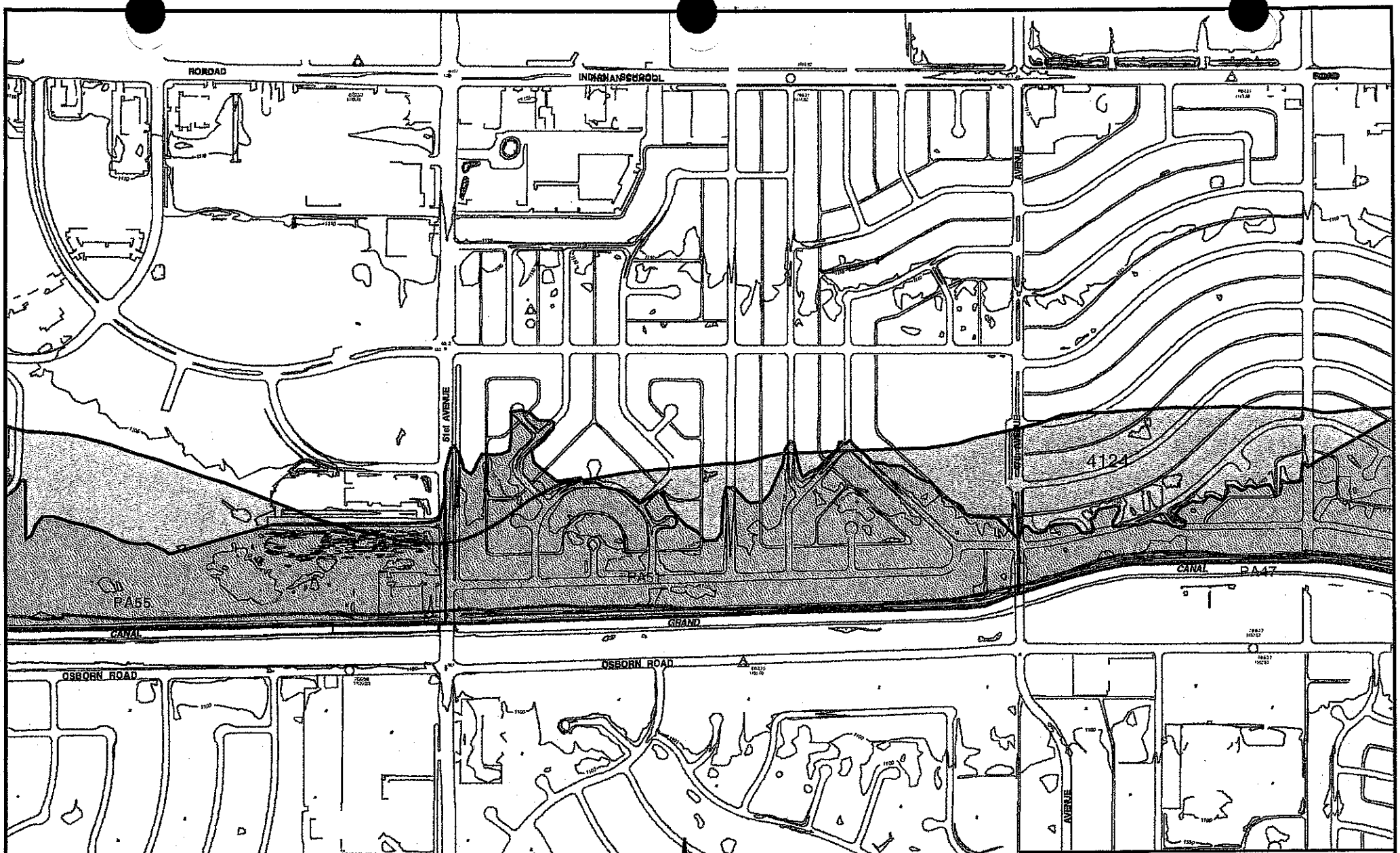
WP# 94154.00
September 1997



Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

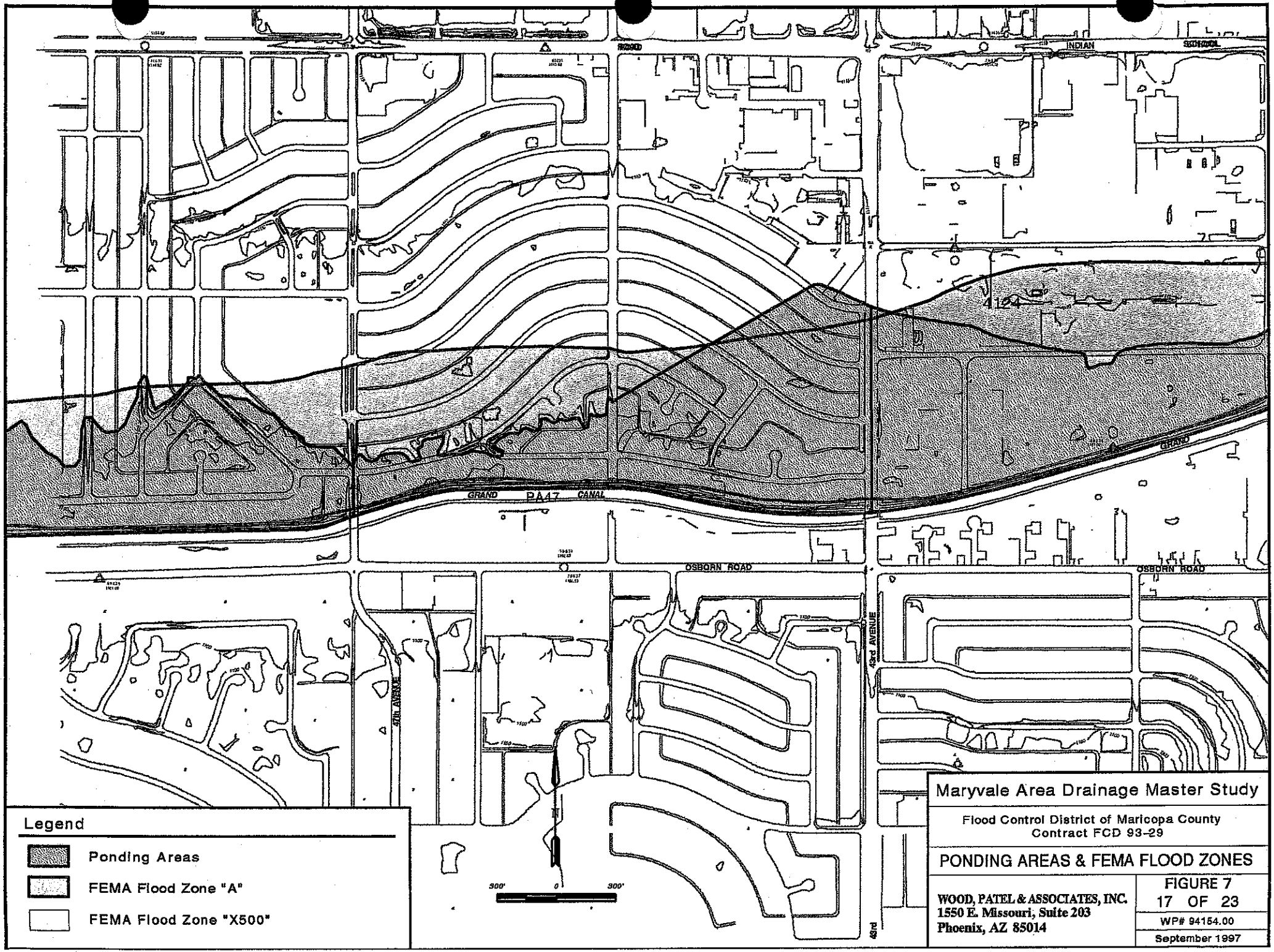
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
16 OF 23

WP# 94154.00

September 1997



Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

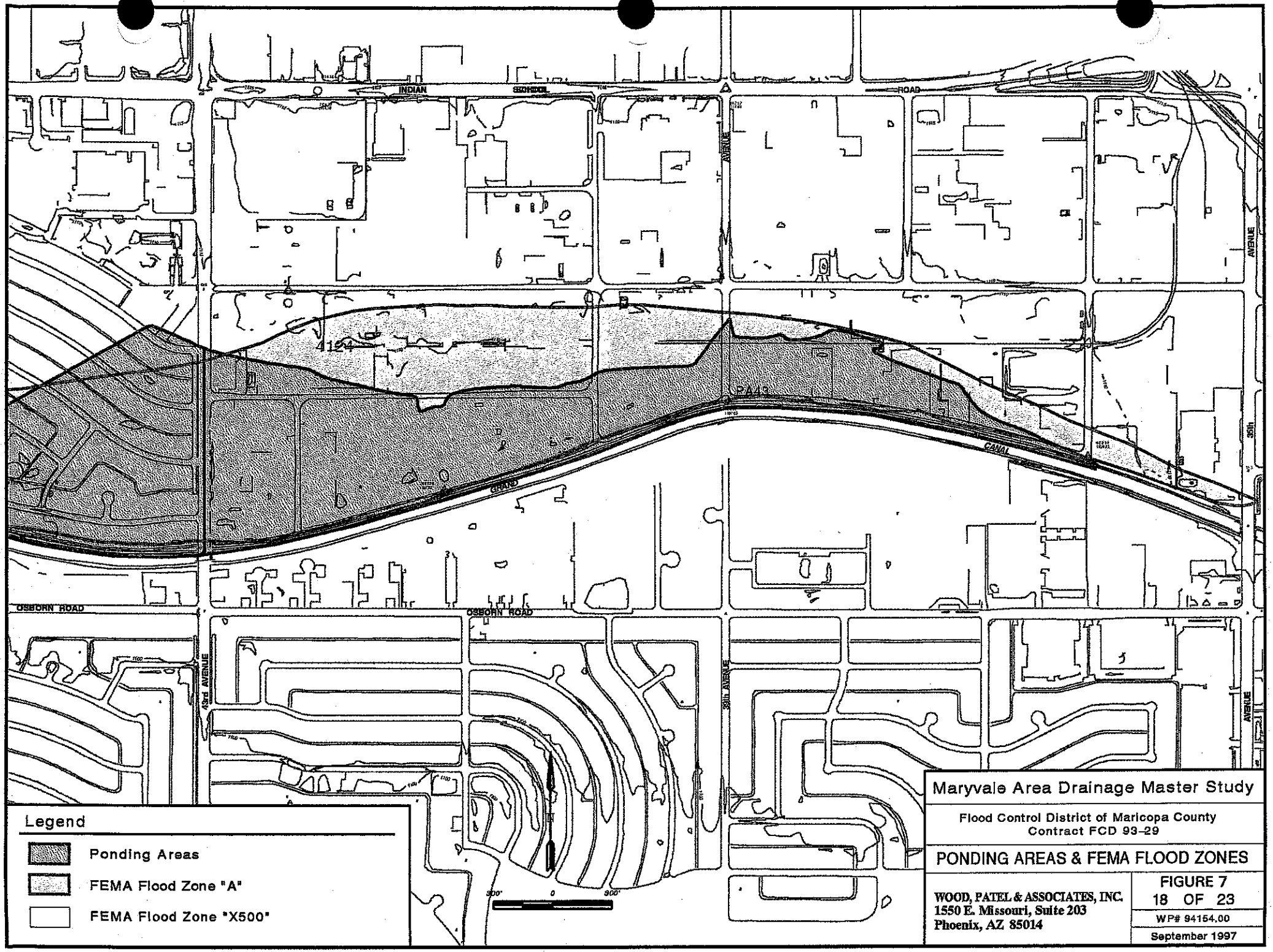
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
17 OF 23

WP# 94154.00

September 1997



Legend

- Ponding Areas
- FEMA Flood Zone "A"
- FEMA Flood Zone "X500"

Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

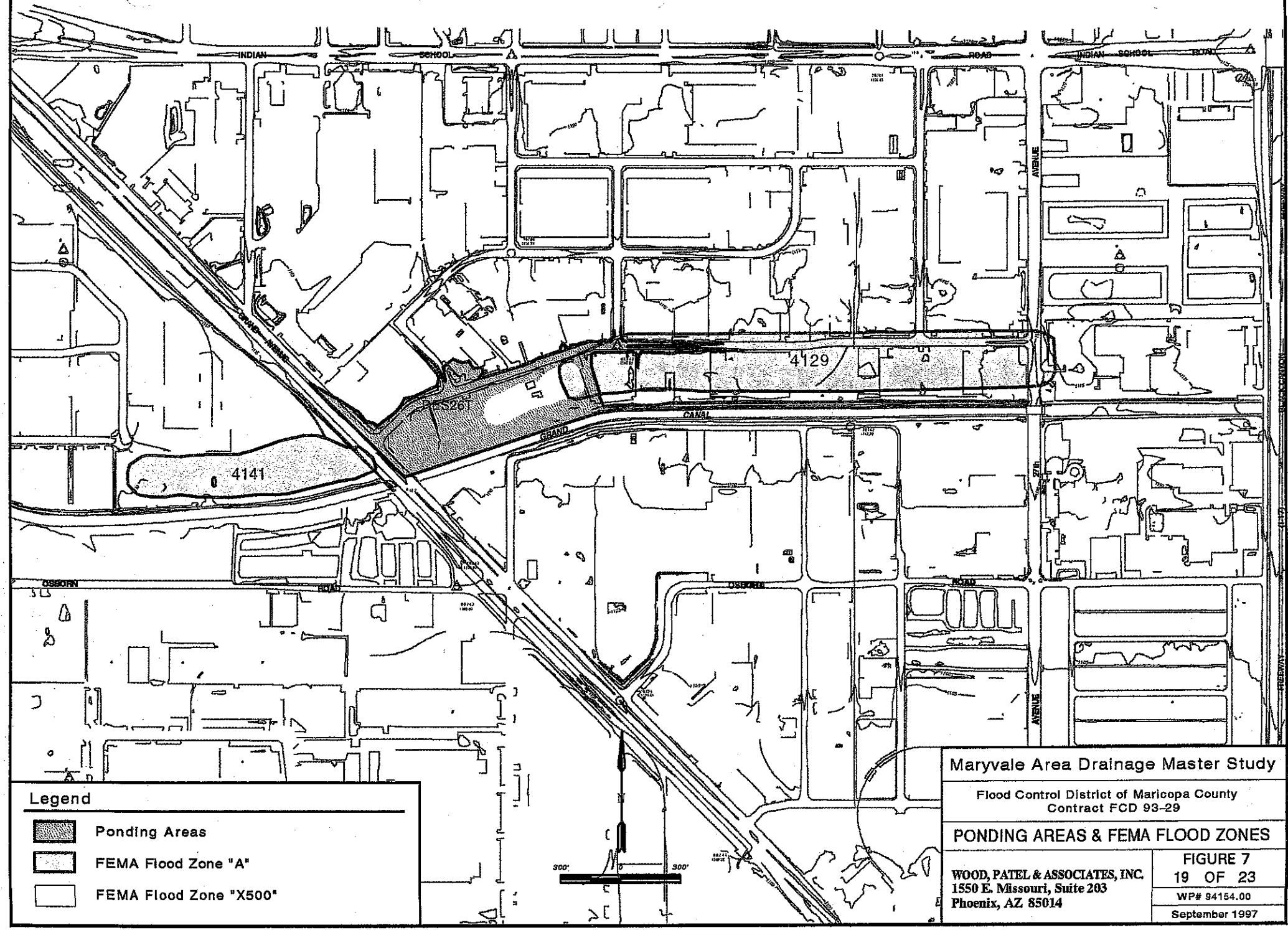
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
18 OF 23

WP# 94154.00

September 1997



Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

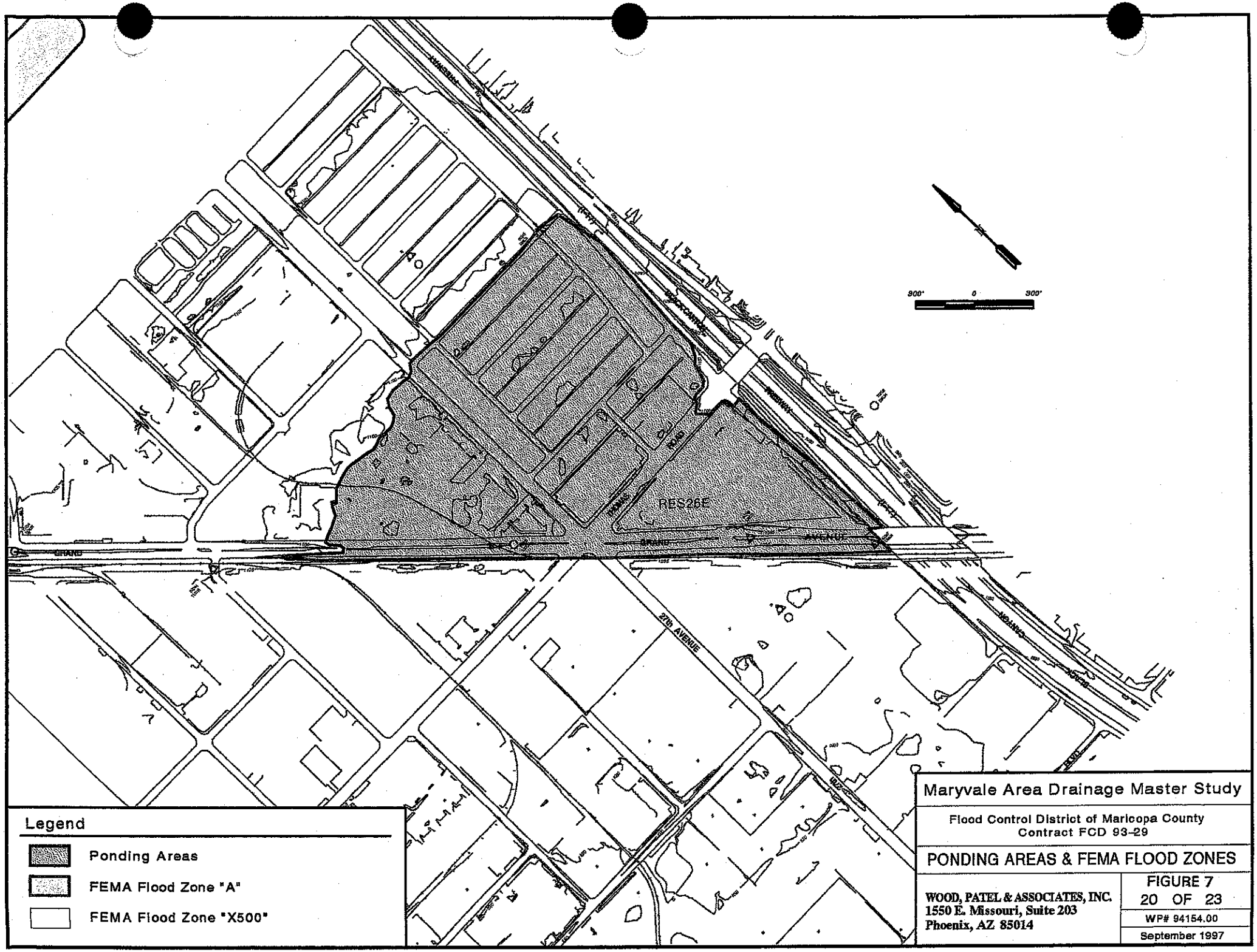
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
19 OF 23

WP# 94154.00

September 1997



Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

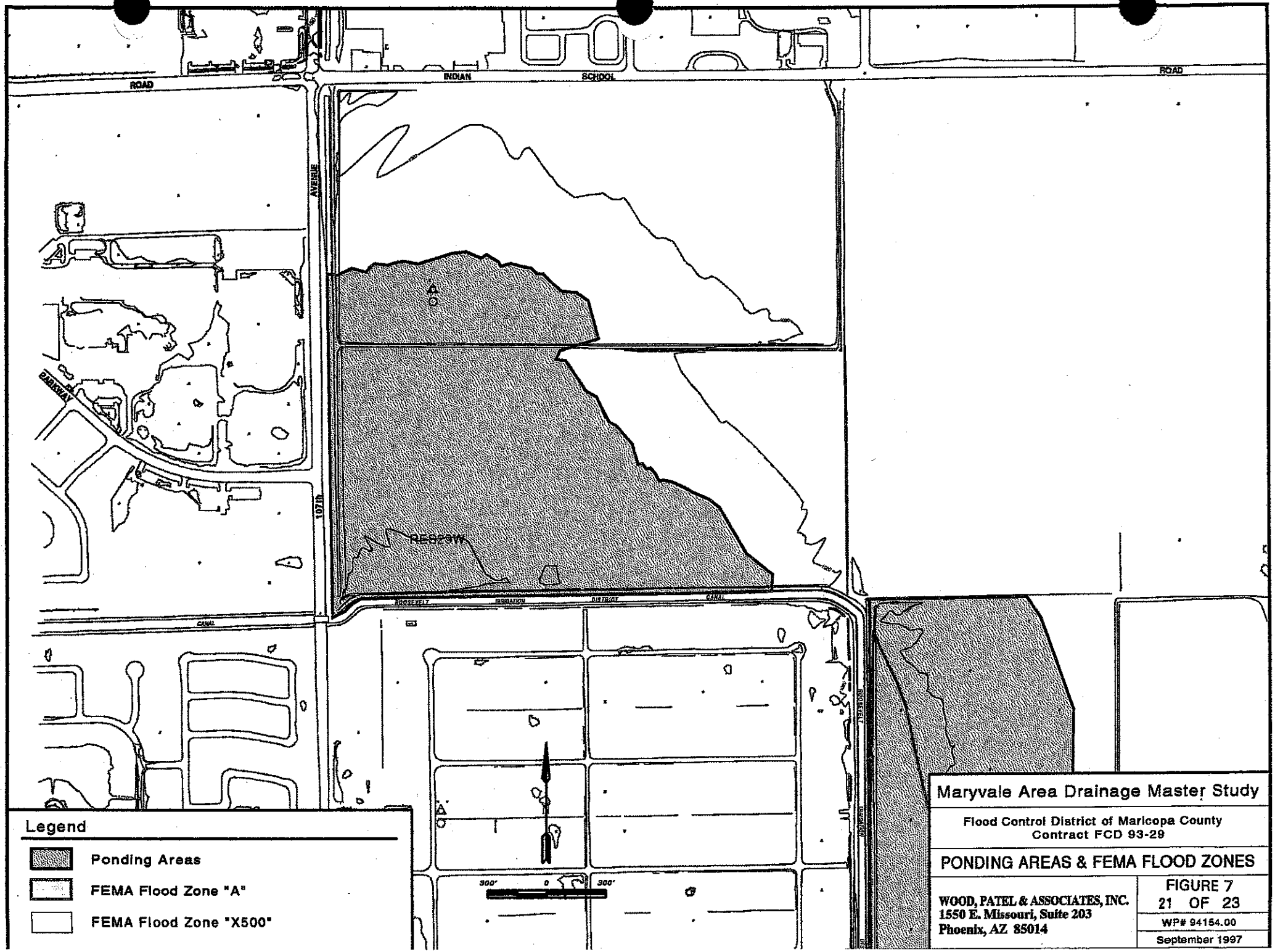
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
20 OF 23

WP# 94154.00

September 1997



Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

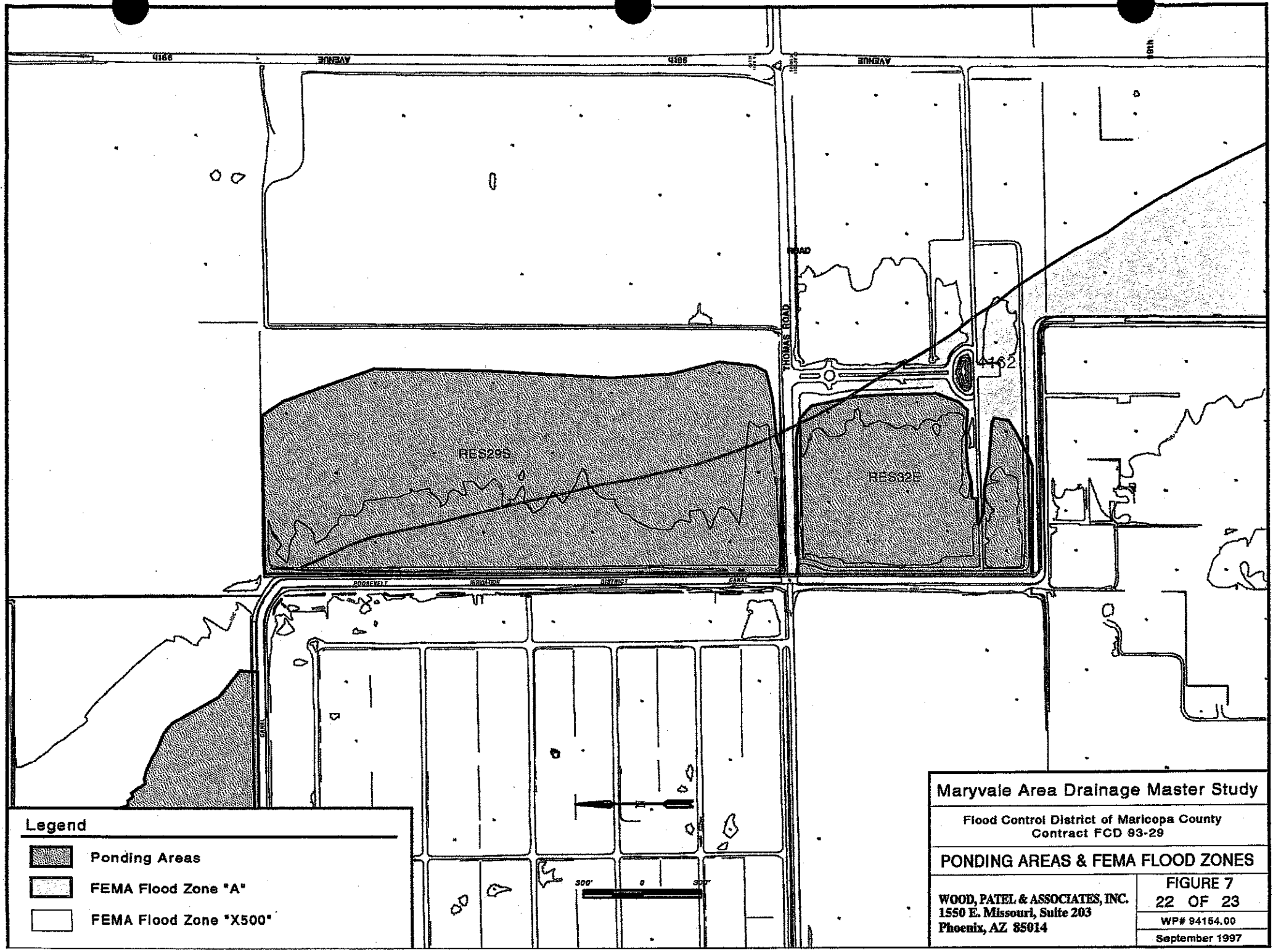
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
21 OF 23

WP# 94154.00

September 1997



Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

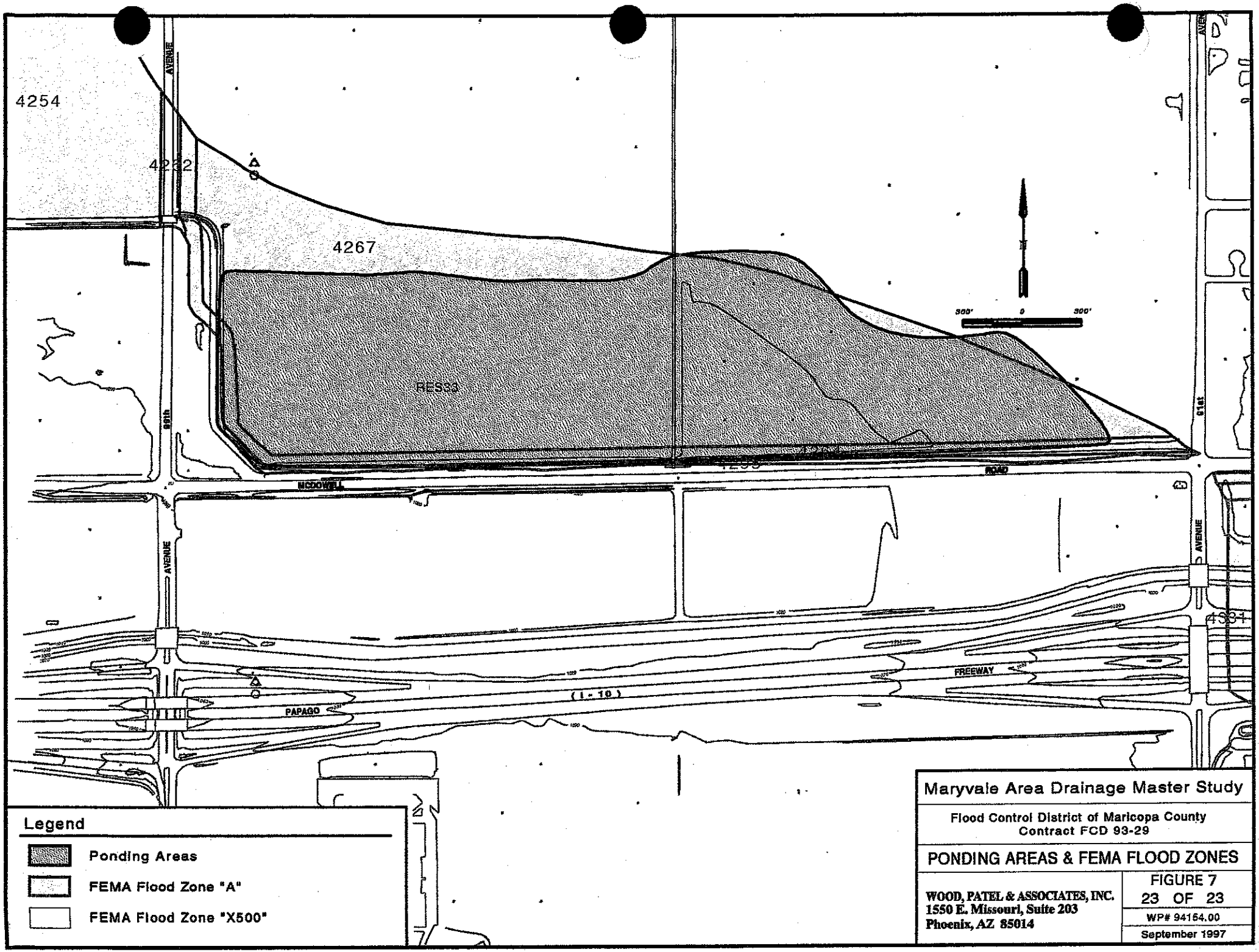
PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
22 OF 23

WP# 94154.00

September 1997



Maryvale Area Drainage Master Study

Flood Control District of Maricopa County
Contract FCD 93-29

PONDING AREAS & FEMA FLOOD ZONES

WOOD, PATEL & ASSOCIATES, INC.
1550 E. Missouri, Suite 203
Phoenix, AZ 85014

FIGURE 7
23 OF 23

WP# 94154.00

September 1997

EXIST.
48" PIPE

EXIST. STORM DRAIN

DETENTION
BASIN

PEORIA AVE.

68 LF
36" PIPE

GRAND AVE.

OLIVE AVE.

83RD AVE.

75TH AVE.

NOTE:
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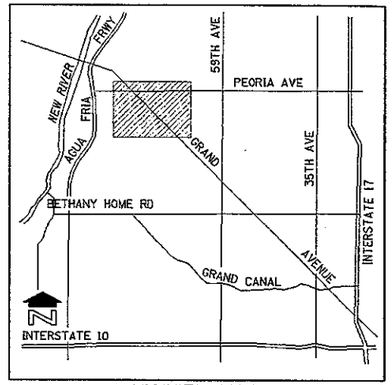
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 79TH AVENUE

MITIGATION OPTION 1, 10-YEAR

N

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

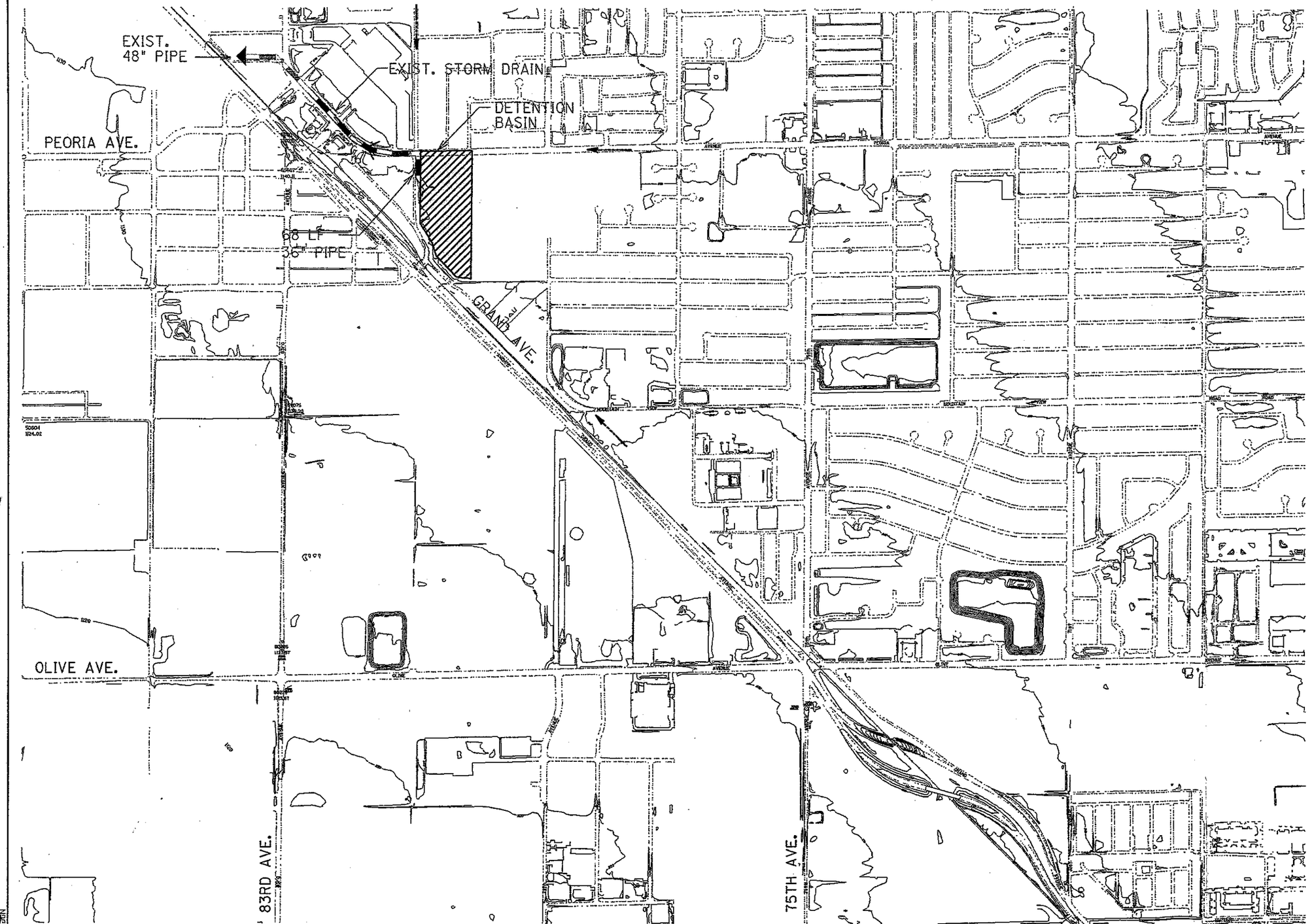
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 1 OF 24

EL-206N



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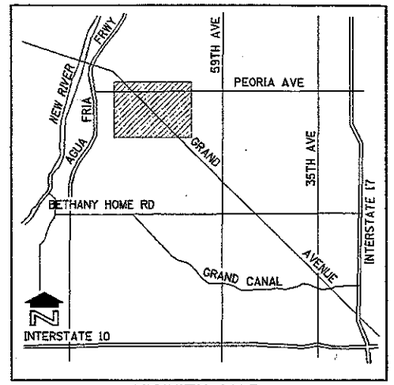
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 79TH AVENUE

MITIGATION OPTION I, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	

SUBMITTED BY: _____ DATE: _____

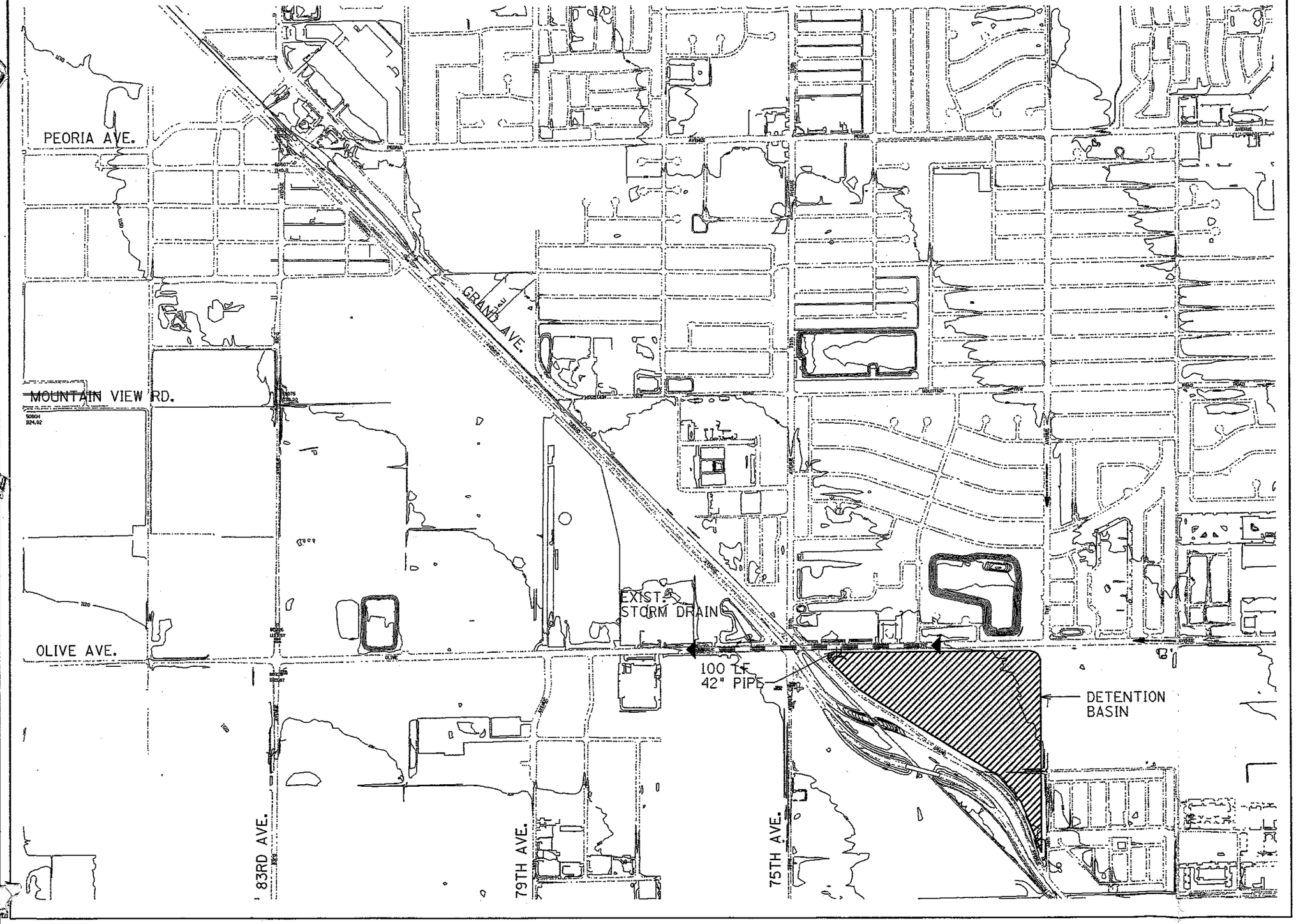
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: _____ DATE _____

APPROVED BY: _____ DATE _____

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 1 OF 24



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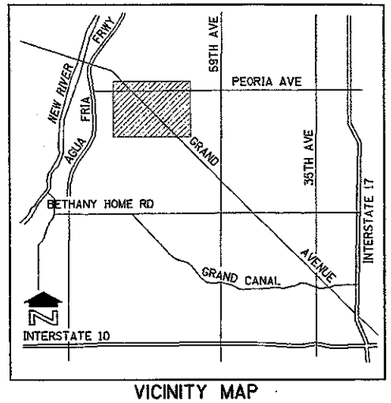
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND AVENUE AT 73RD AVENUE

MITIGATION OPTION 1, 100-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

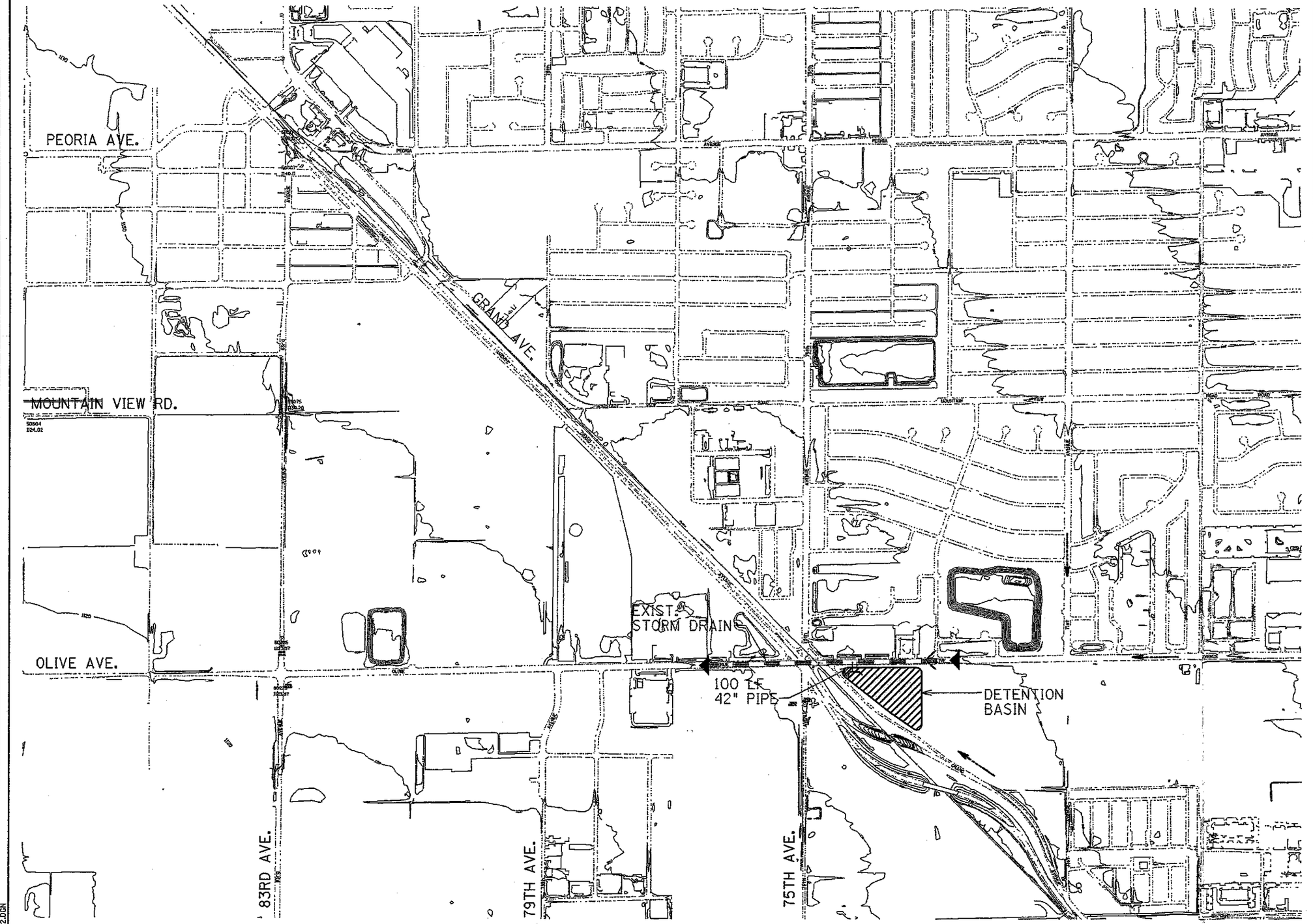
	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER



E6-2.DGN

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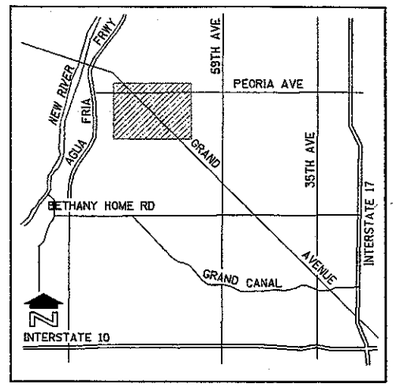
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND AVENUE AT 73RD AVENUE

MITIGATION OPTION 1, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

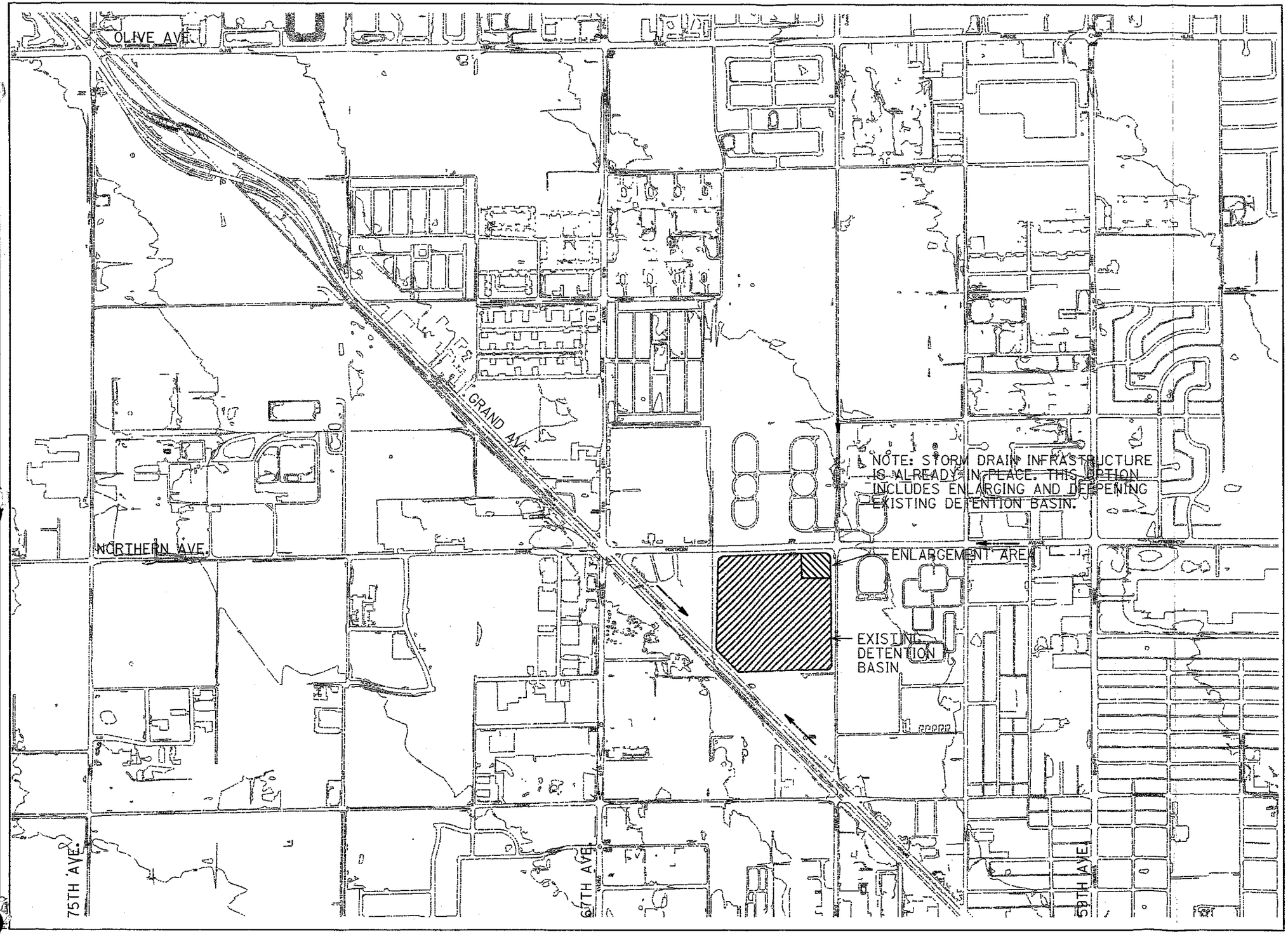
	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER



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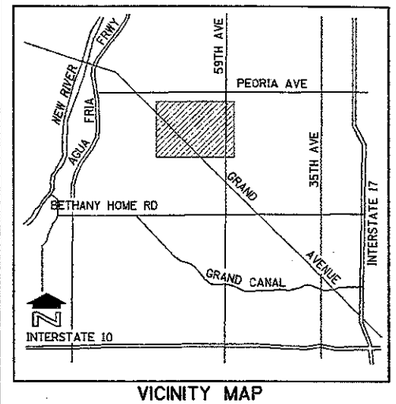
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND AVENUE AT 67TH AVENUE

MITIGATION OPTION I, 100-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	

SUBMITTED BY: DATE:

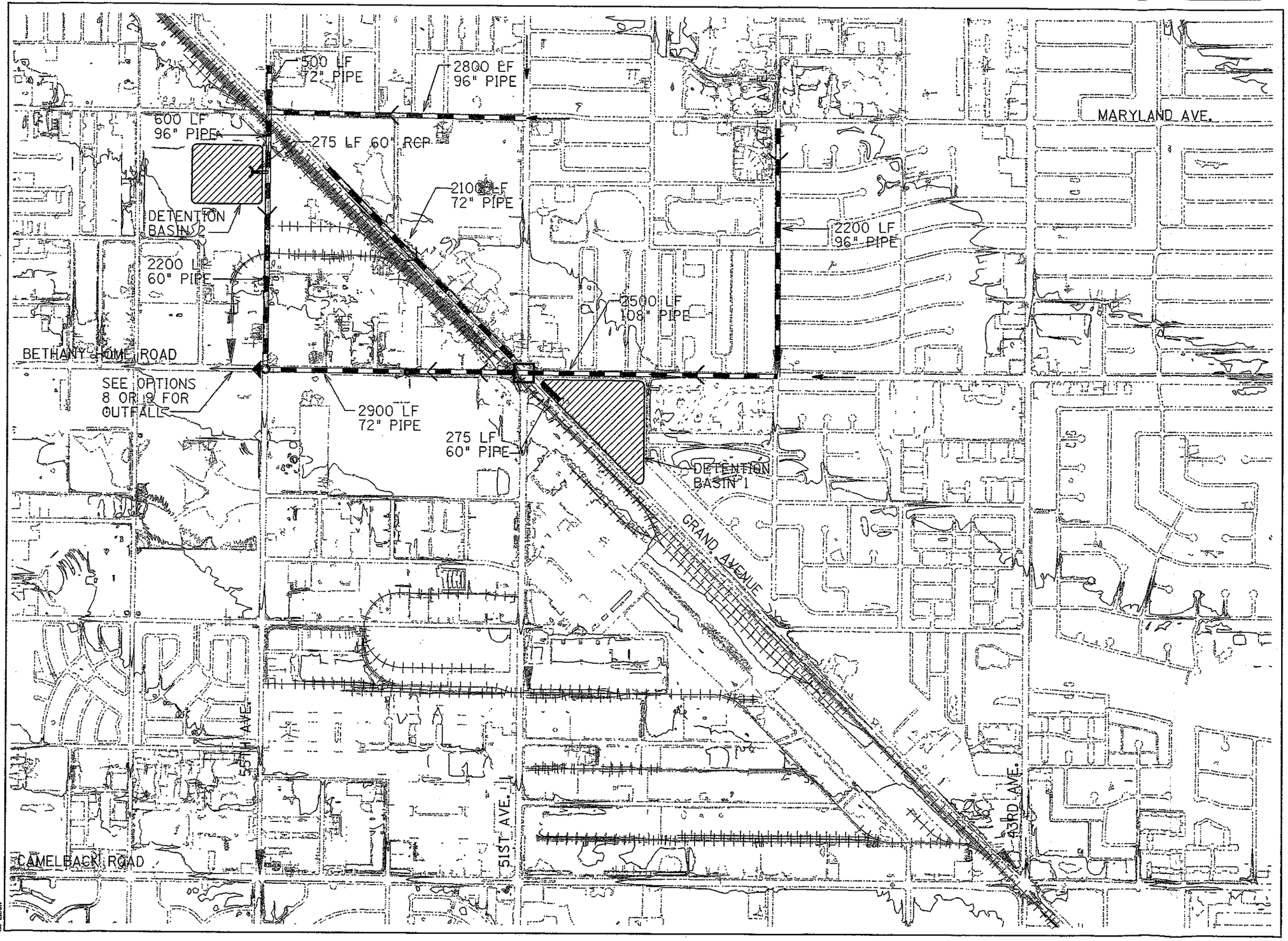
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 5 OF 24



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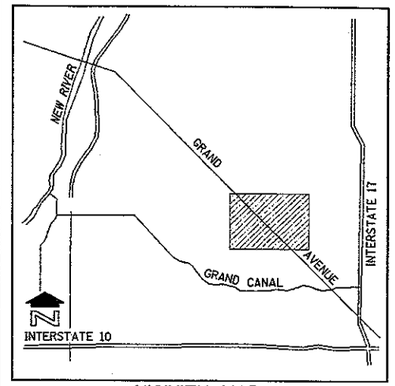
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 4, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	

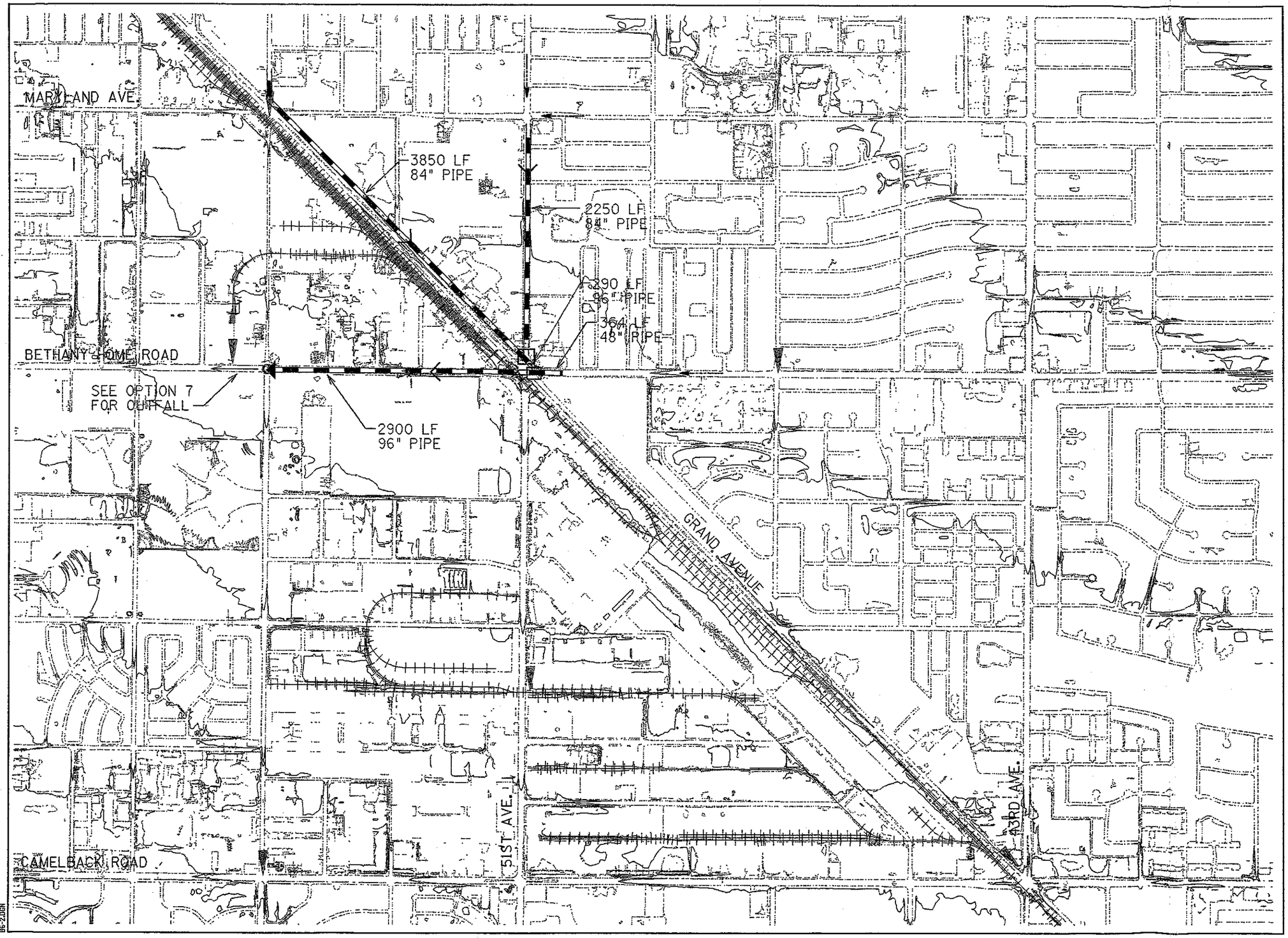
SUBMITTED BY: _____ DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: _____ DATE

APPROVED BY: _____ DATE

CHIEF ENGINEER AND GENERAL MANAGER



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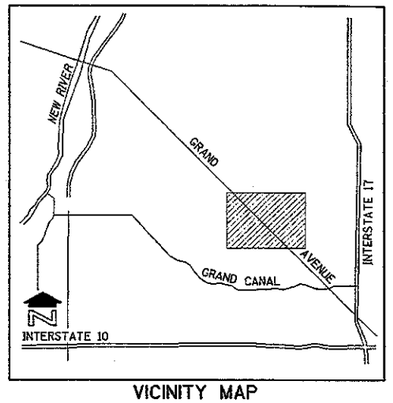
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 5, 10-YEAR

N

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

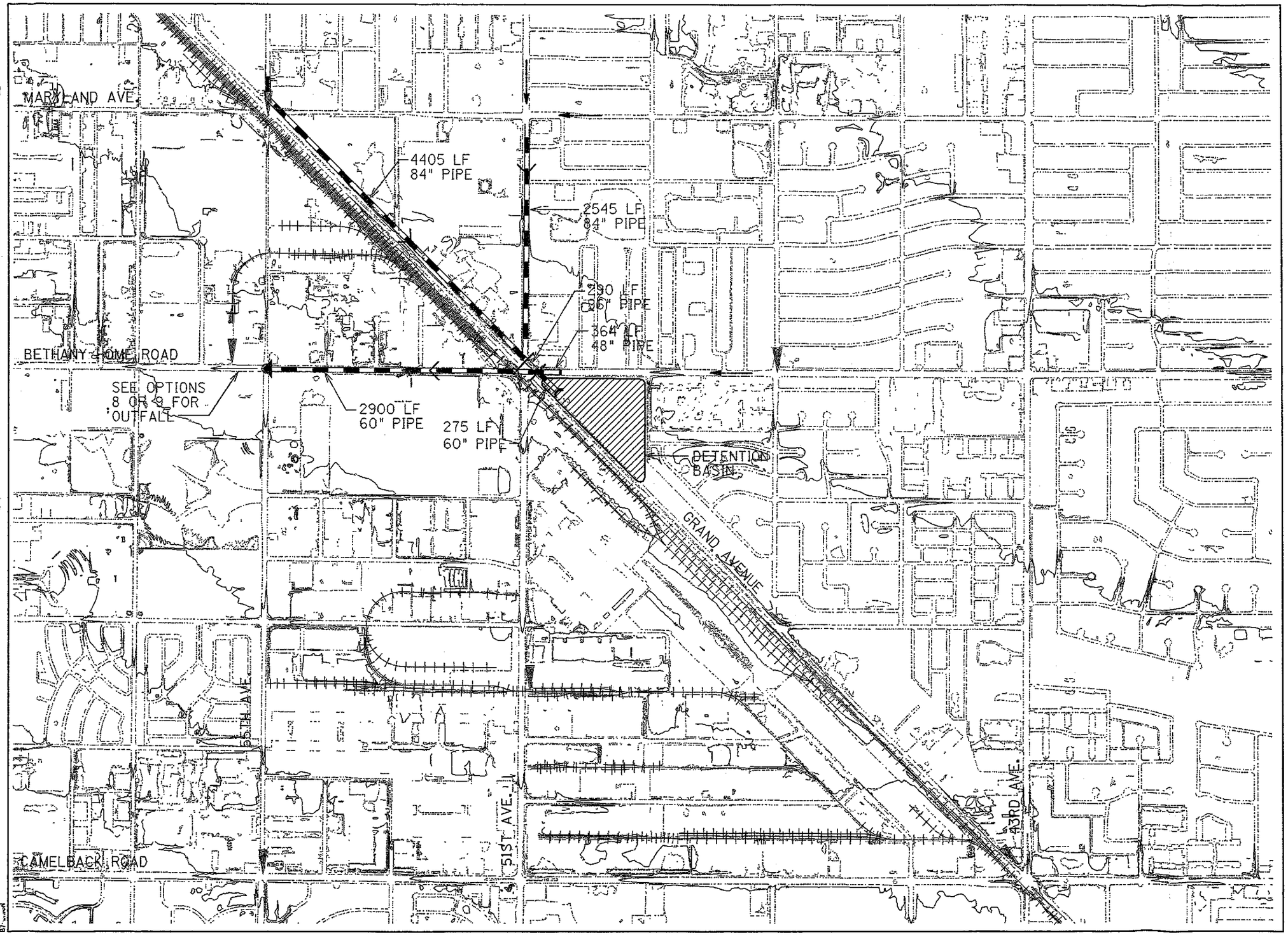
WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 7 OF 24

BS-2.DGN



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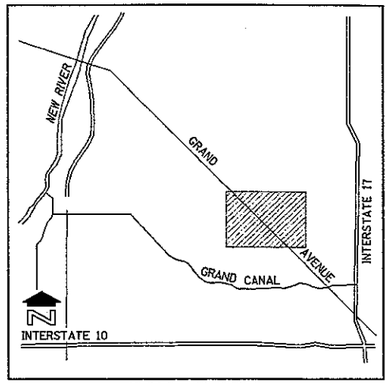
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

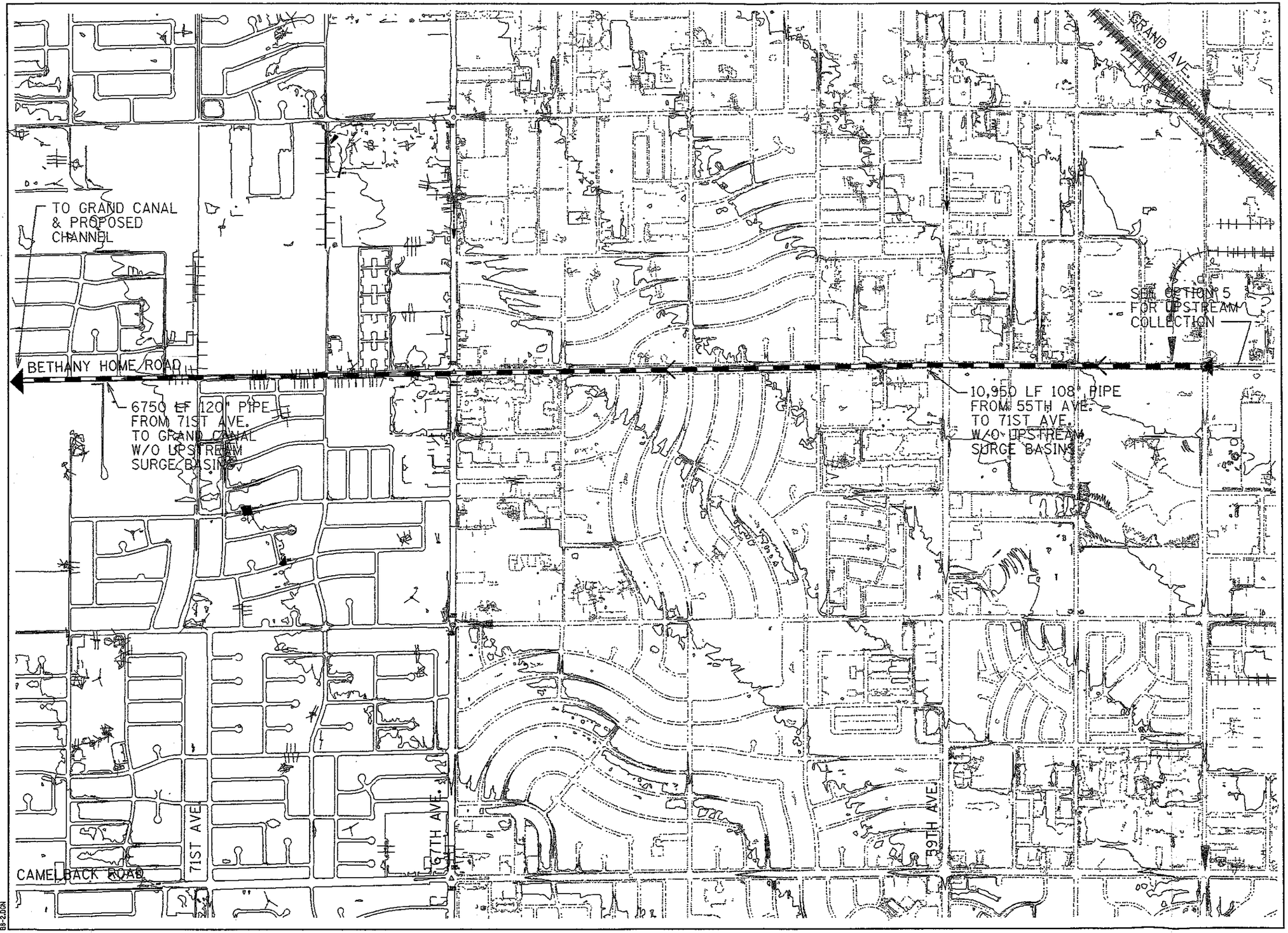
500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY: DATE:		

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 8 OF 24



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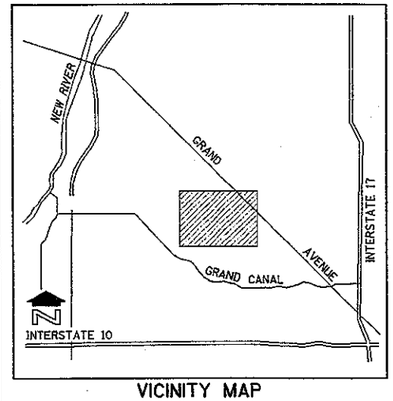
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND AVENUE AT 51ST AVENUE

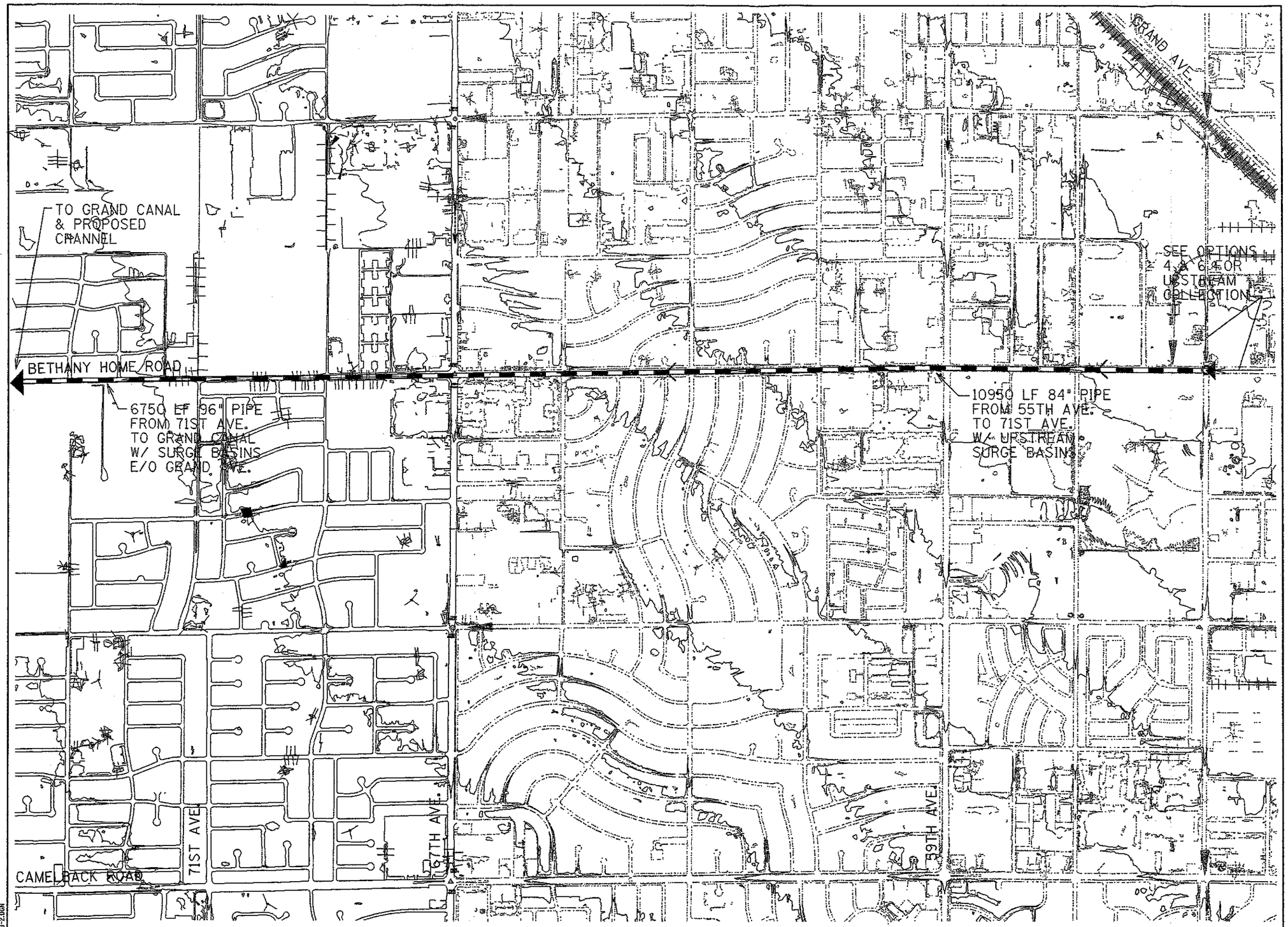
MITIGATION OPTION 7, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE	
DESIGN	JT/AR		FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	DP/JM		RECOMMENDED BY: DATE
PLANS	SH/AL		APPROVED BY: DATE
PLANS CHK.	JM/AP		CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY: DATE:			FIGURE 8 SHEET 9 OF 24

85-2.00N



B3-2.00N

NOTE:
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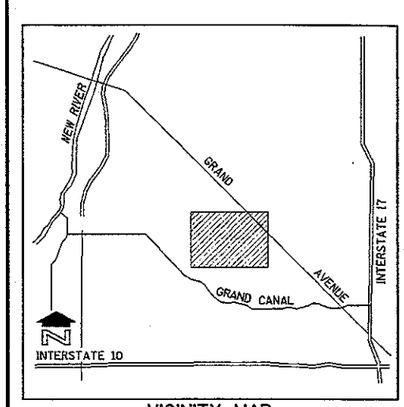
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

N

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JN	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

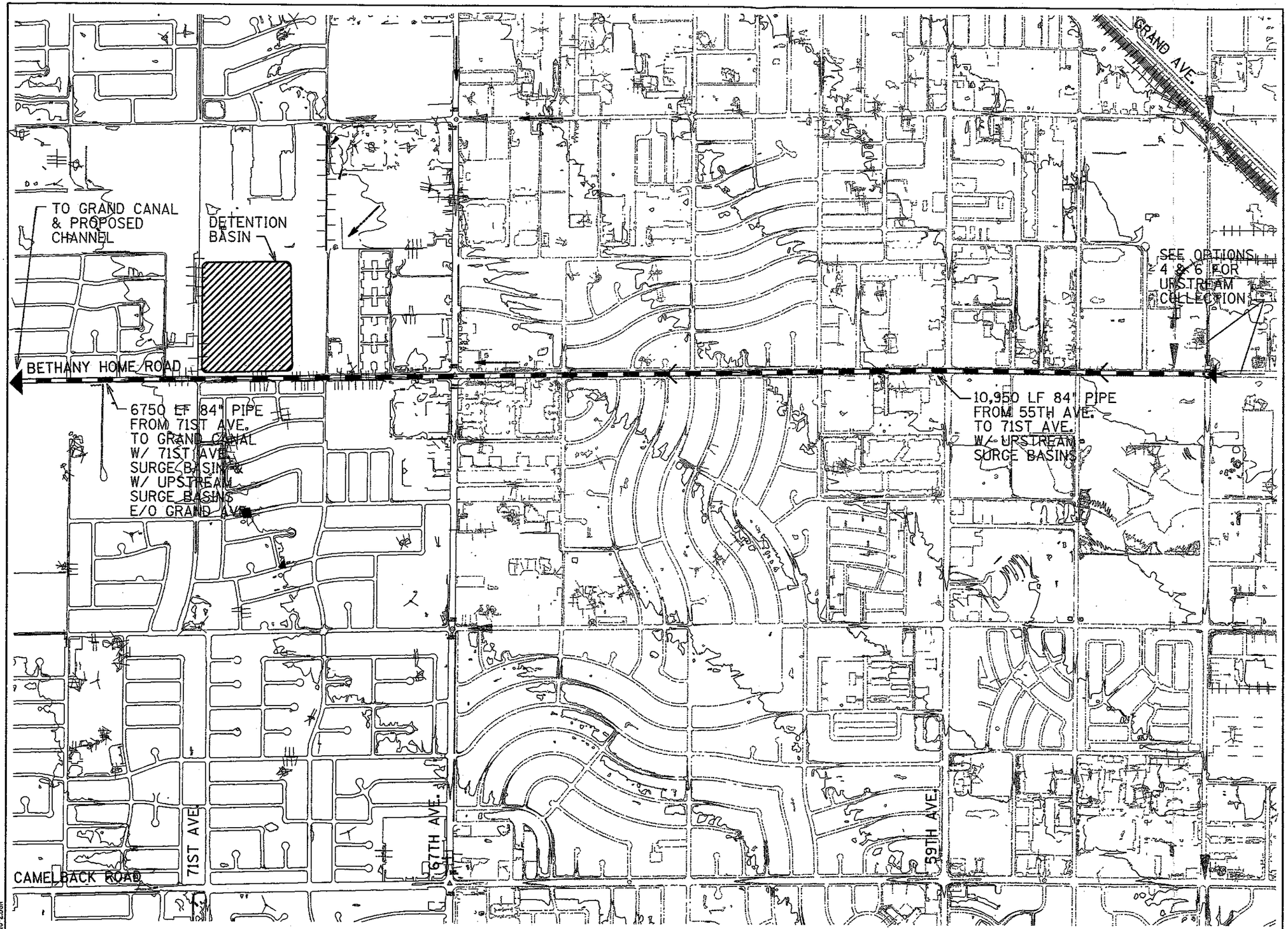
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 10 OF 24



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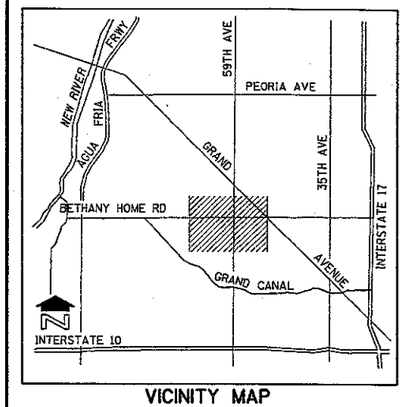
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND AVENUE AT 51ST AVENUE

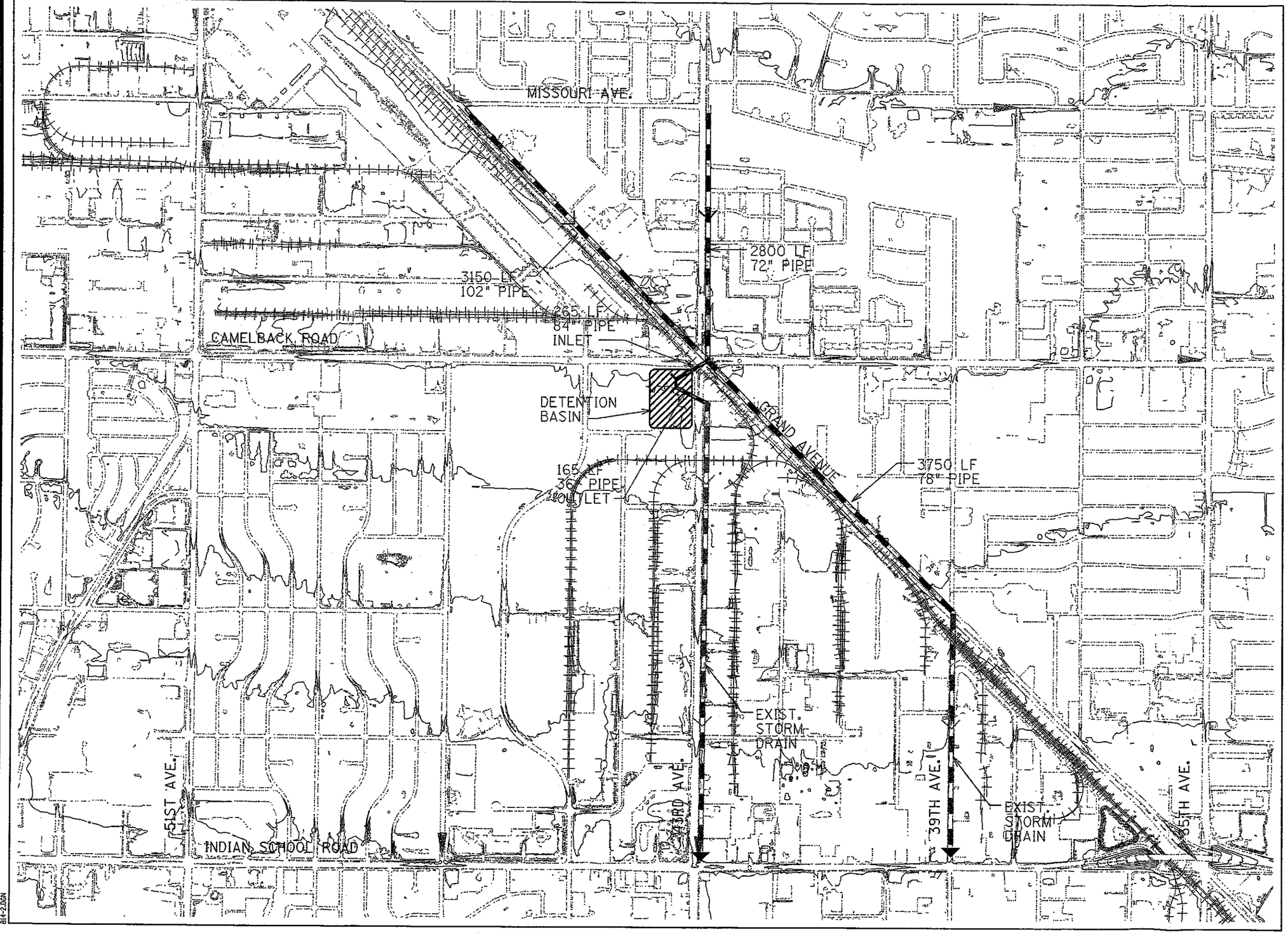
MITIGATION OPTION 9, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE	
DESIGN	JT/AR		FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	DP/JM		RECOMMENDED BY: DATE
PLANS	SH/AL		APPROVED BY: DATE
PLANS CHK.	JM/AP		CHIEF ENGINEER AND GENERAL MANAGER
SUBMITTED BY: DATE:			FIGURE 8 SHEET 11 OF 24

BID-2.DGN



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814-2.DGN

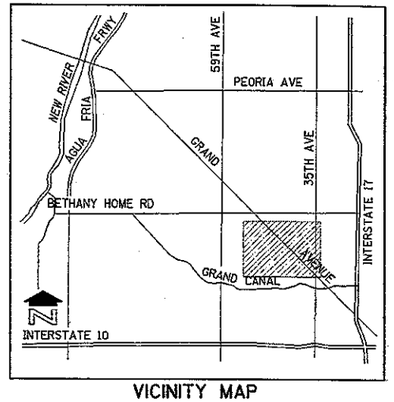
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT 43rd AVENUE

MITIGATION OPTION 4 , 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

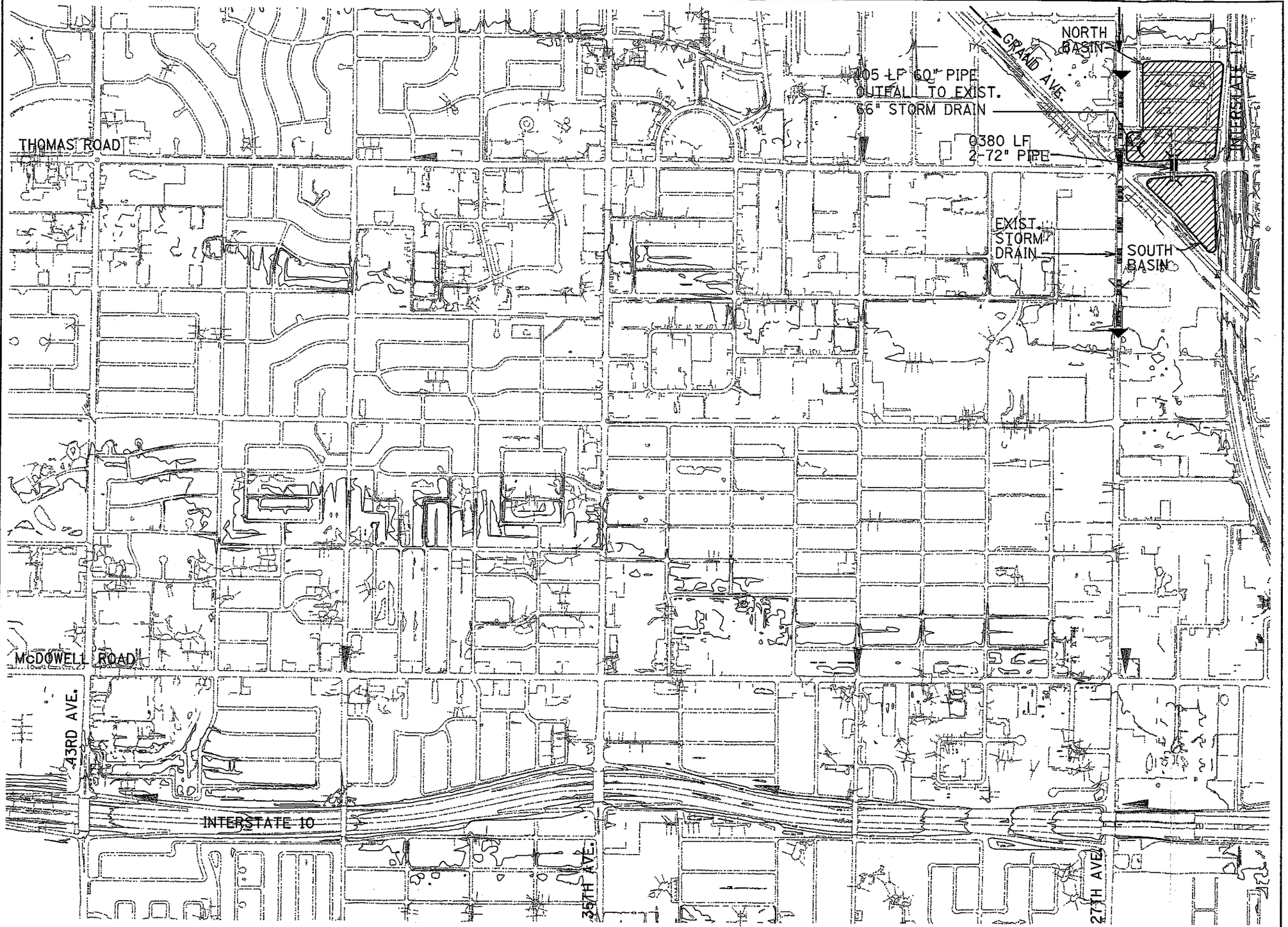
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: _____ DATE

APPROVED BY: _____ DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 12 OF 24



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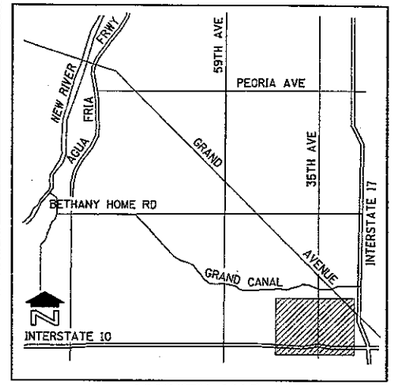
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUTION LEVEL II

GRAND AVENUE AT INTERSTATE 17

MITIGATION OPTION 2, 100-YEAR

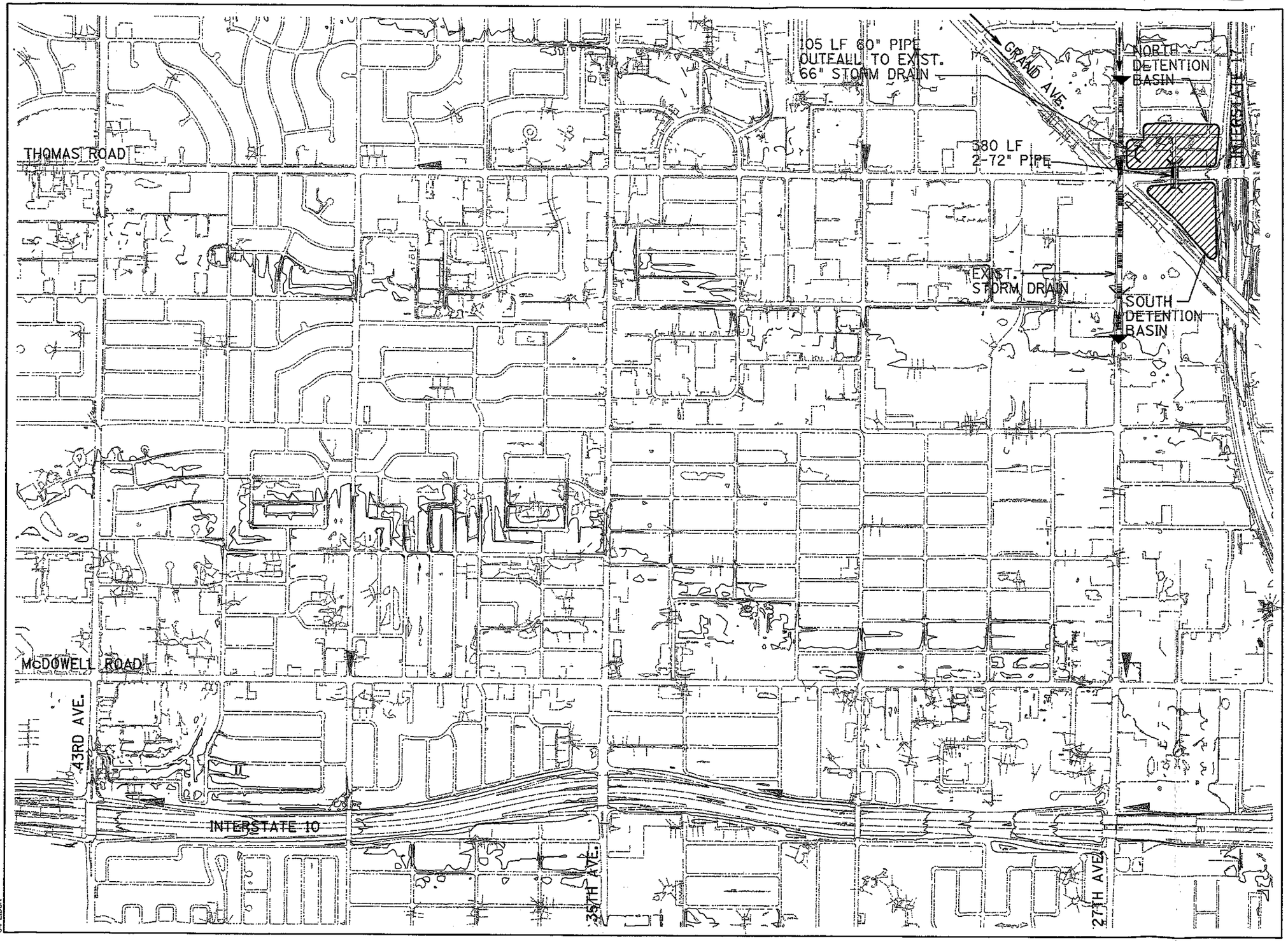
N

500 0 500 1000

SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

DESIGN	BY JT/AR	DATE	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
DESIGN CHK.	DP/JM		
PLANS	SH/AL		RECOMMENDED BY: DATE
PLANS CHK.	JM/AP		APPROVED BY: DATE
SUBMITTED BY: DATE:			CHIEF ENGINEER AND GENERAL MANAGER
			FIGURE 8 SHEET 13 OF 24



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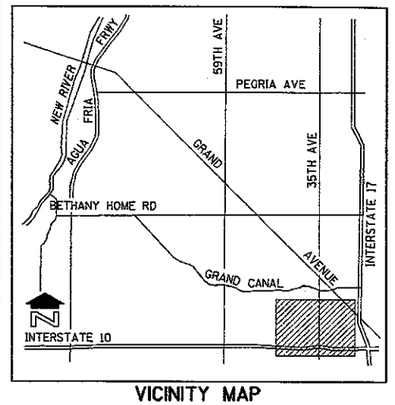
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT INTERSTATE 17

MITIGATION OPTION 2, 10-YEAR

N

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

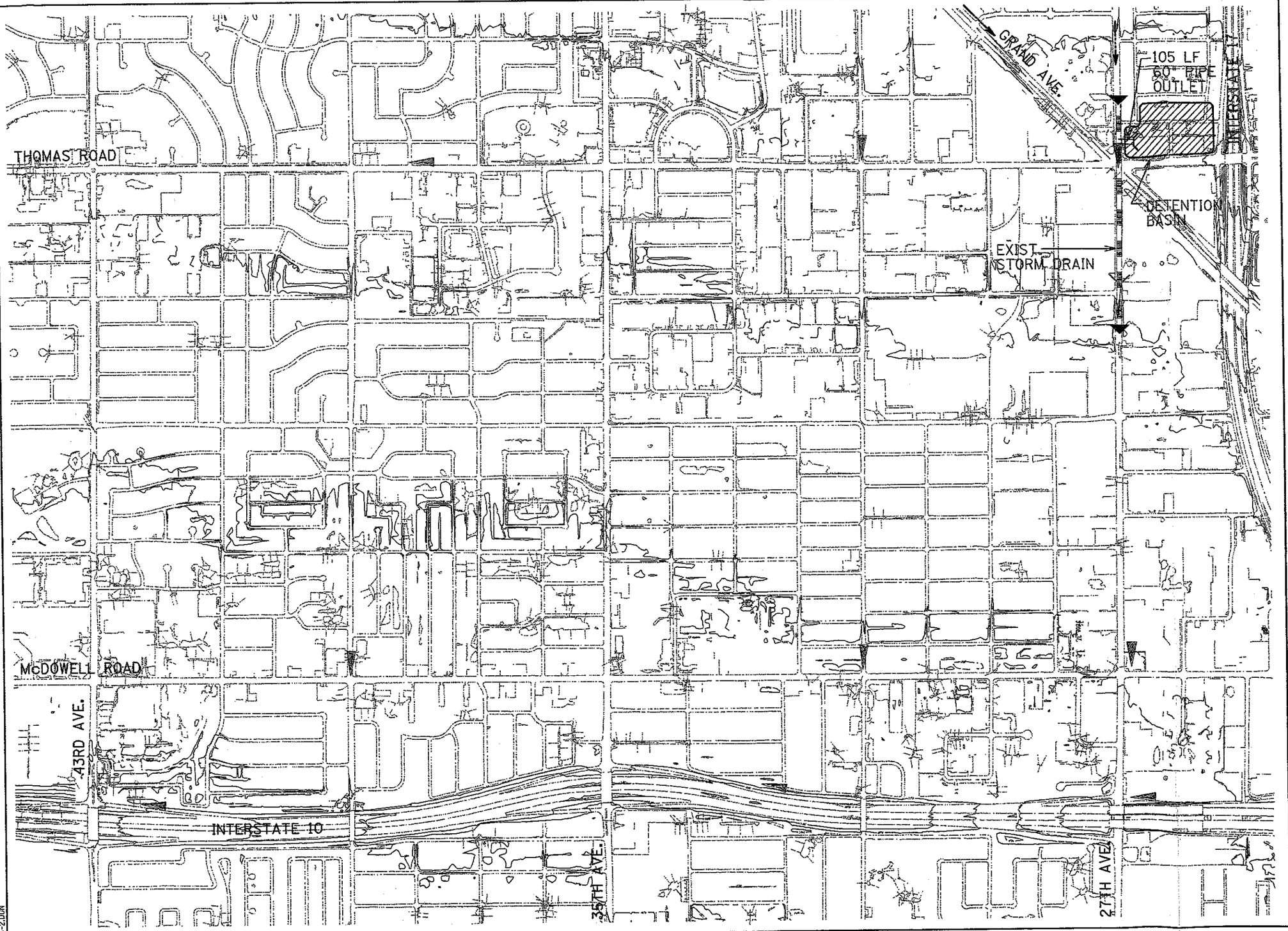
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 14 OF 24

2.DGN

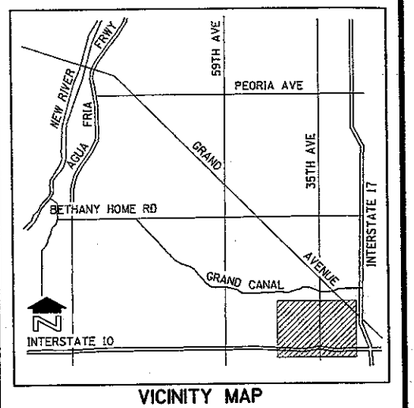


FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL II

GRAND AVENUE AT INTERSTATE 17

MITIGATION OPTION 1, 5-YEAR

N

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

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PROJECT NO. 94154.00

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

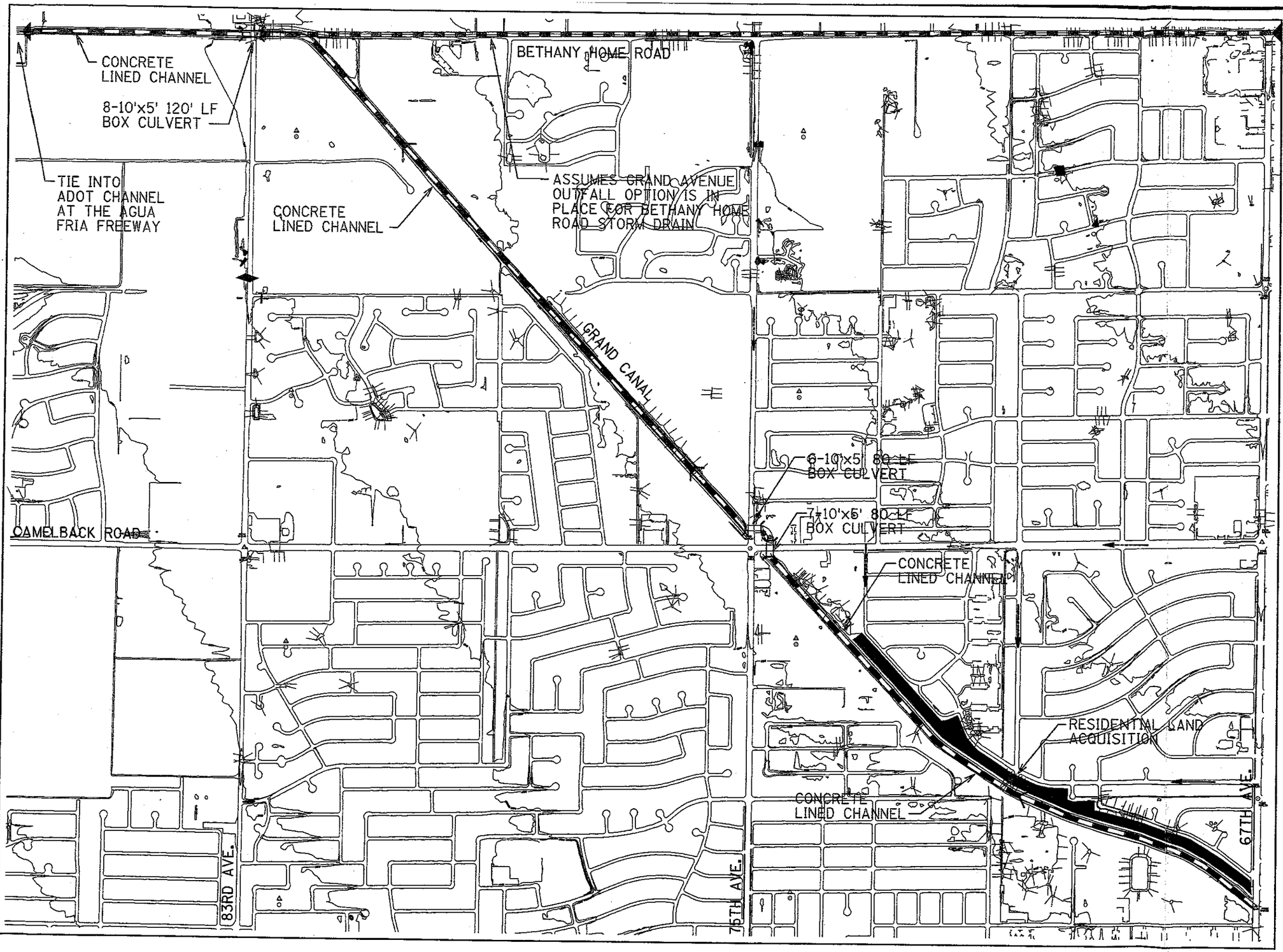
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 15 OF 24

C6-2.DGN



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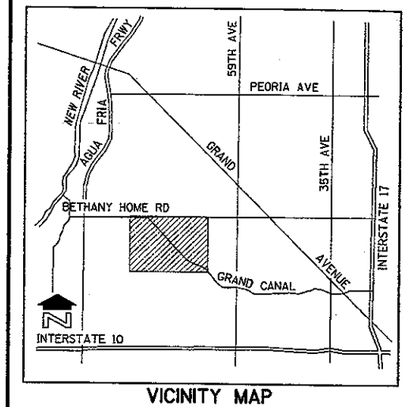
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 1, 100-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 16 OF 24

CONCRETE LINED CHANNEL

8-10'x15' 120 LF BOX CULVERT

TIE INTO ADOT CHANNEL AT THE AGUA FRIA FREEWAY

BETHANY HOME ROAD

ASSUMES GRAND AVENUE OUTFALL OPTION IS IN PLACE FOR BETHANY HOME ROAD STORM DRAIN

CONCRETE LINED CHANNEL

GRAND CANAL

6-10'x5' 80 LF BOX CULVERT

5280 LF 90" PIPE FROM 59TH AVE.

2640 LF 2-84" PIPES

CAMELBACK ROAD

7-10'x5' 80 LF BOX CULVERT

CONCRETE LINED CHANNEL

2640 LF 2-78" PIPES

67TH AVE.

RESIDENTIAL LAND ACQUISITION (63 LOTS)

83RD AVE.

75TH AVE.

A102-2.DGN

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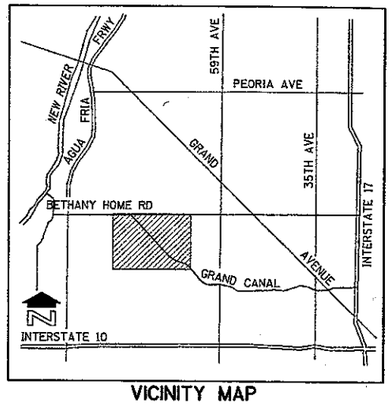
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 2 , 100-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

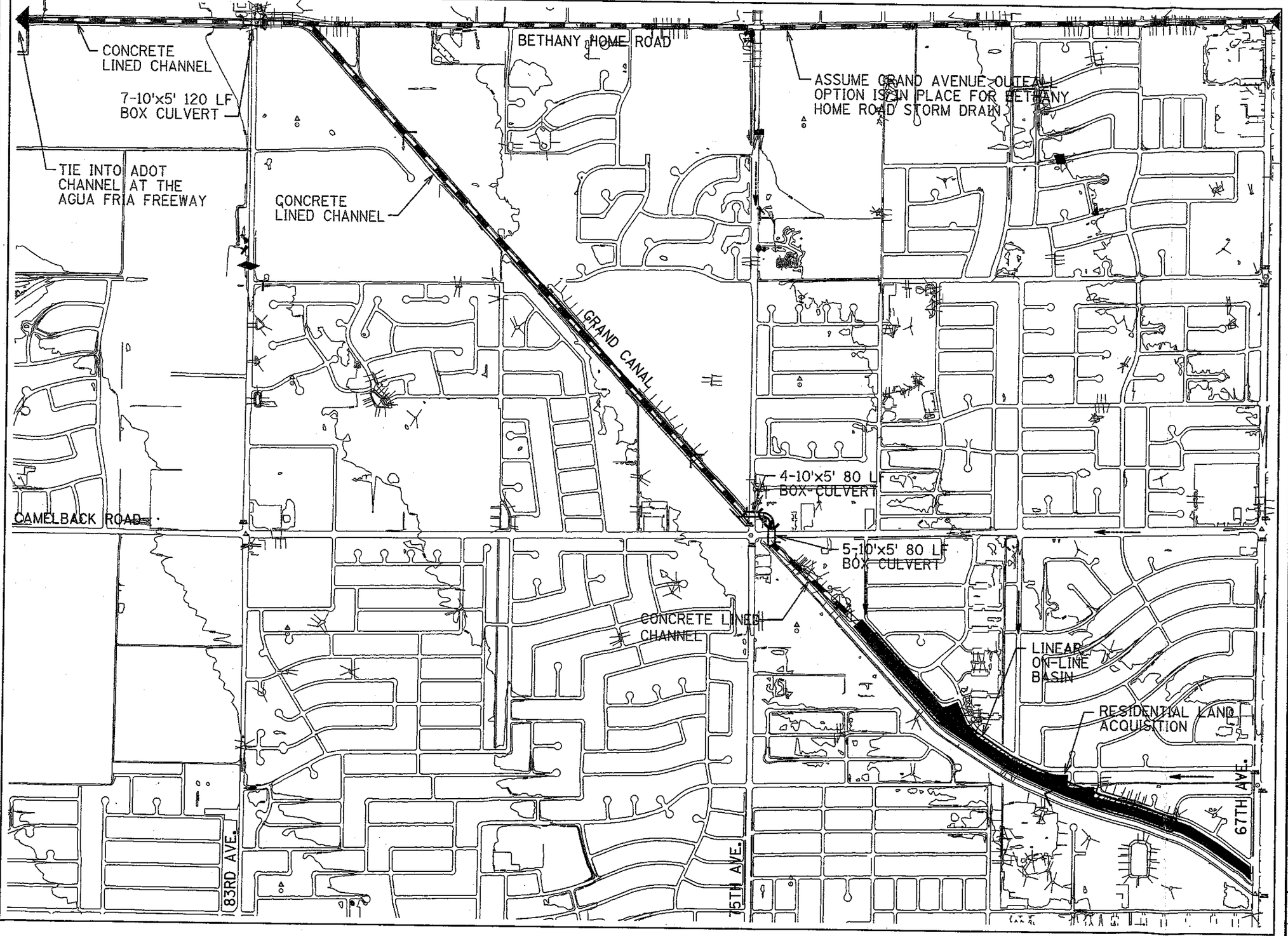
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: _____ DATE

APPROVED BY: _____ DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 17 OF 24



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PROJECT NO. 94154.00

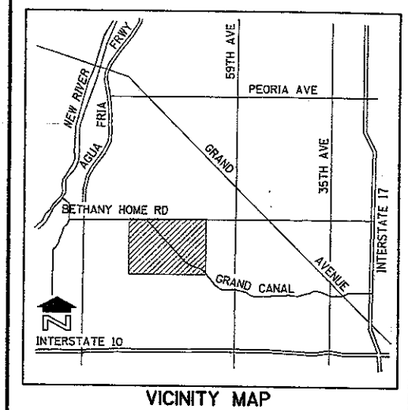
A4-2.DGN

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 4, 100-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

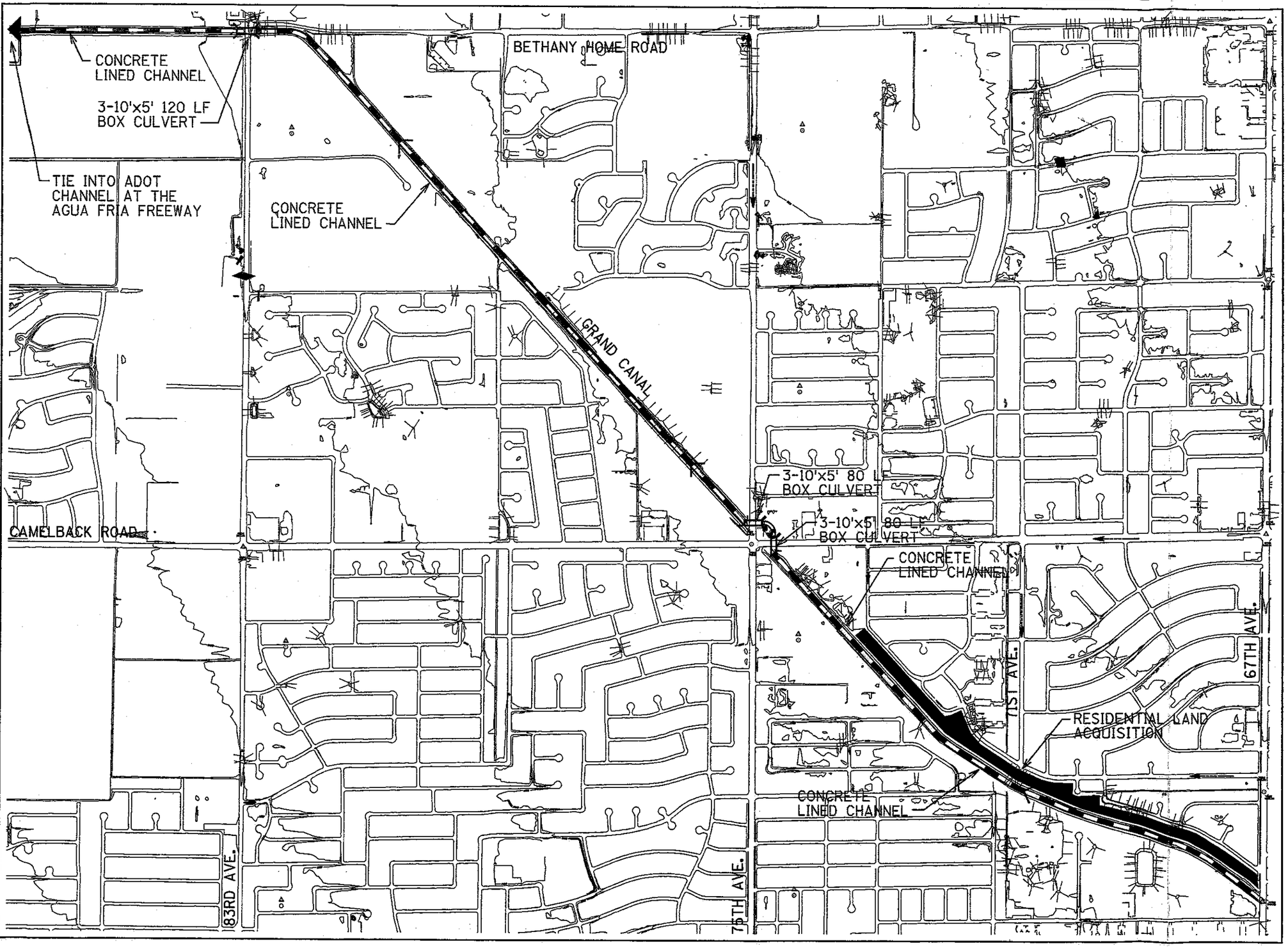
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 18 OF 24



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PROJECT NO. 94154.00

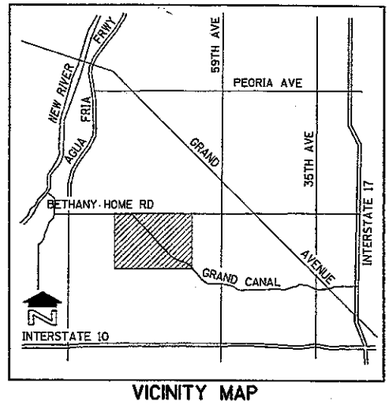
AS-2.DGN

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 1, 10-YEAR

N

500 0 500 1000

SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

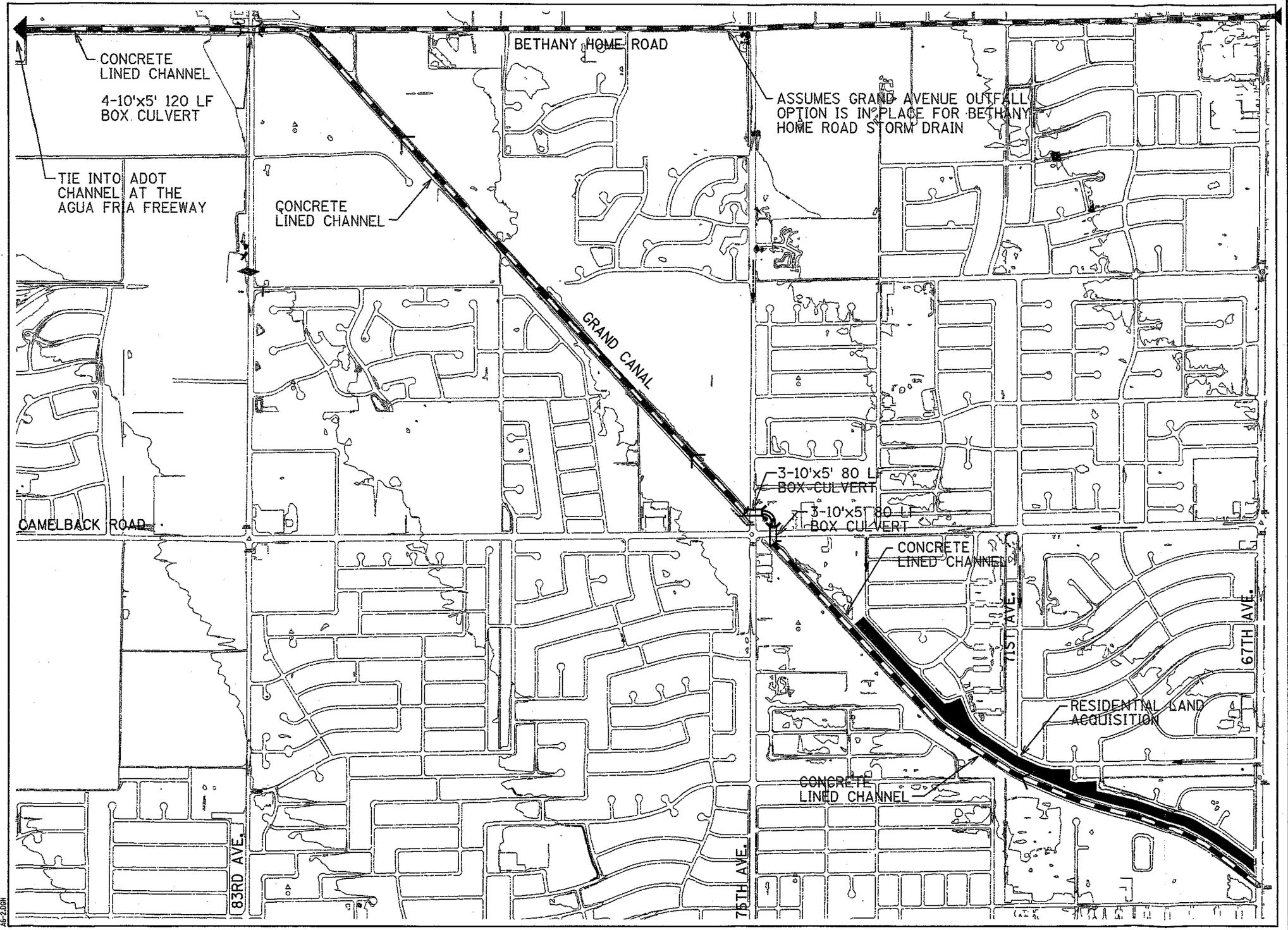
	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER



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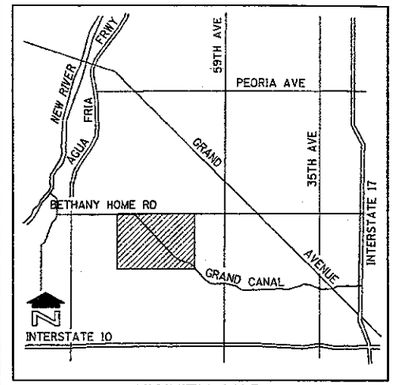
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 2, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

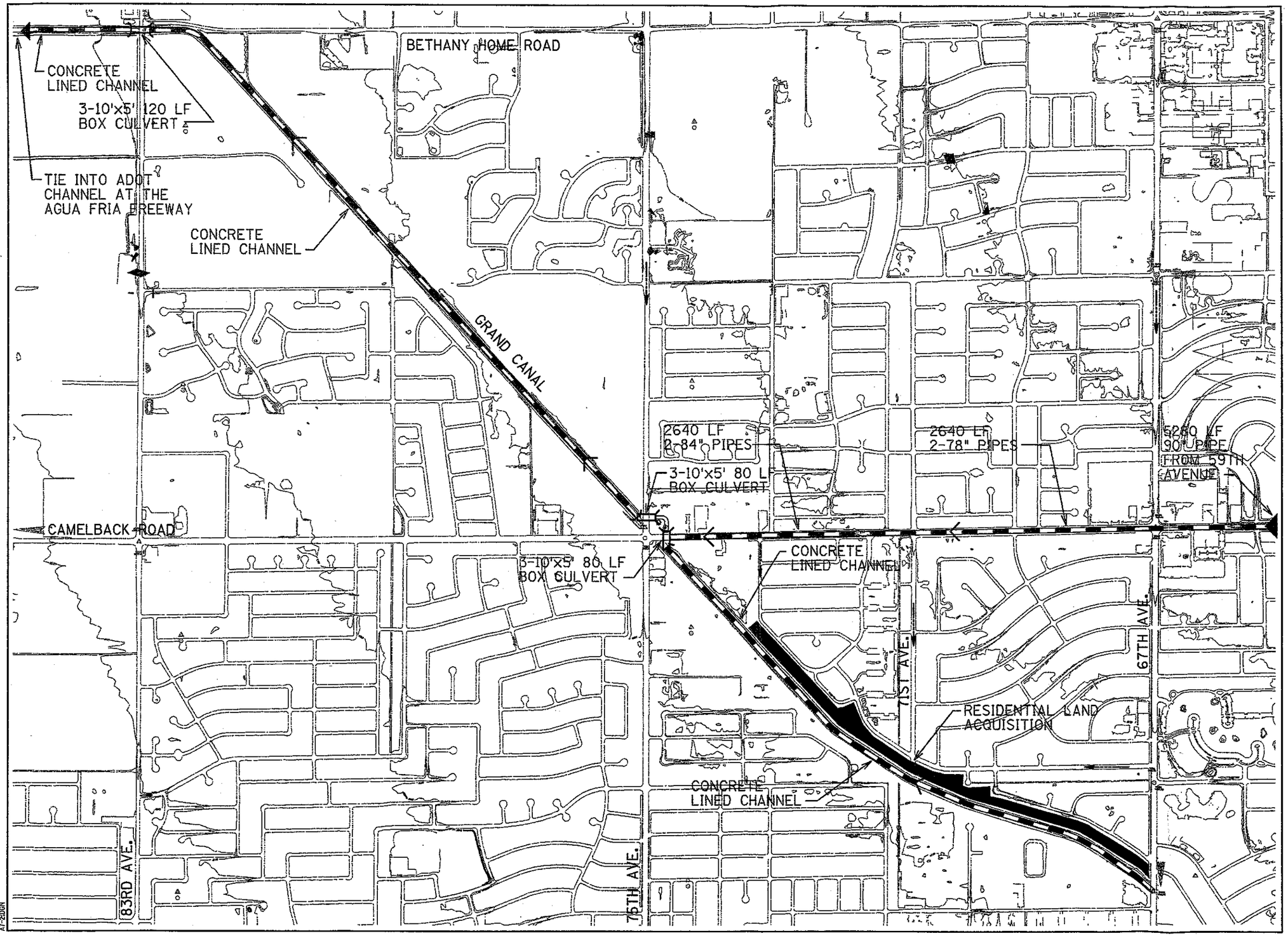
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 20 OF 24

AS-2.DGN



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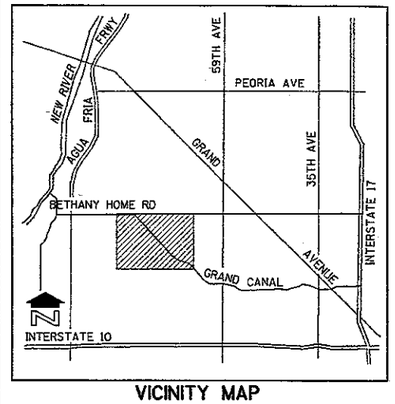
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 3, 10-YEAR

N

500 0 500 1000

SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 21 OF 24

AT-200N

BETHANY HOME ROAD

CONCRETE LINED CHANNEL

4-10'x5' 120 LF BOX CULVERT

TIE INTO ADOT CHANNEL AT THE AGUA FRIA FREEWAY

CONCRETE LINED CHANNEL

GRAND CANAL

ASSUMES GRAND AVENUE OUTFALL OPTION IS IN PLACE FOR BETHANY HOME ROAD STORM DRAIN

2640 LF 2-78" PIPES

2640 LF 2-66" PIPES

5280 LF 78" PIPE FROM 59TH AVENUE

3-10'x5' 80 LF BOX CULVERT

CAMELBACK ROAD

3-10'x5' 80 LF BOX CULVERT

CONCRETE LINED CHANNEL

67TH AVE.

71ST AVE.

RESIDENTIAL LAND ACQUISITION

CONCRETE LINED CHANNEL

83RD AVE.

75TH AVE.

A8-2.DGN

NOTE:
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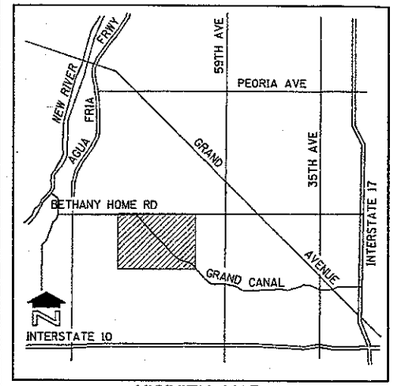
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 4, 10-YEAR

N

500 0 500 1000

SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:		DATE:

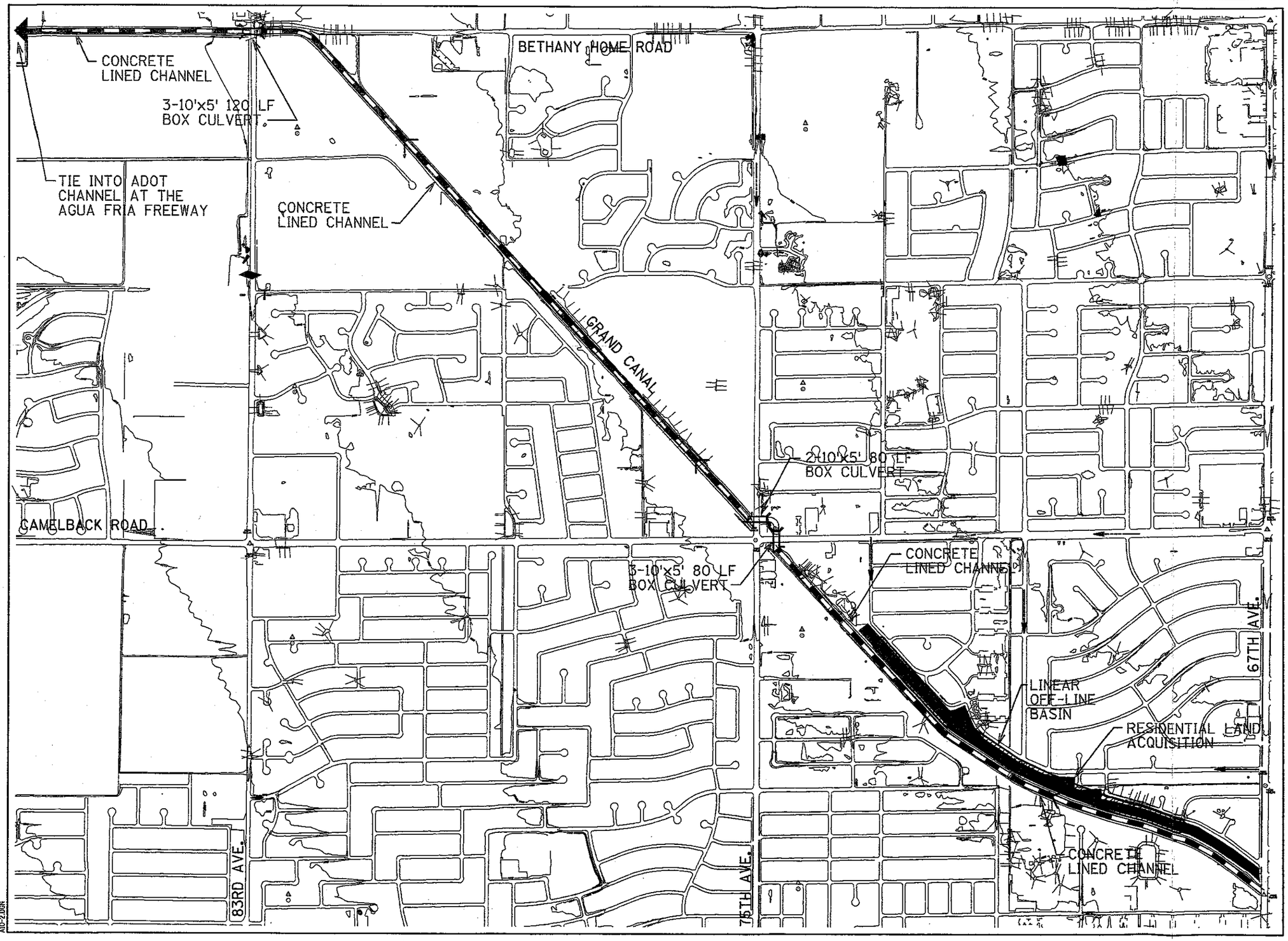
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 22 OF 24



A10-2.DGN

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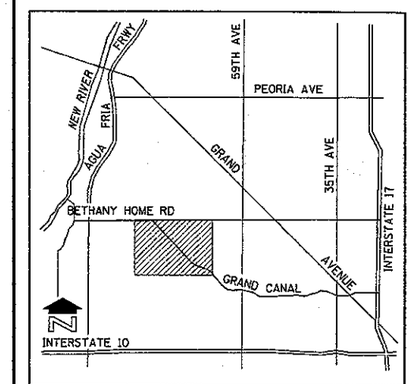
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MITIGATION OPTION 6, 10-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

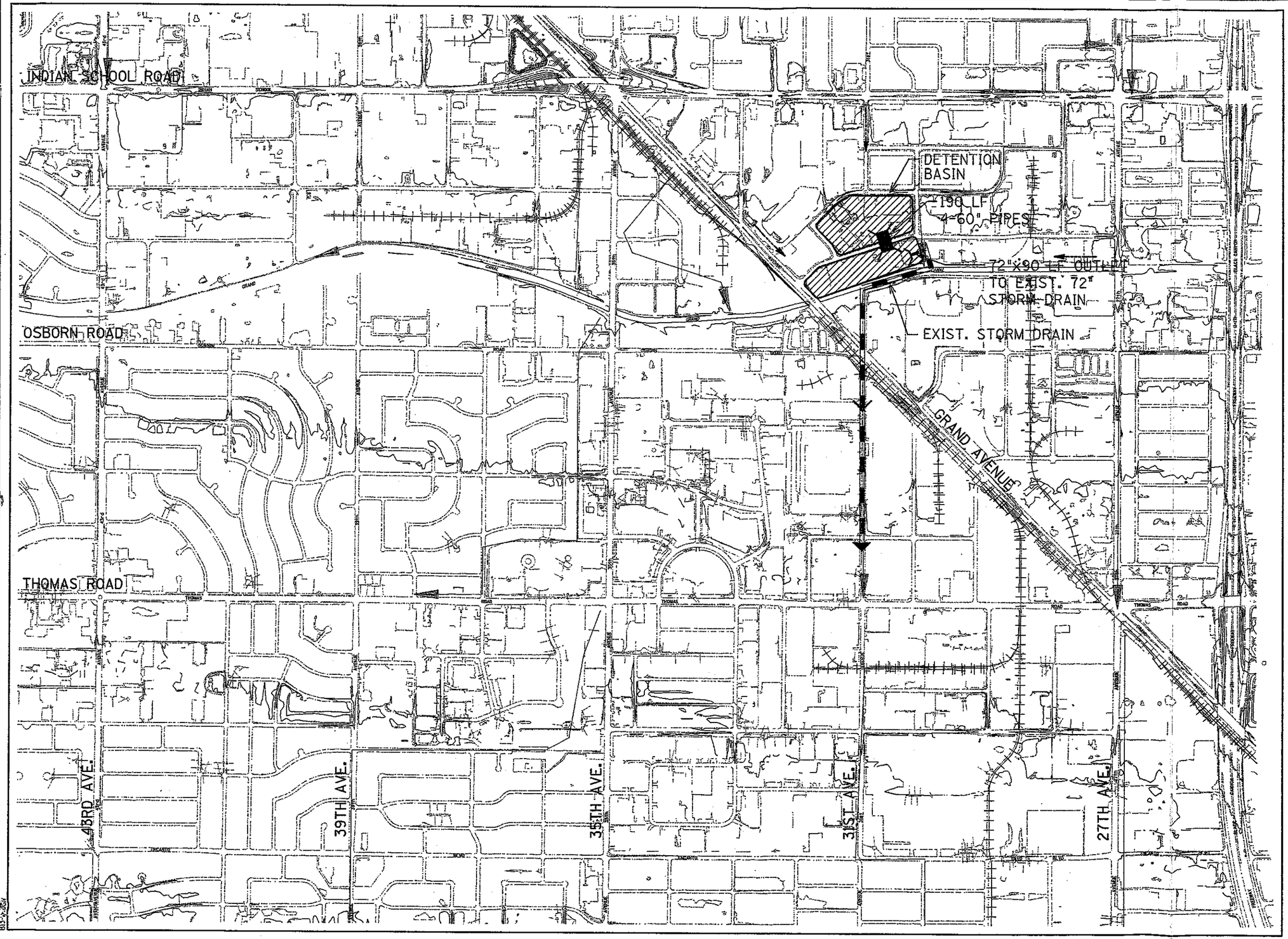
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 23 OF 24



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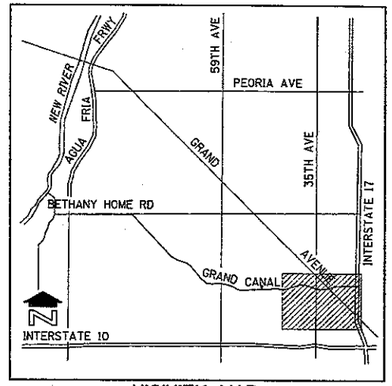
PROJECT NO. 94154.00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL II

GRAND CANAL AT 31ST AVENUE

MITIGATION OPTION 1, 5-YEAR

500 0 500 1000
SCALE IN FEET
CONTOUR INTERVAL = 10 FEET

WOOD, PATEL & ASSOCIATES, INC.

	BY	DATE
DESIGN	JT/AR	
DESIGN CHK.	DP/JM	
PLANS	SH/AL	
PLANS CHK.	JM/AP	
SUBMITTED BY:	DATE:	

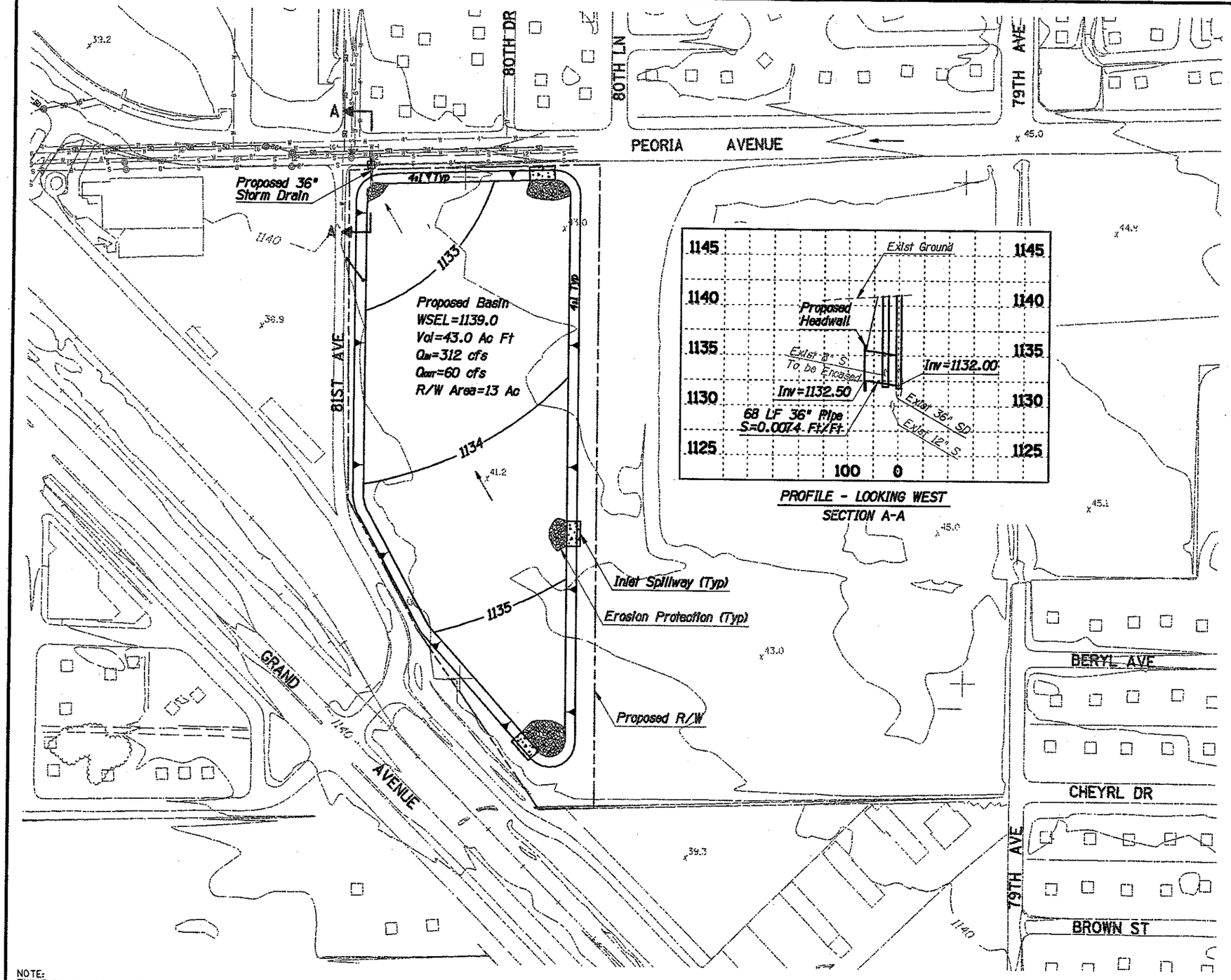
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

FIGURE 8 SHEET 24 OF 24



PROFILE - LOOKING WEST
SECTION A-A

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE

NOTE:
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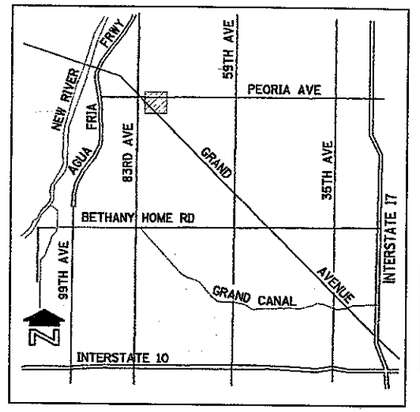
NOTE: Depiction of Inlet Spillways is Conceptual. Size, Number & Location of Required Spillways to be Determined With Final Design.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 79TH AVENUE

MITIGATION OPTION 1, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

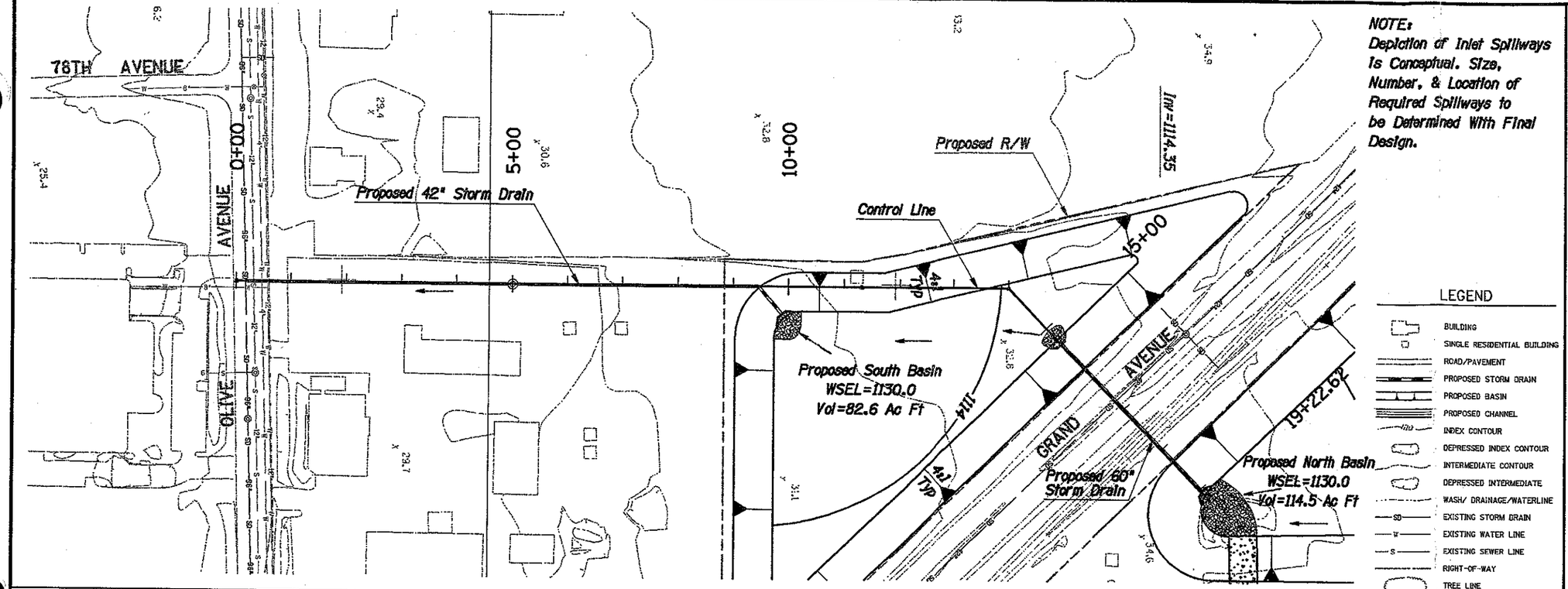
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN | FIGURE 9 | SHEET 1 OF 44

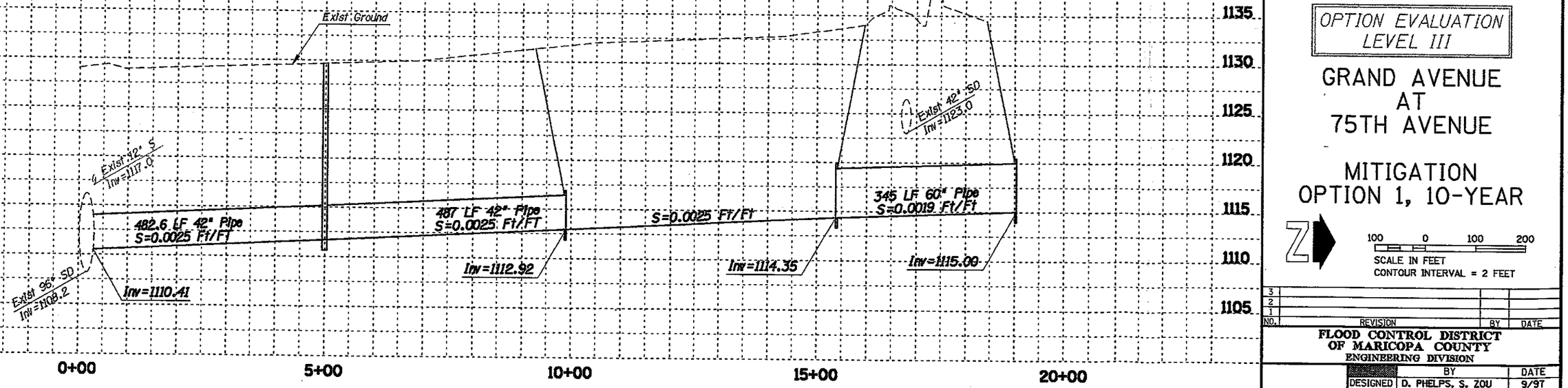
TRACS NO.



NOTE:
Depiction of Inlet Spillways is Conceptual. Size, Number, & Location of Required Spillways to be Determined With Final Design.

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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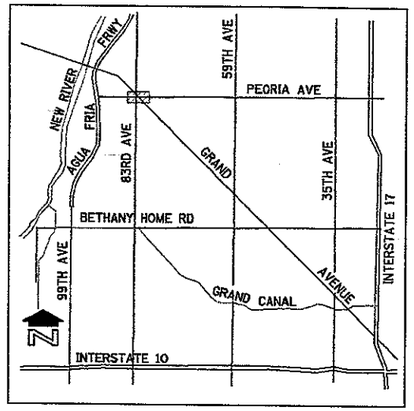
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 75TH AVENUE

MITIGATION OPTION 1, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

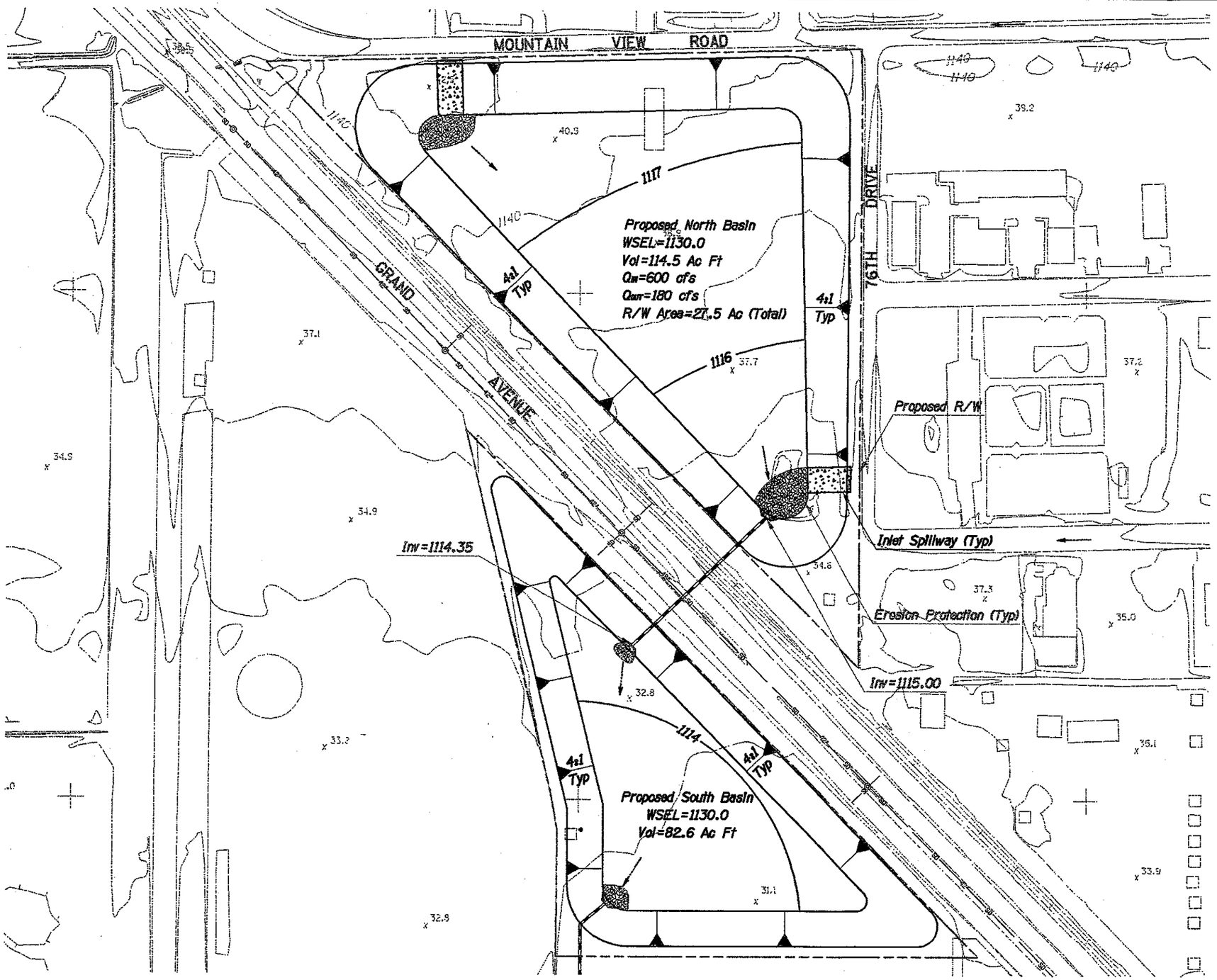
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 0+00 TO 19+30

FIGURE	SHEET	OF
9	2	44

TRACS NO.



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LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- 50 EXISTING STORM DRAIN
- W EXISTING WATER LINE
- S EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE

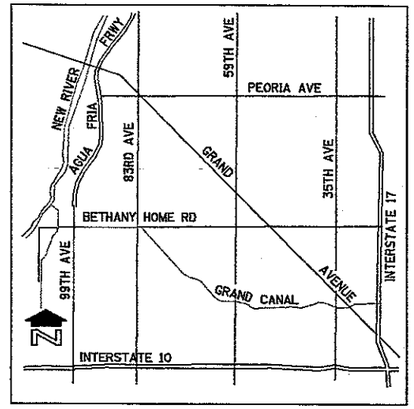
NOTE:
Depiction of Inlet Spillways is Conceptual. Size, Number, & Location of Required Spillways to be Determined With Final Design.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 75TH AVENUE

MITIGATION OPTION 1, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

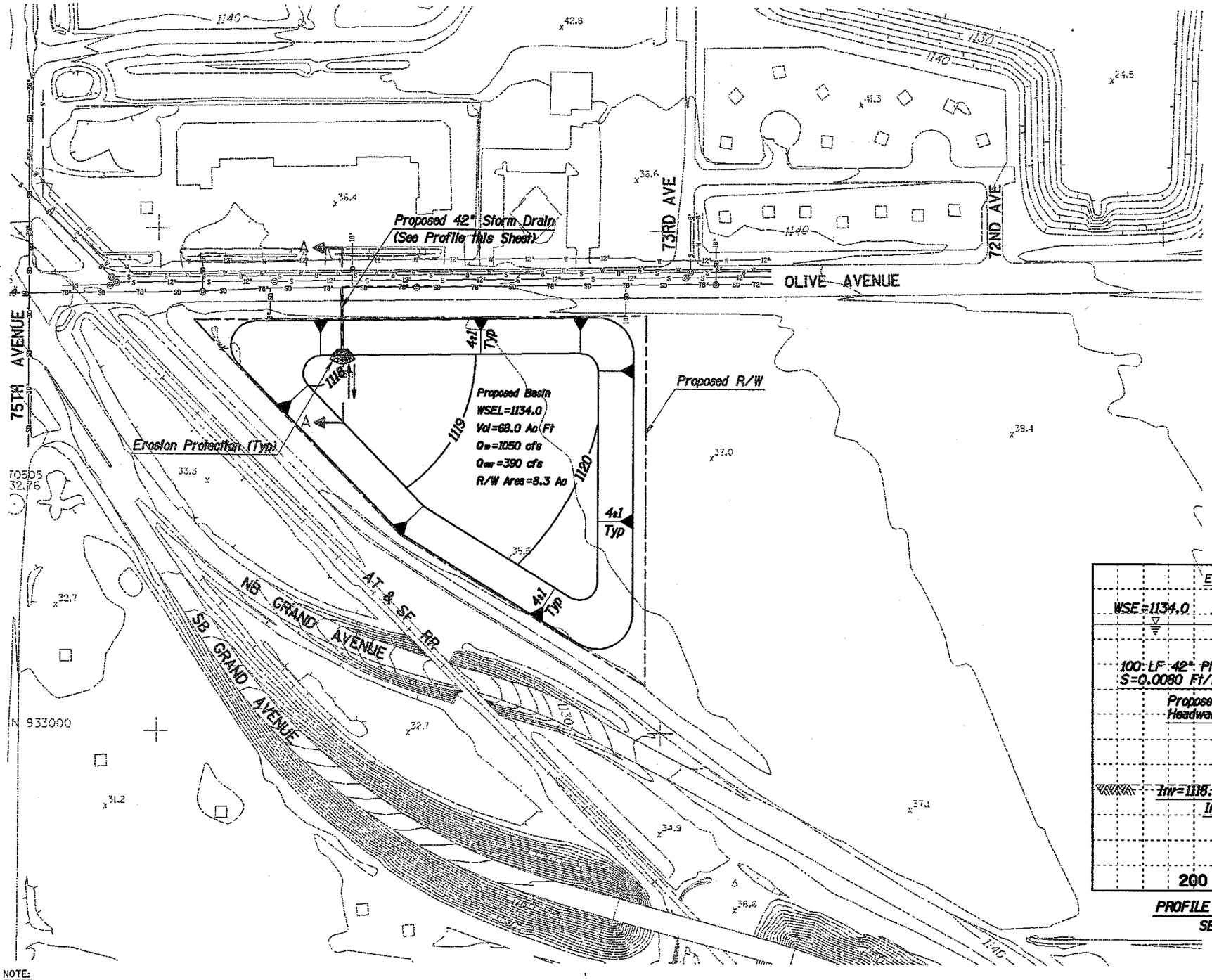
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

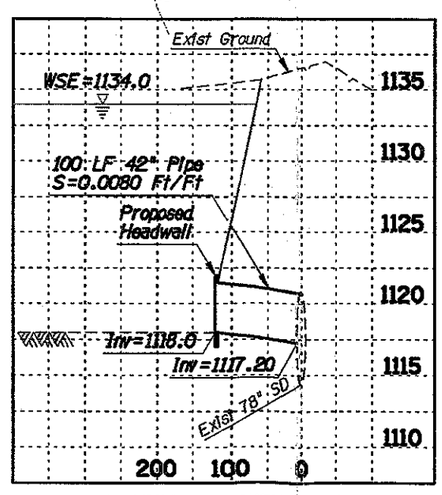
DRAINAGE SYSTEM PLAN | FIGURE 9 | SHEET OF 3 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED-CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



PROFILE - LOOKING WEST
SECTION A-A

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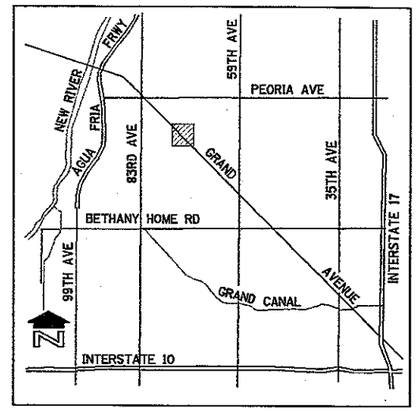
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 73RD AVENUE

MITIGATION OPTION 1, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

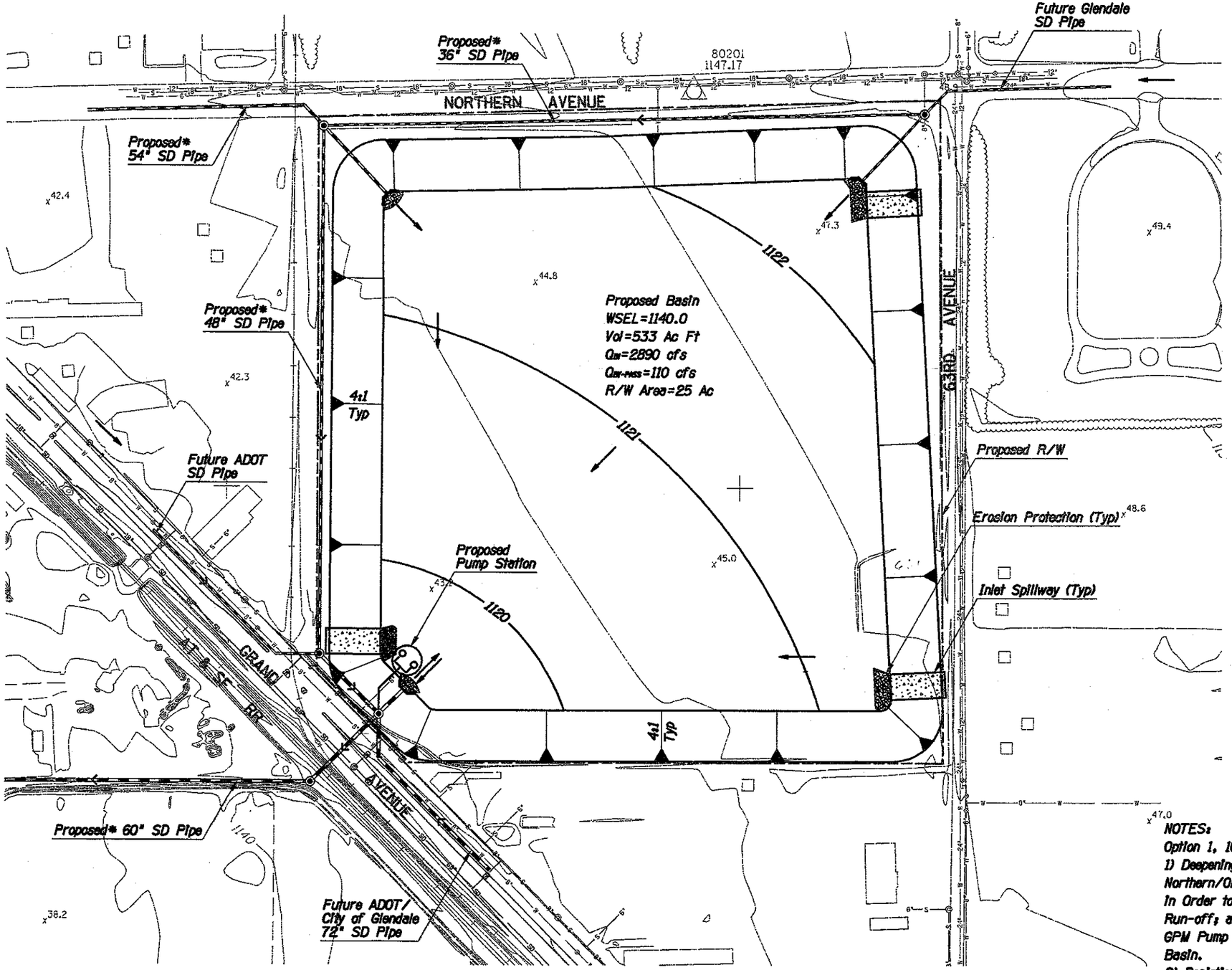
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN | FIGURE 9 | SHEET 4 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE
- FLOW DIRECTION

NOTES:
Option 1, 100-Year Only Consists of 1) Deepening & Enlarging the Proposed Northern/Orangewood 10-Year Basin In Order to Contain the 100-Year Run-off; and Installing a 36,000 GPM Pump Station to Drain the Deeper Basin. 2) Depiction of Inlet Spillways is Conceptual Size, Number & Location of Required Spillways to be Determined with Final Design

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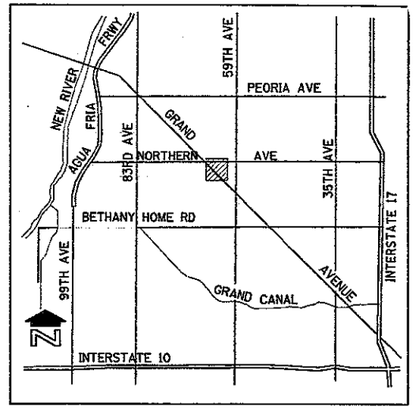
* Northern/Orangewood Project

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 67TH AVENUE

MITIGATION OPTION 1, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

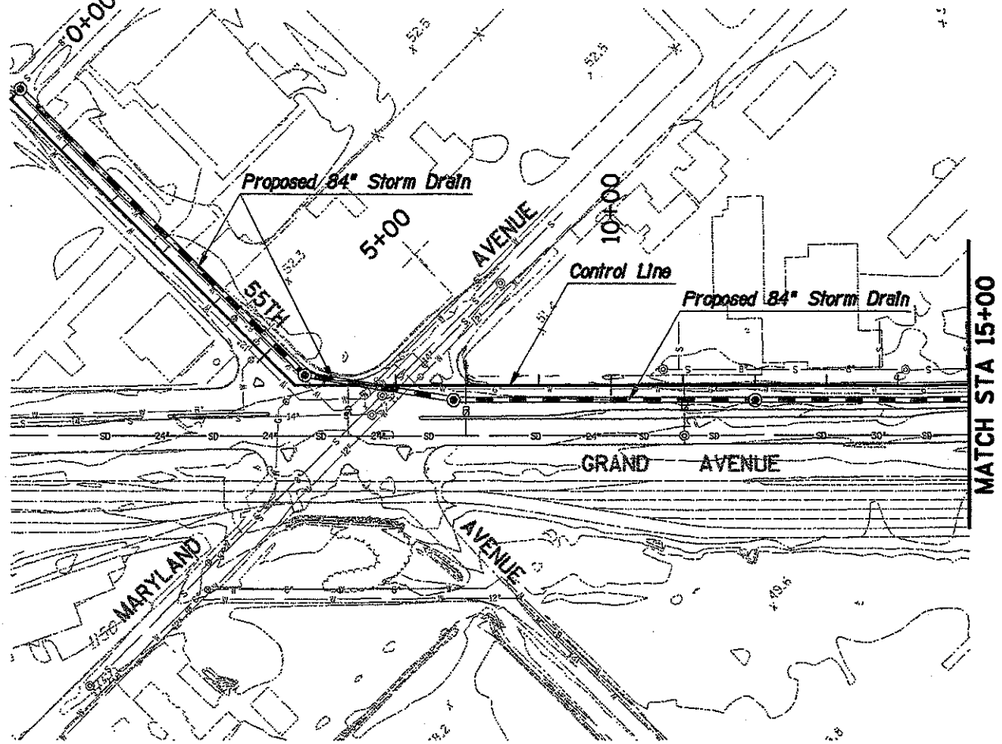
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

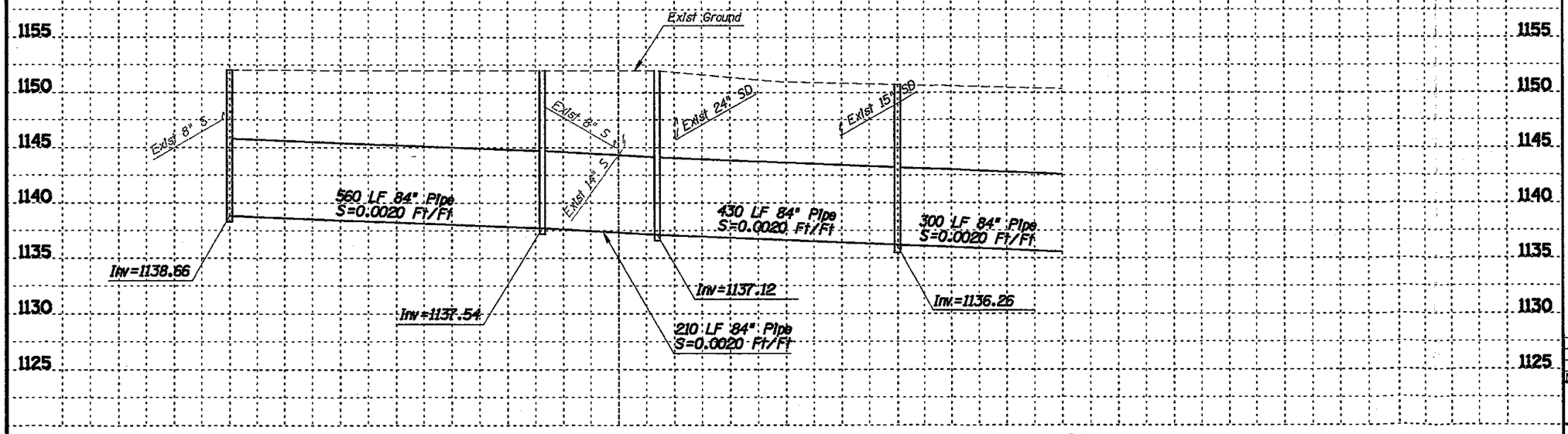
DRAINAGE SYSTEM PLAN | FIGURE 9 | SHEET OF 5 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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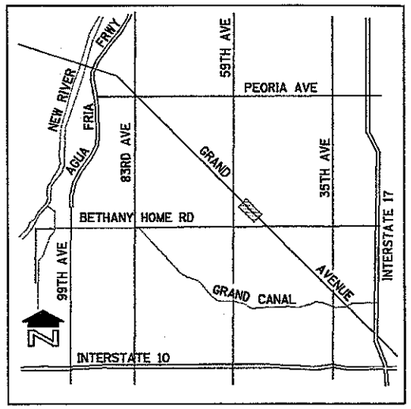
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

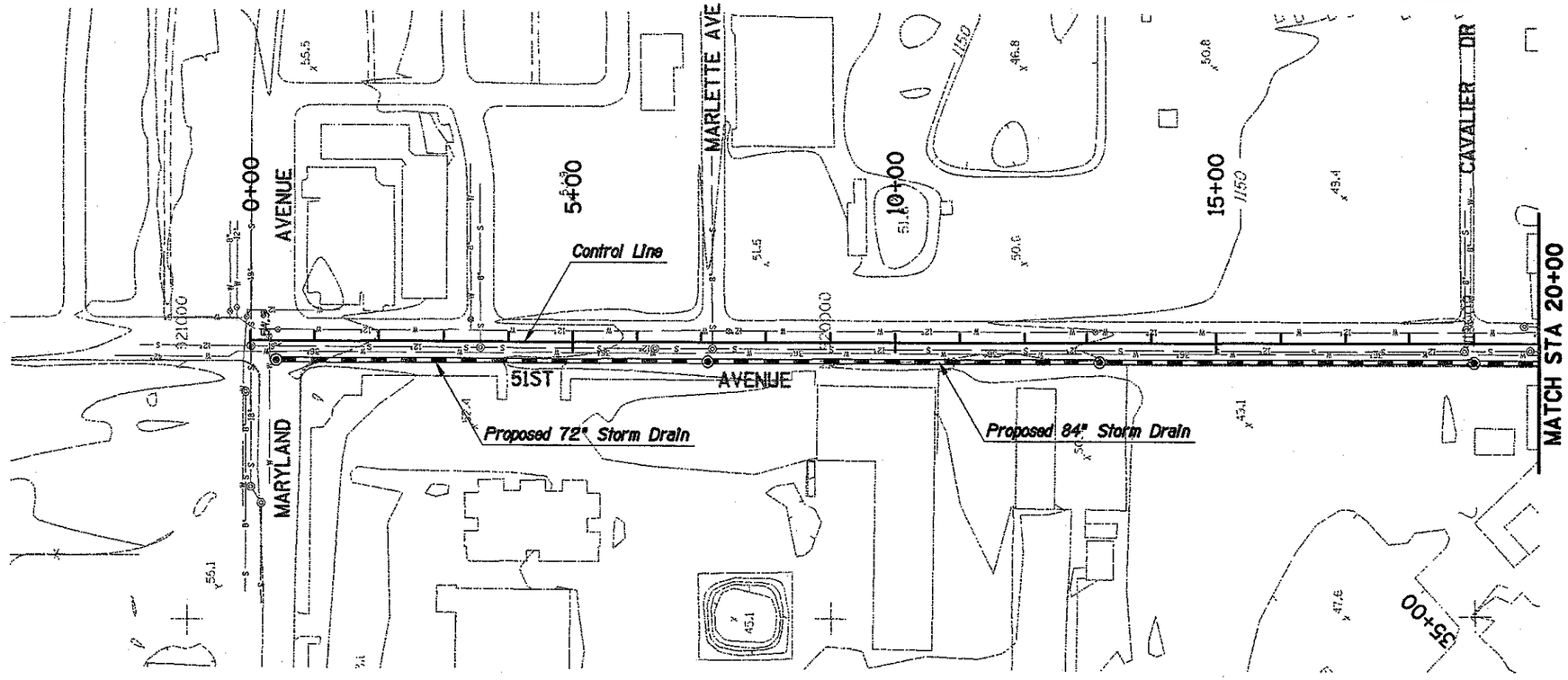
CONCEPT PLAN		BY	DATE
	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 0+00 TO 15+00

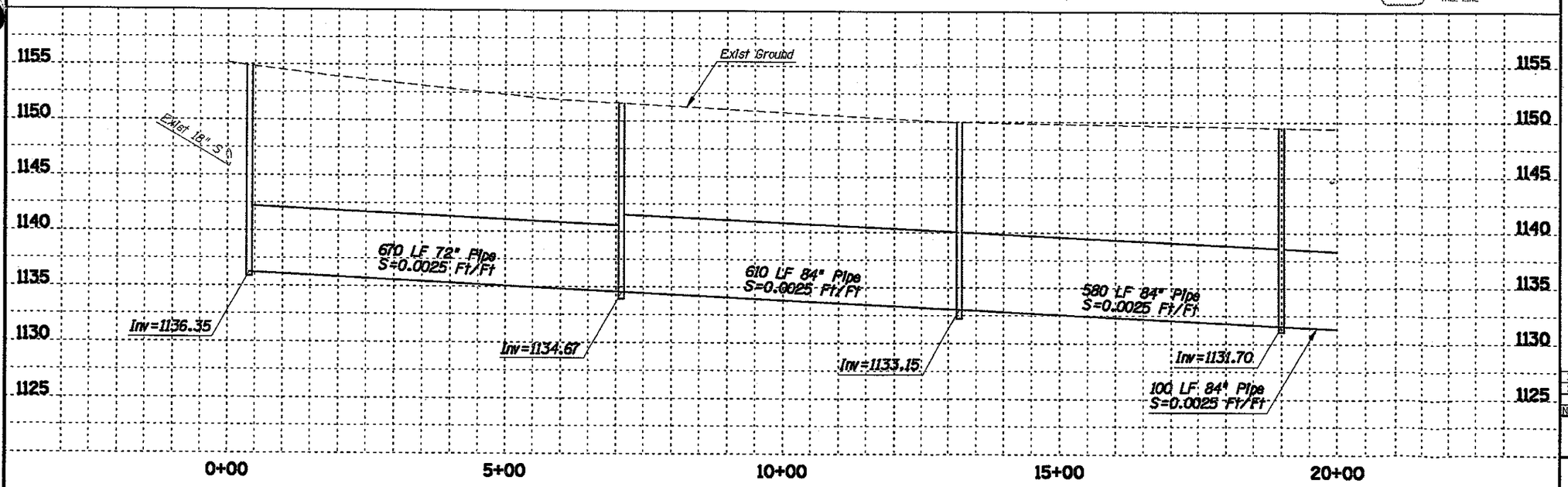
FIGURE 9 | SHEET 6 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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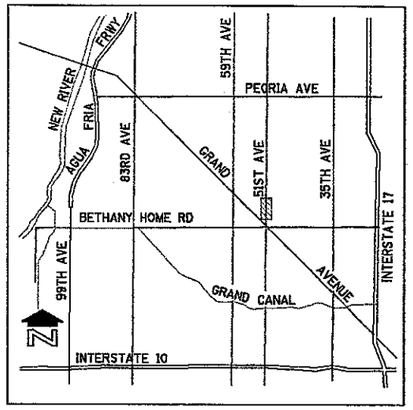
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

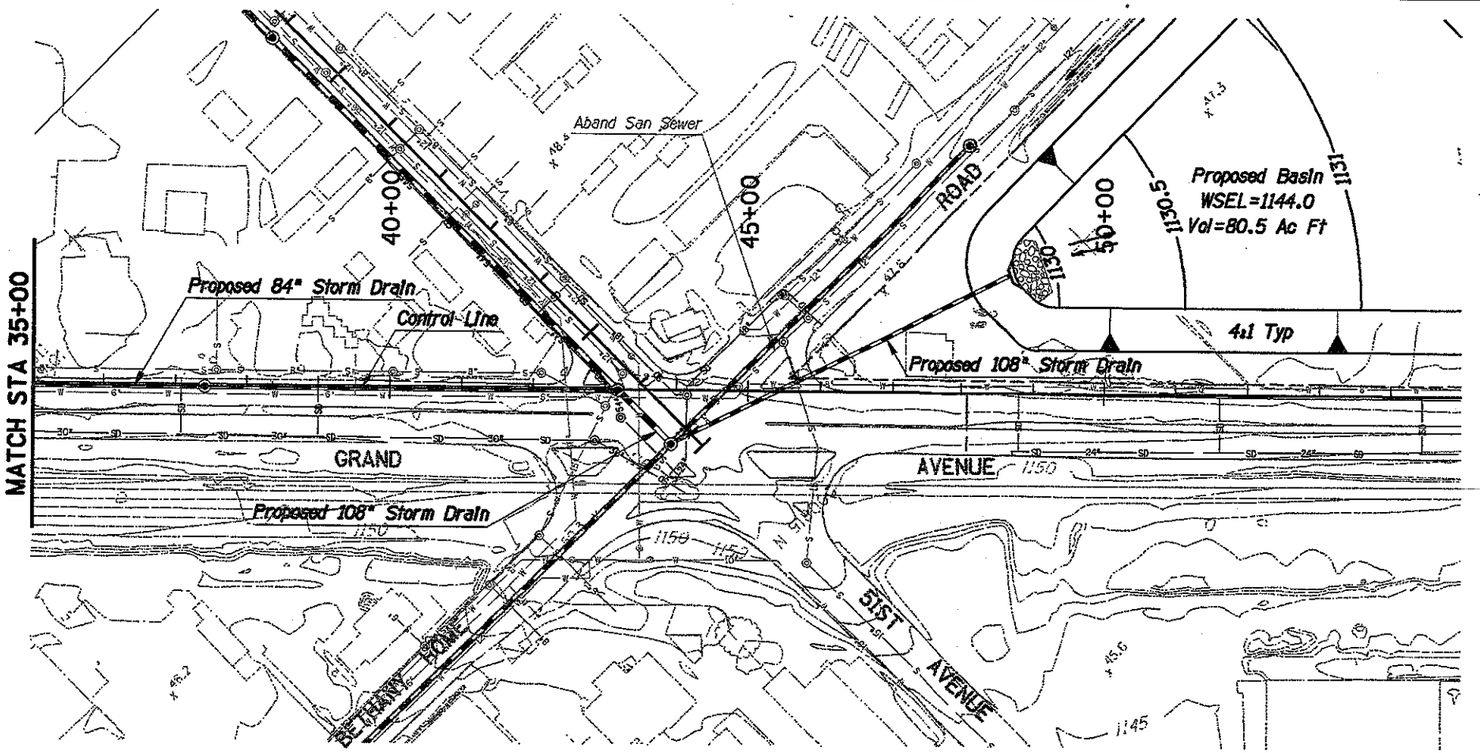
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 0+00 TO 20+00

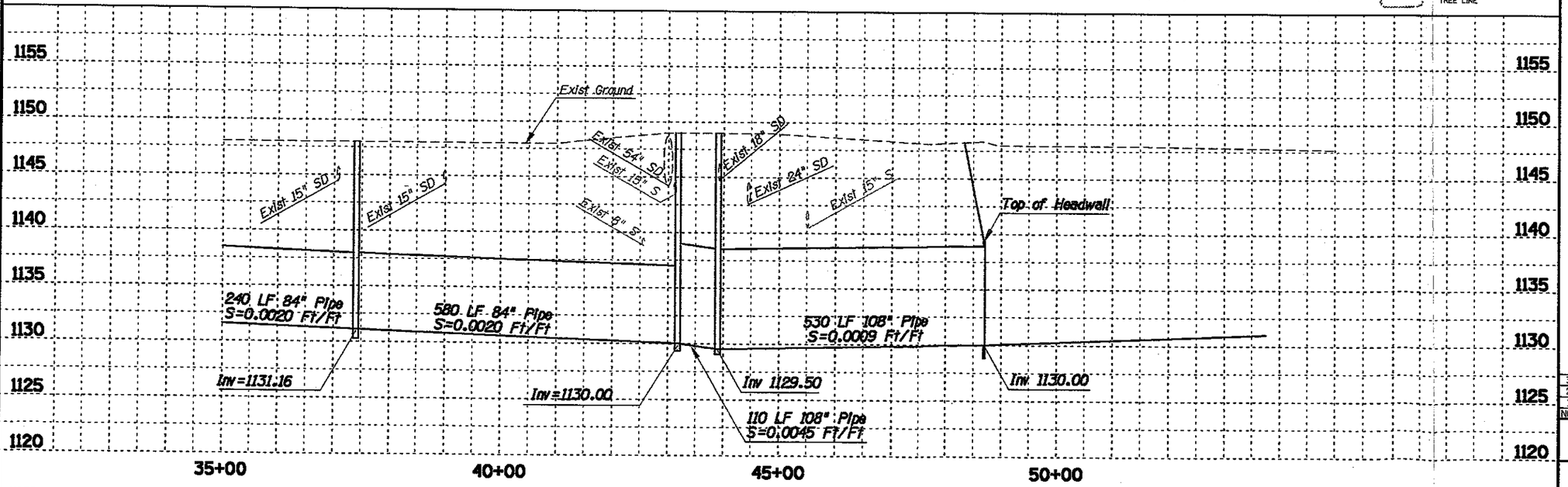
FIGURE	SHEET	OF
9	9	44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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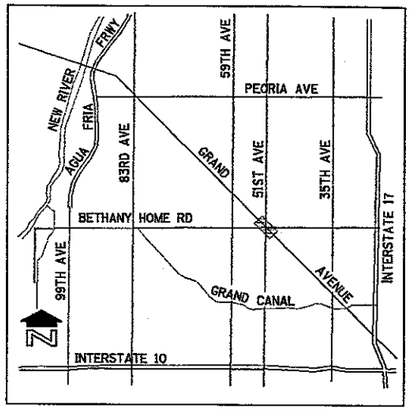
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

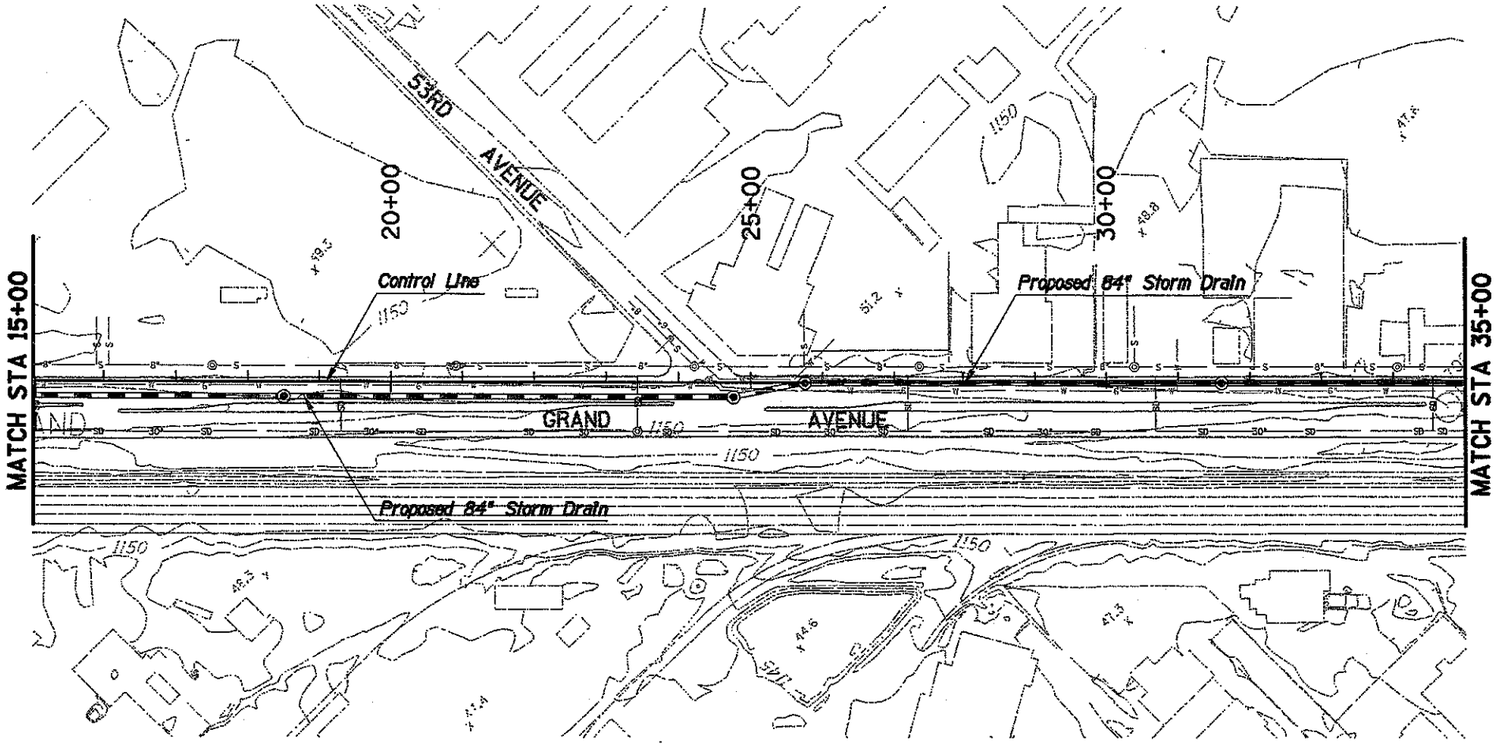
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 35+00 TO 48+70

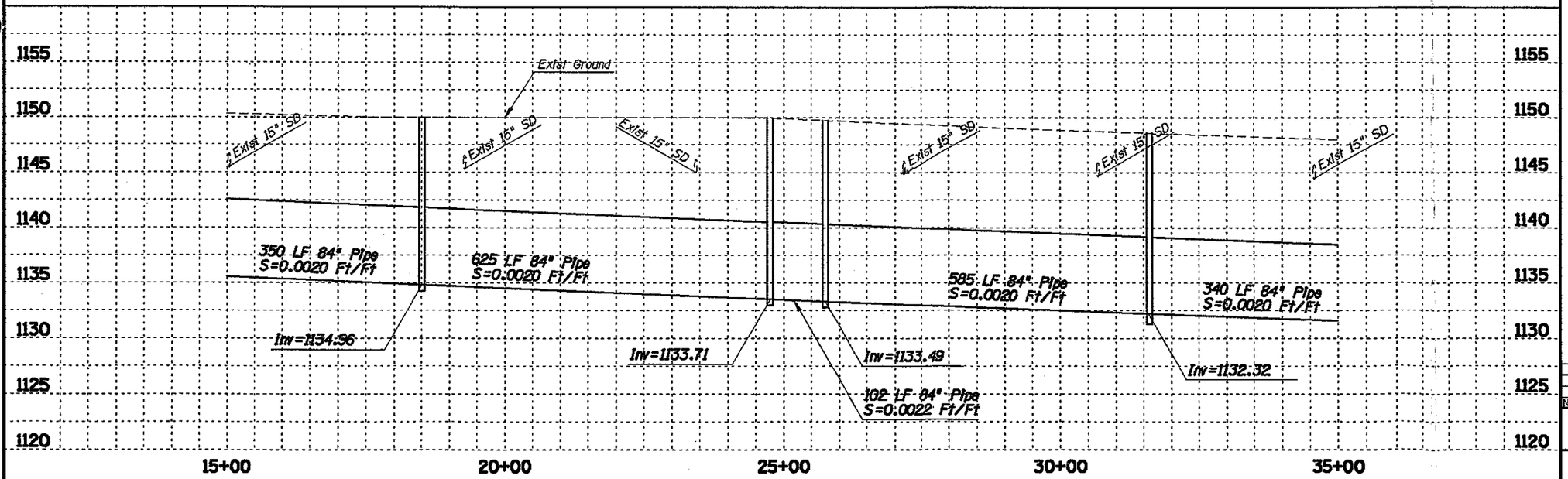
FIGURE 9 | SHEET 8 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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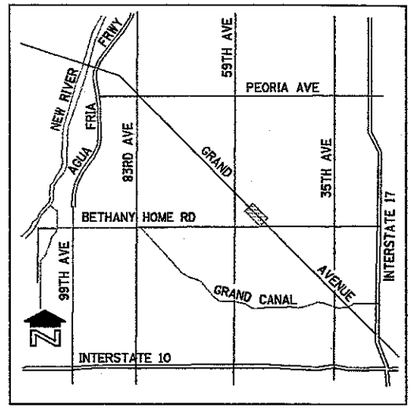
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

- MITIGATION OPTION 6, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

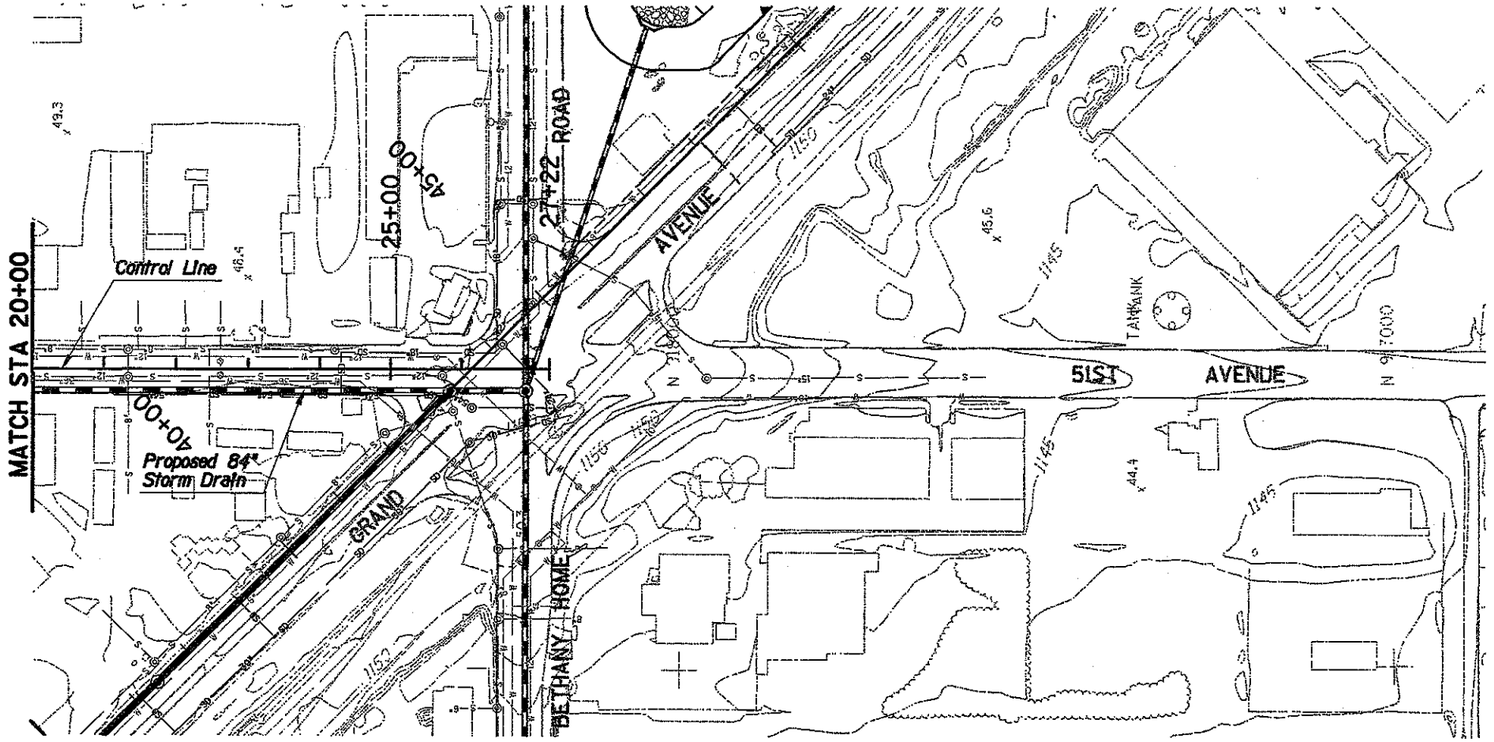
		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 15+00 TO 35+00

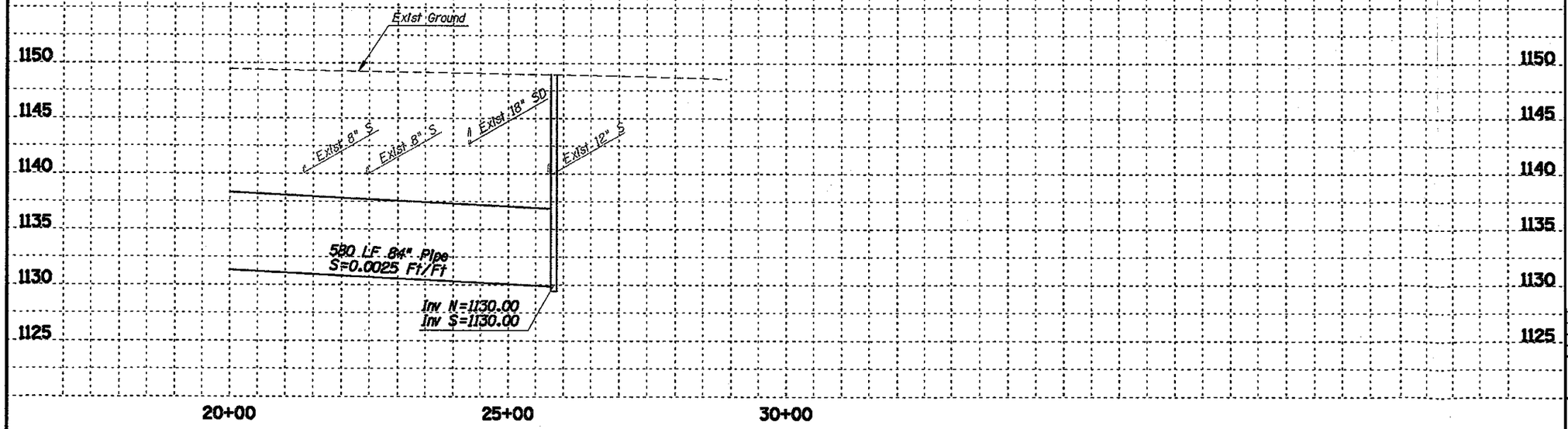
FIGURE 9 | SHEET 7 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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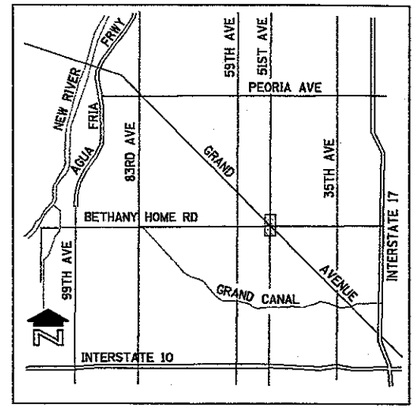
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

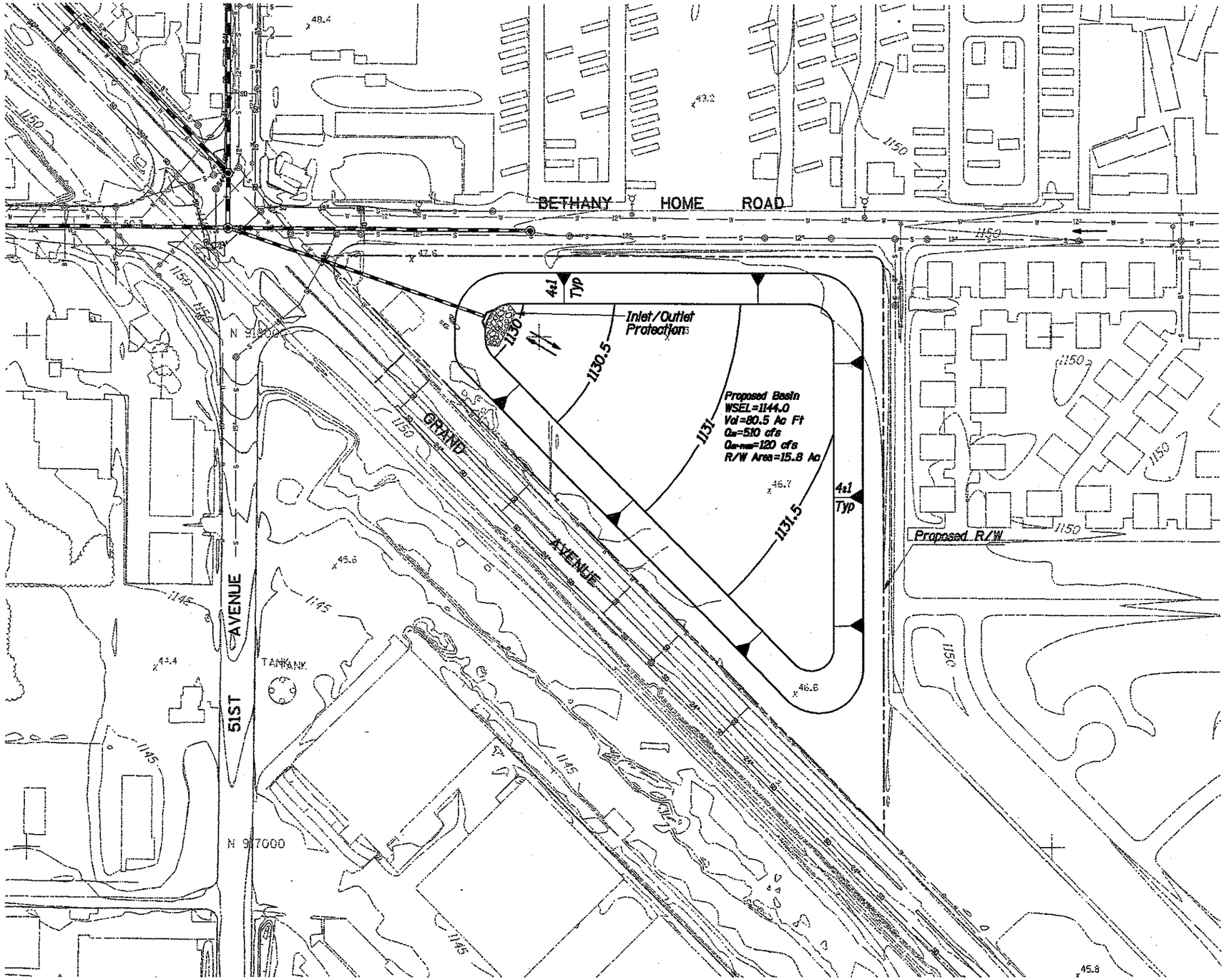
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 20+00 TO 26+89.5

FIGURE 9 | SHEET 10 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
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- RIGHT-OF-WAY
- TREE LINE

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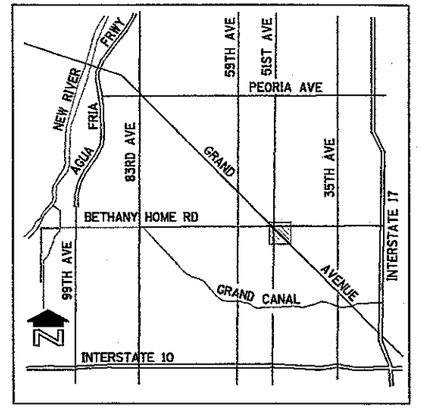
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
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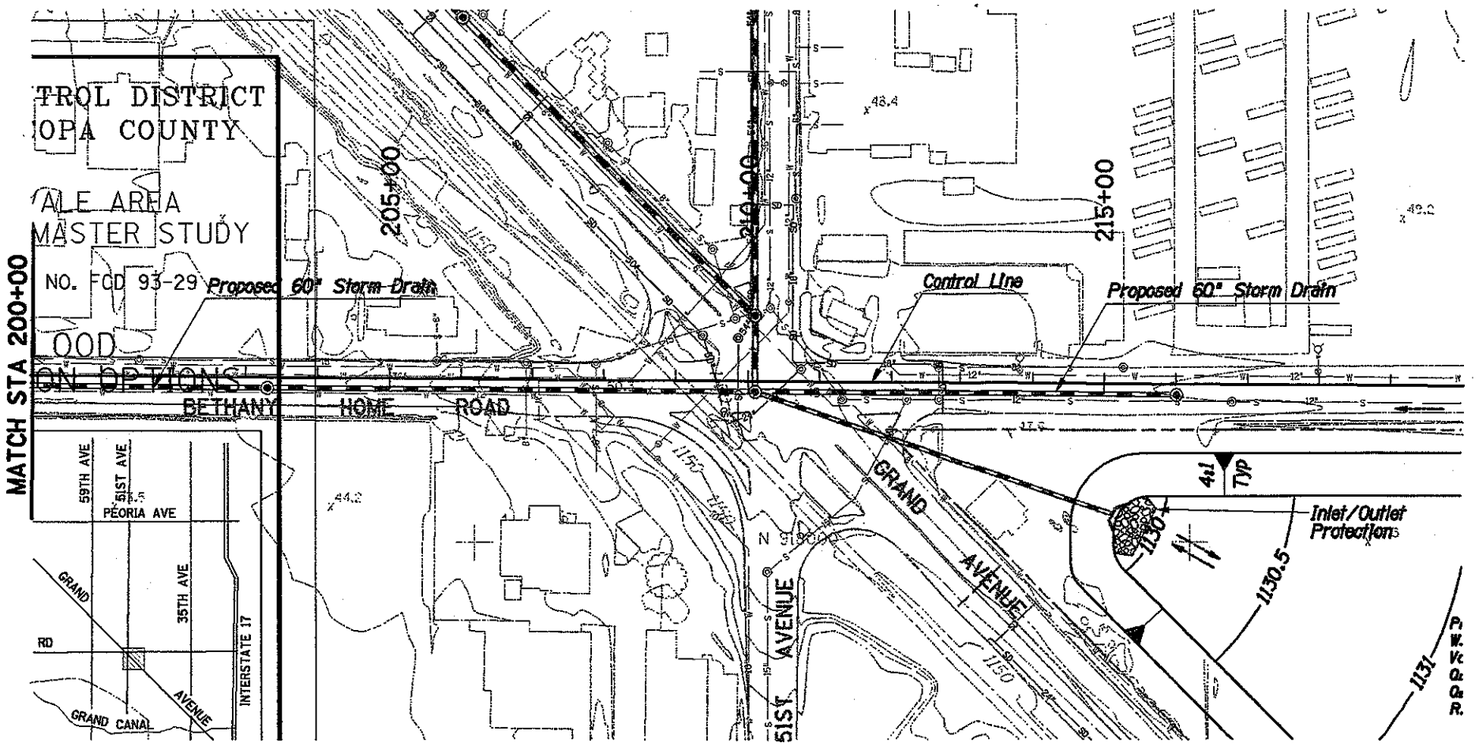
CONCEPT PLAN

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN

FIGURE 9 | SHEET 11 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
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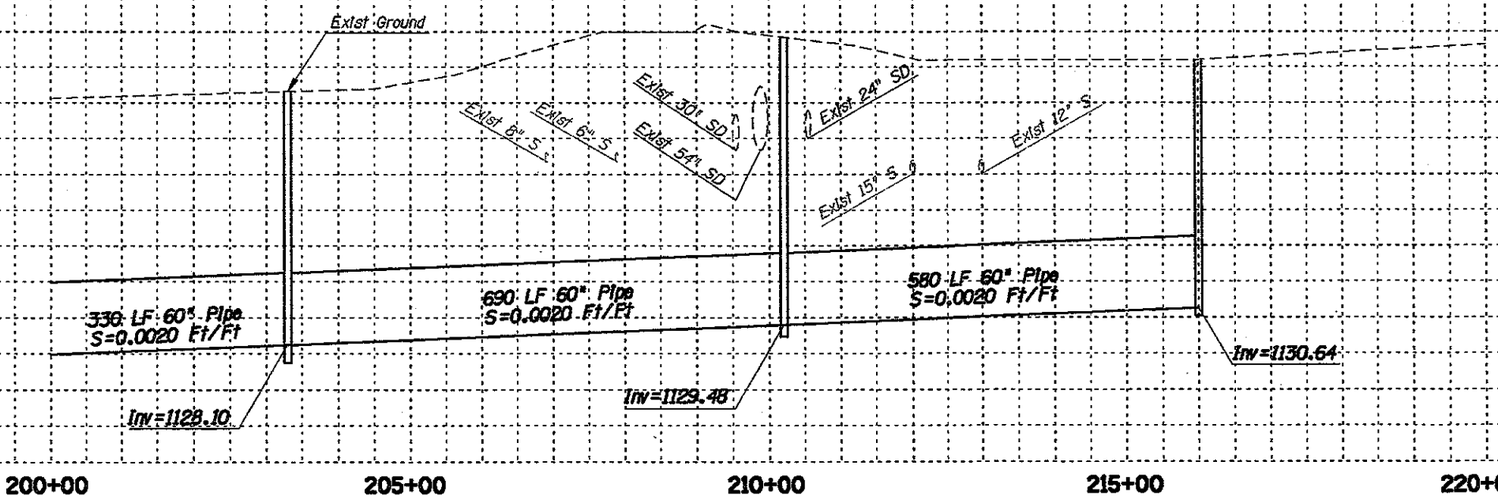
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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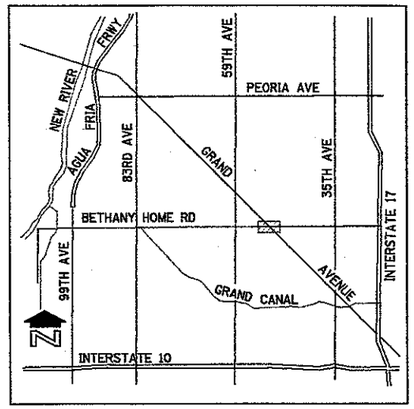
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

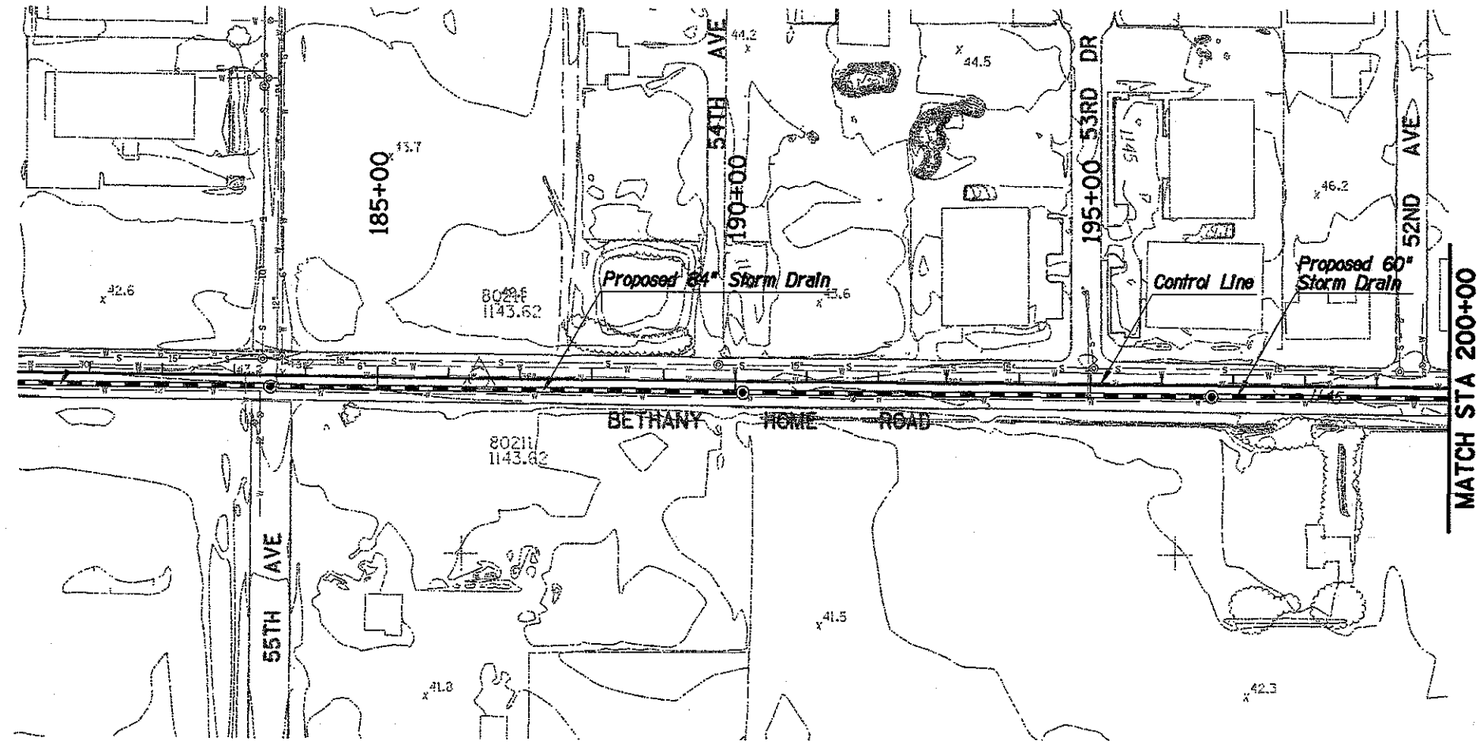
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 200+00 TO 216+00

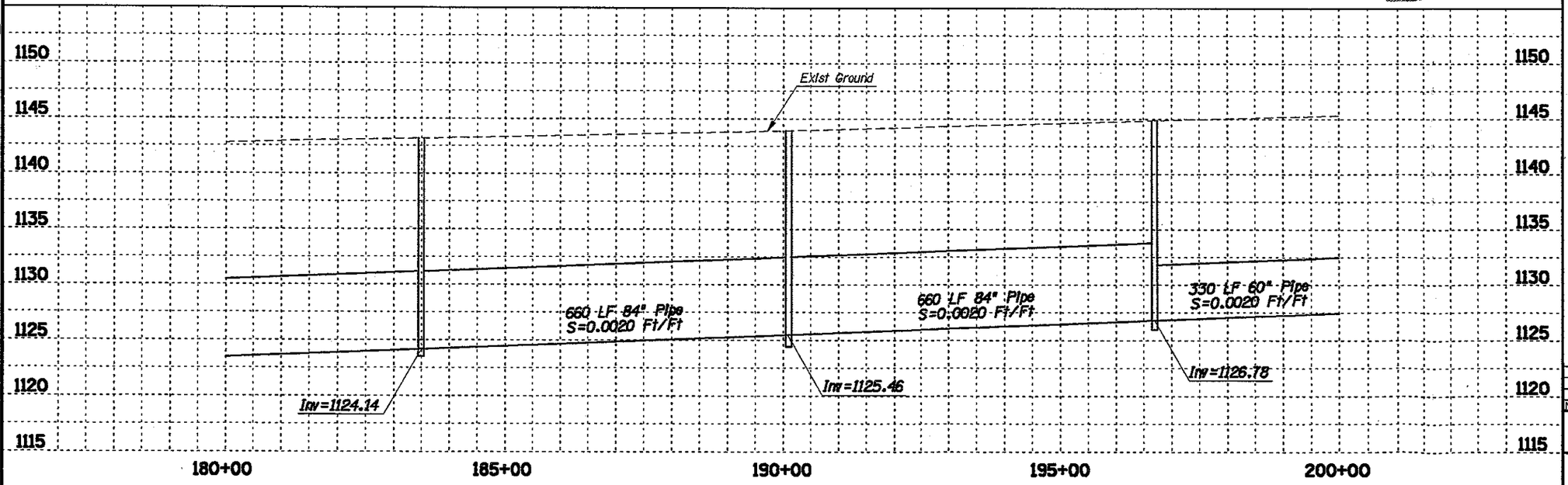
FIGURE	SHEET	OF
9	12	44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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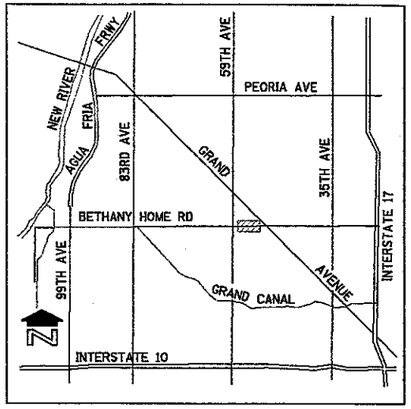
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 6, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
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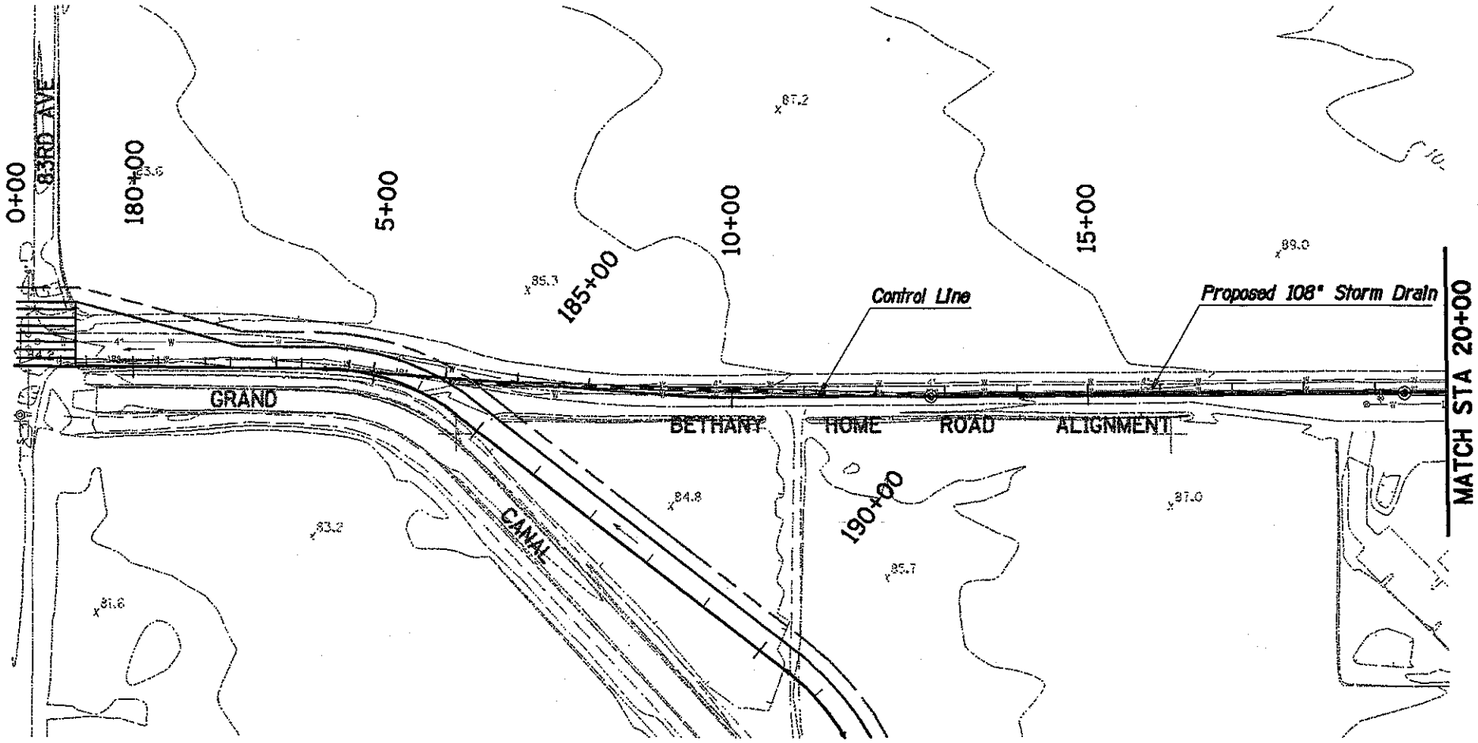
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 180+00 TO 200+00

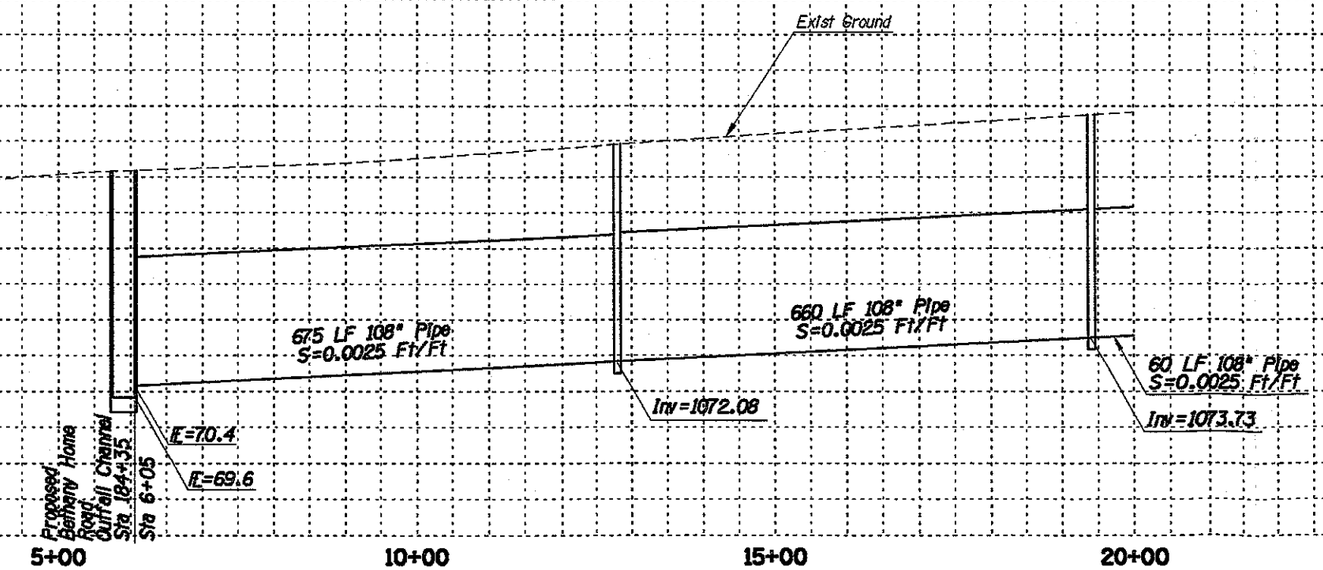
FIGURE 9 | SHEET 13 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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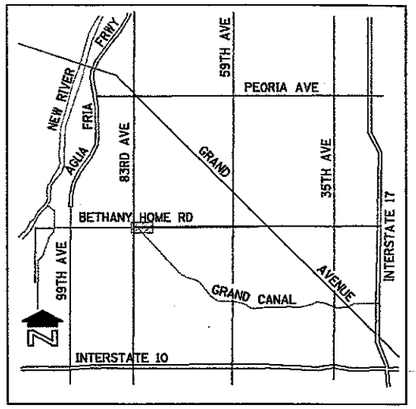
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
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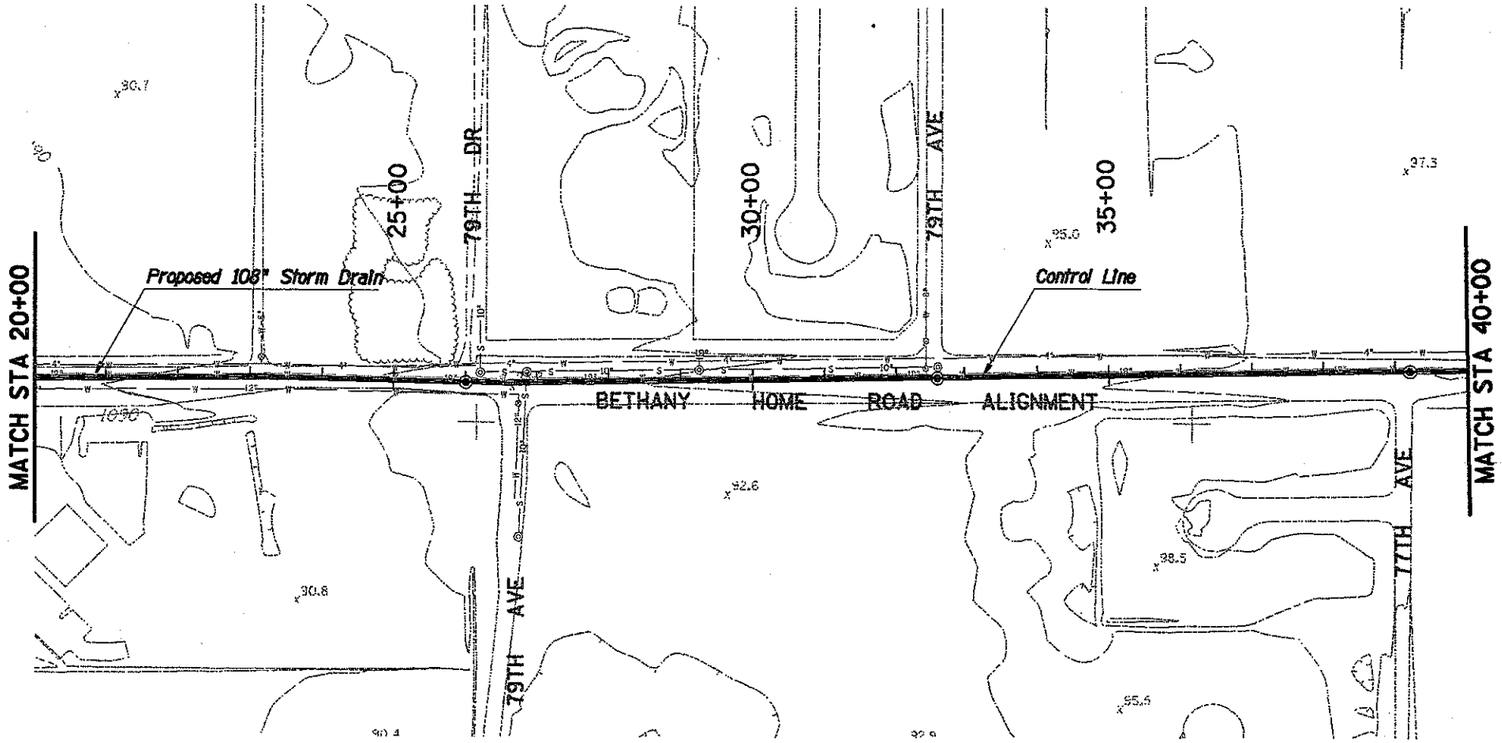
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 6+50 TO 20+00

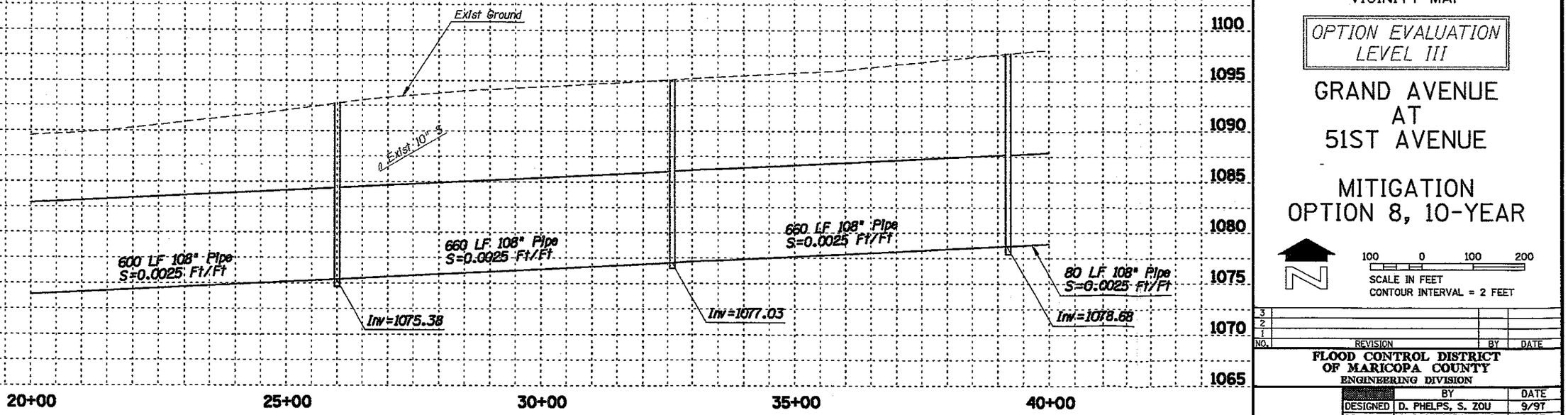
FIGURE 9 | SHEET 14 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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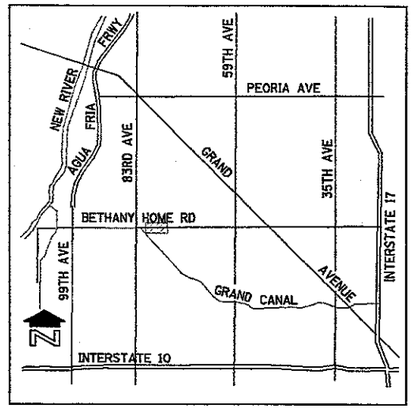
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

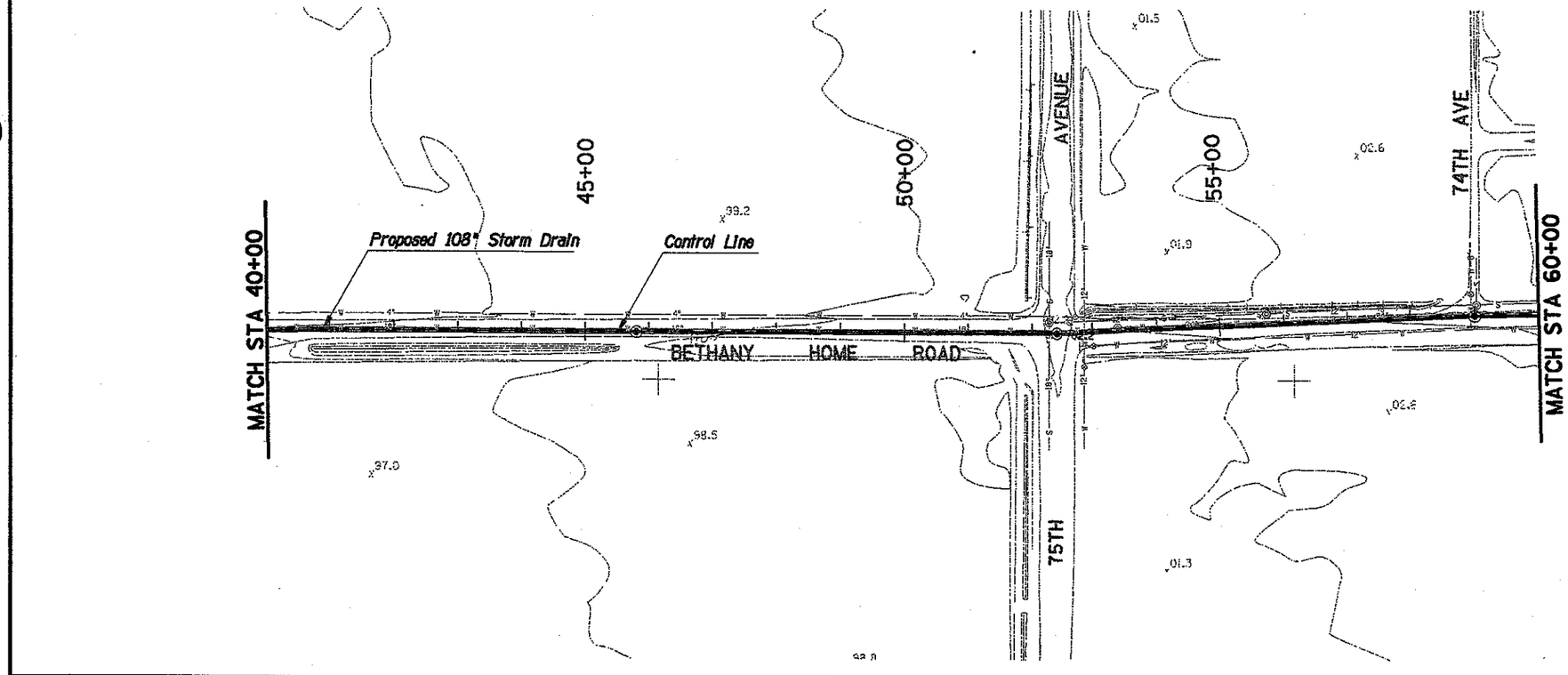
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 20+00 TO 40+00

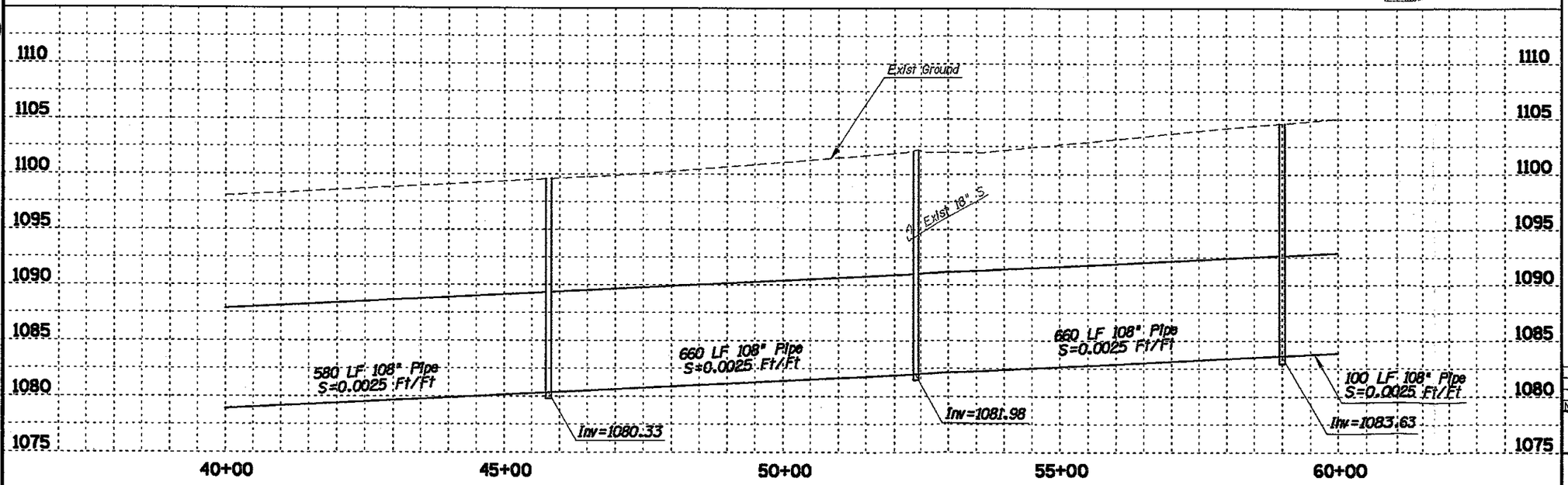
FIGURE	SHEET	OF
9	15	44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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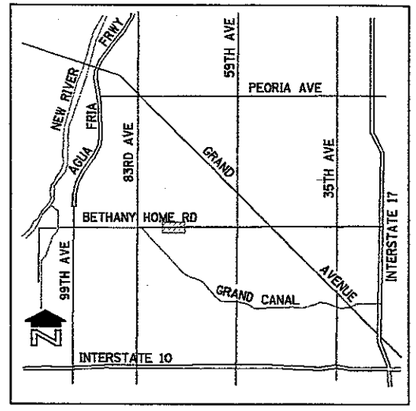
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

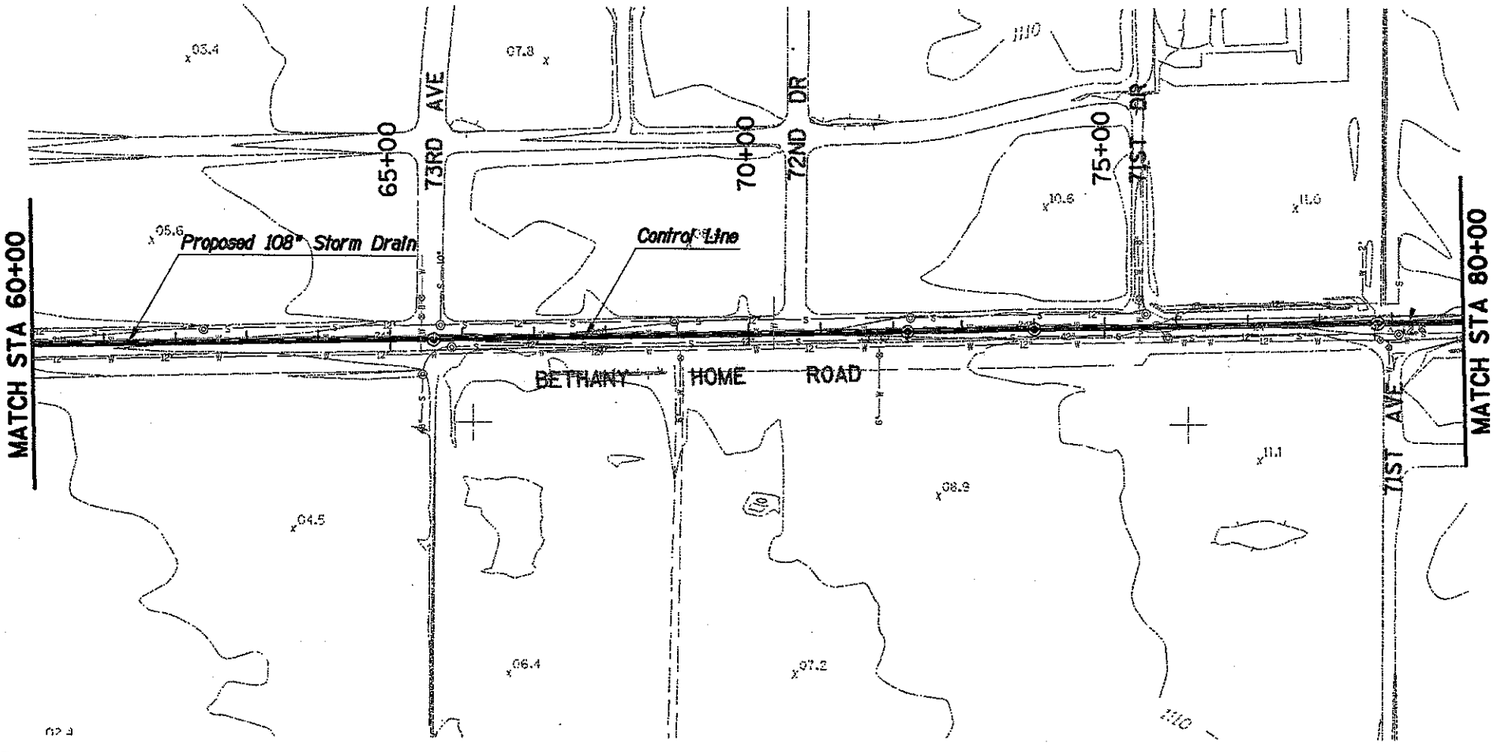
		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 40+00 TO 60+00

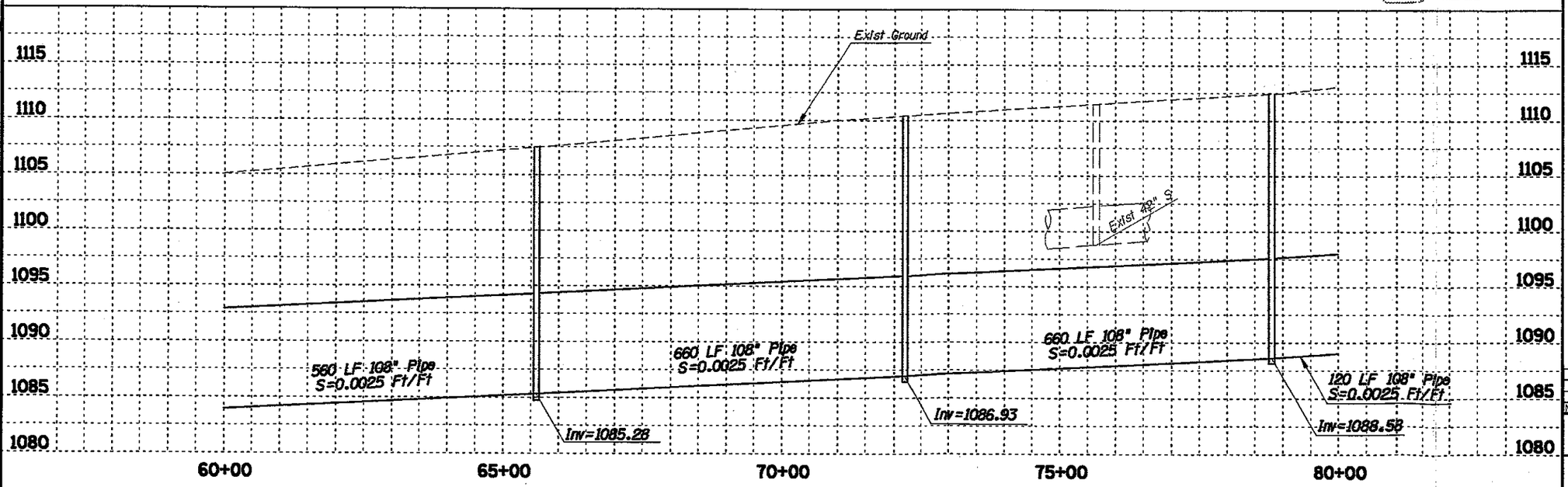
FIGURE 9 | SHEET 16 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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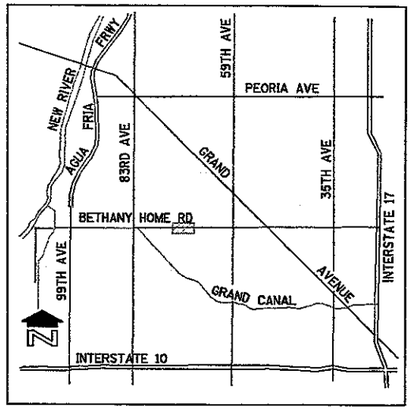
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

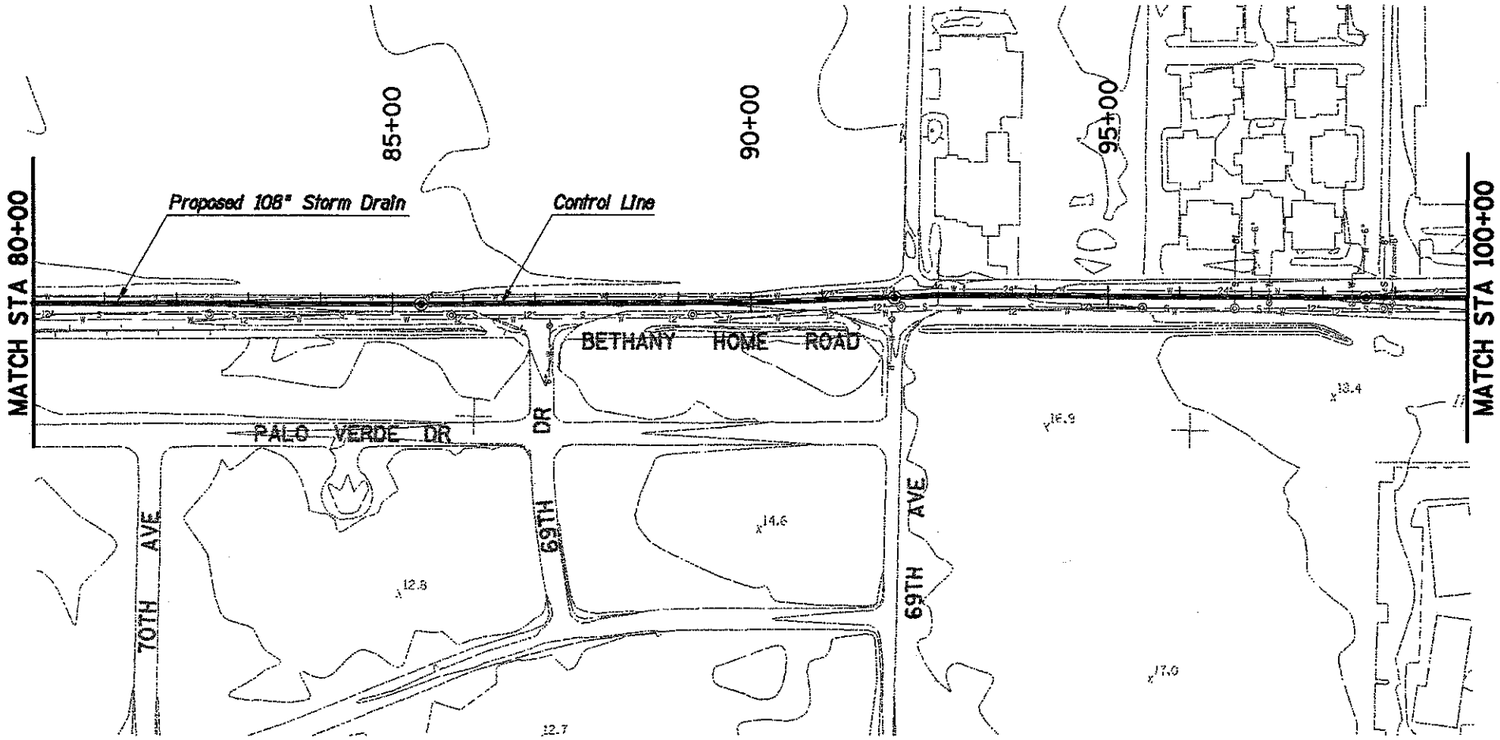
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 60+00 TO 80+00

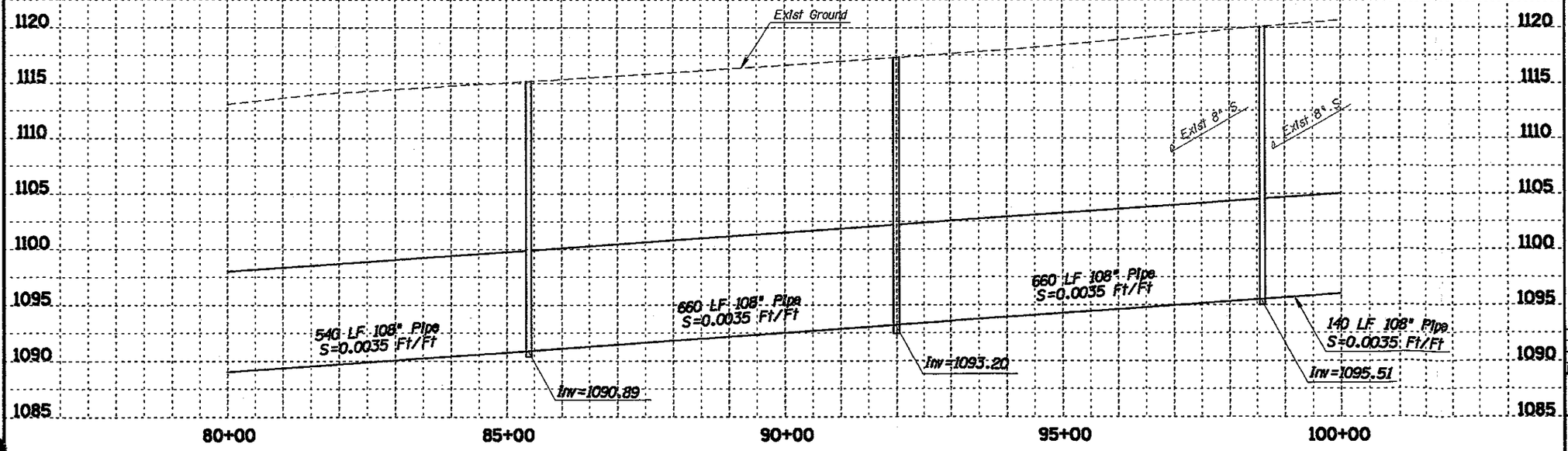
FIGURE 9 | SHEET 17 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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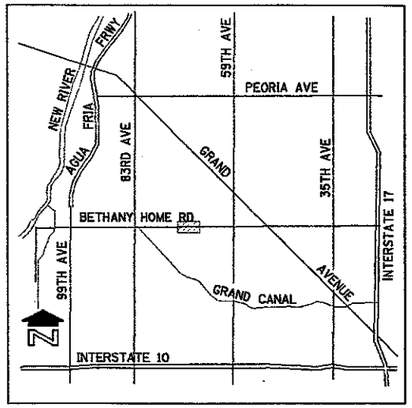
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

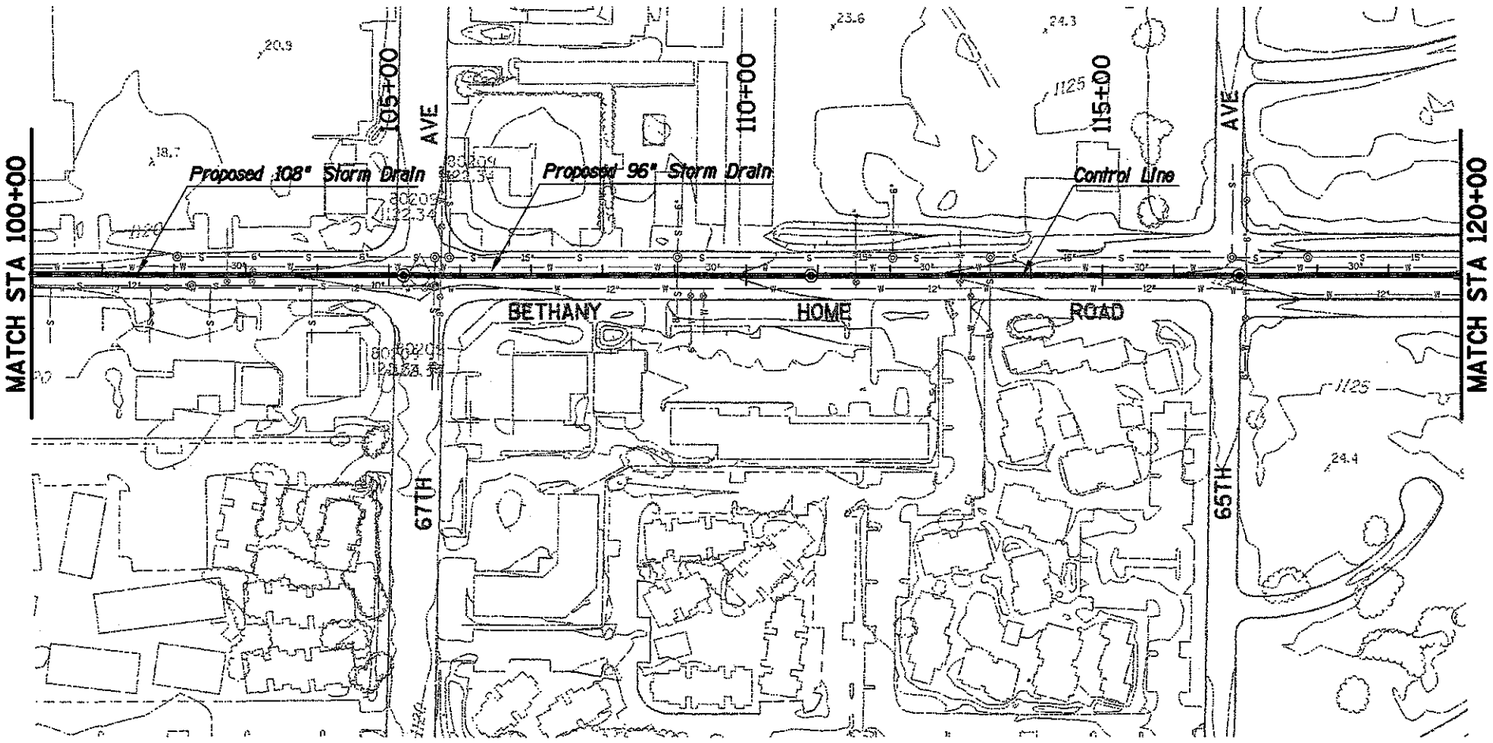
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 80+00 TO 100+00

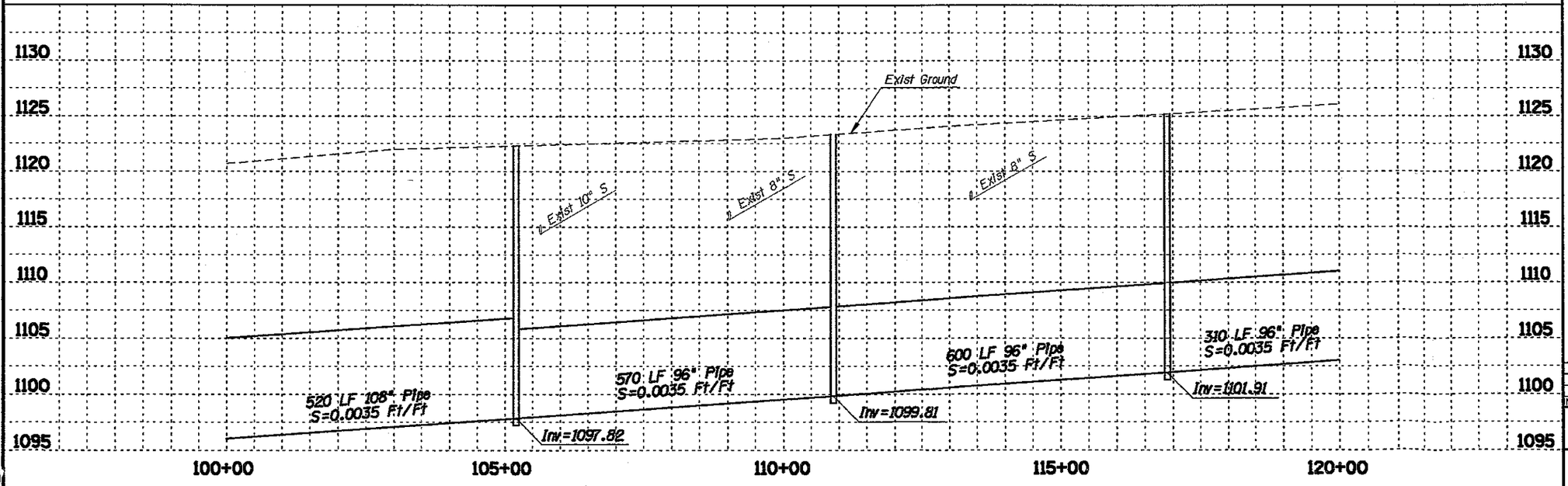
FIGURE 9 | SHEET 18 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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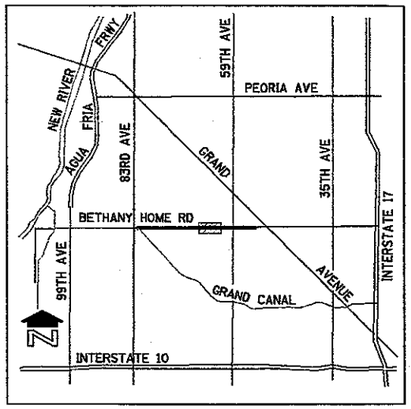
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

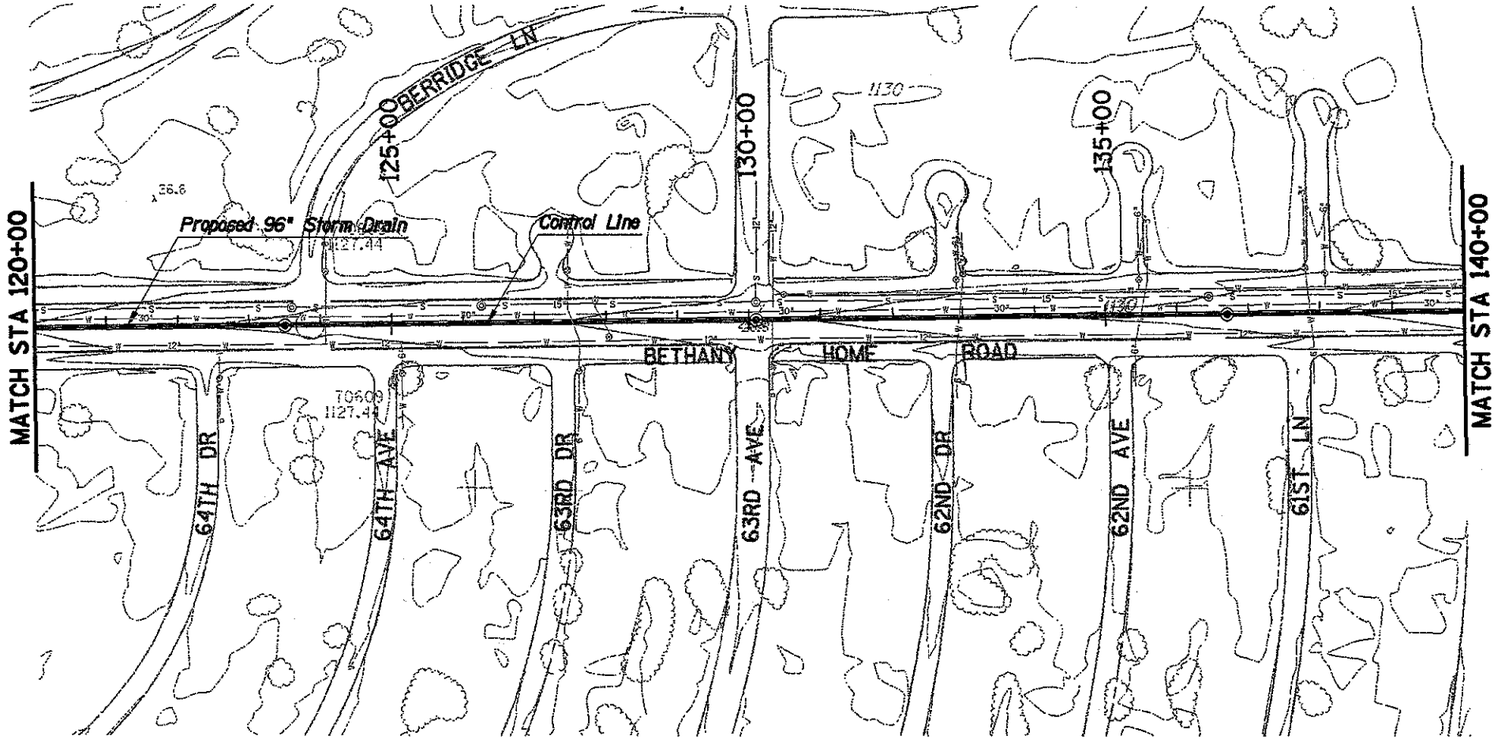
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 100+00 TO 120+00

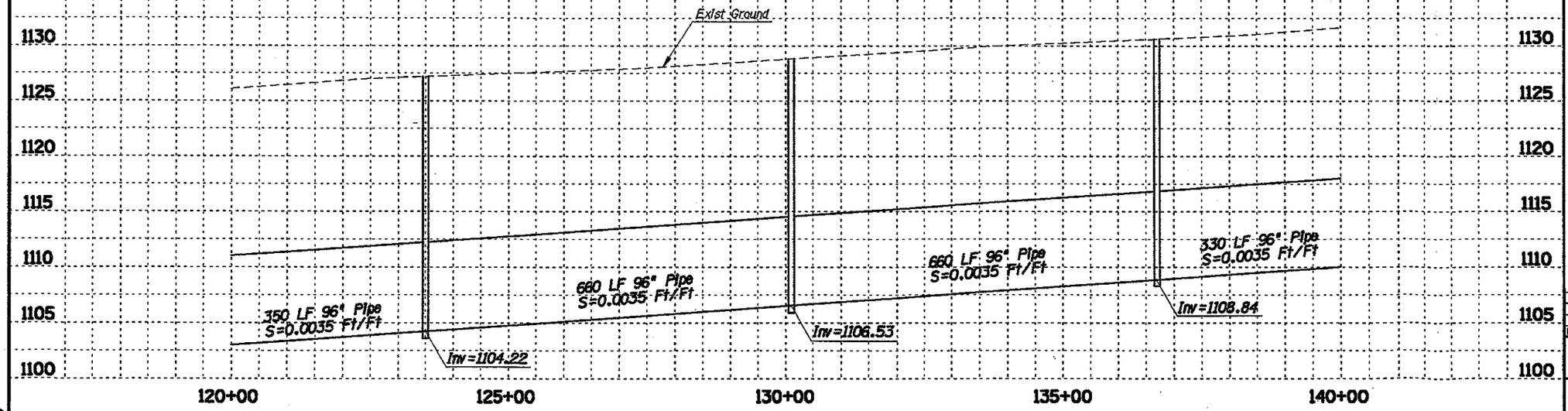
FIGURE 9 | SHEET 19 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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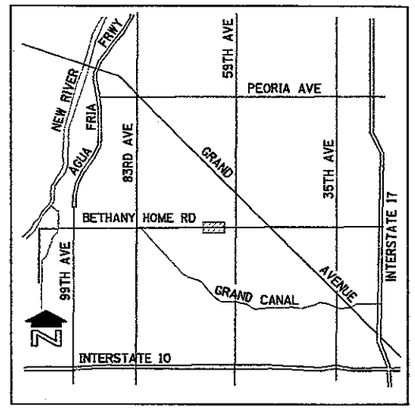
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

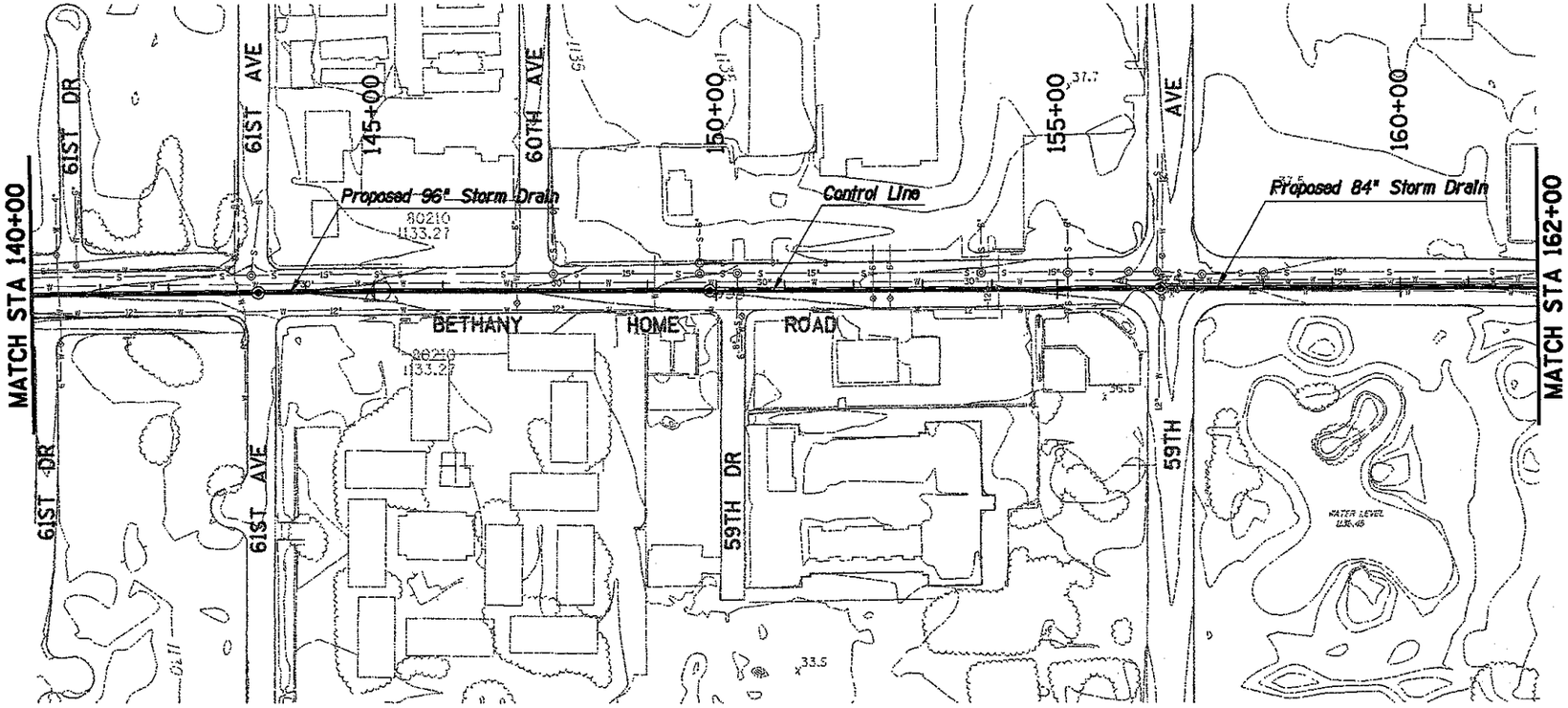
		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 120+00 TO 140+00

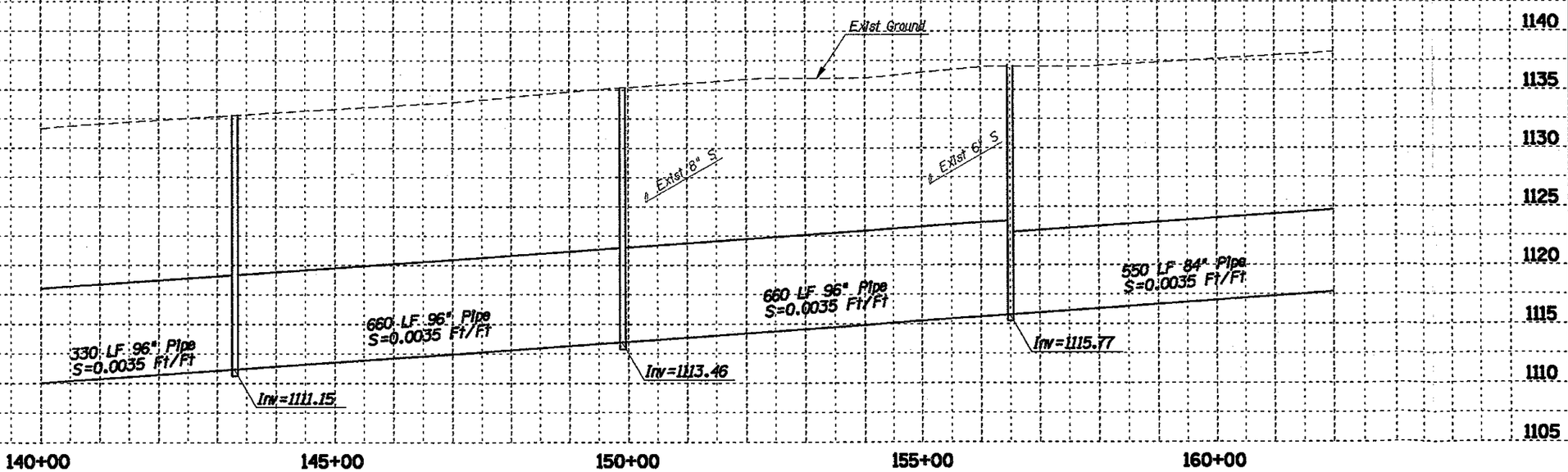
FIGURE 9 SHEET 20 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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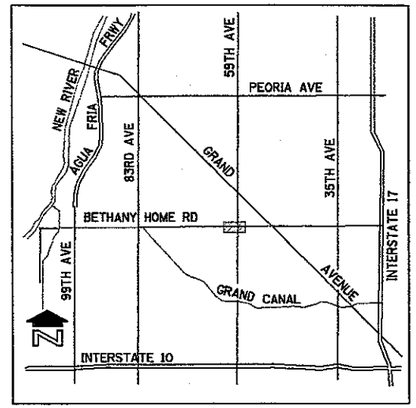
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

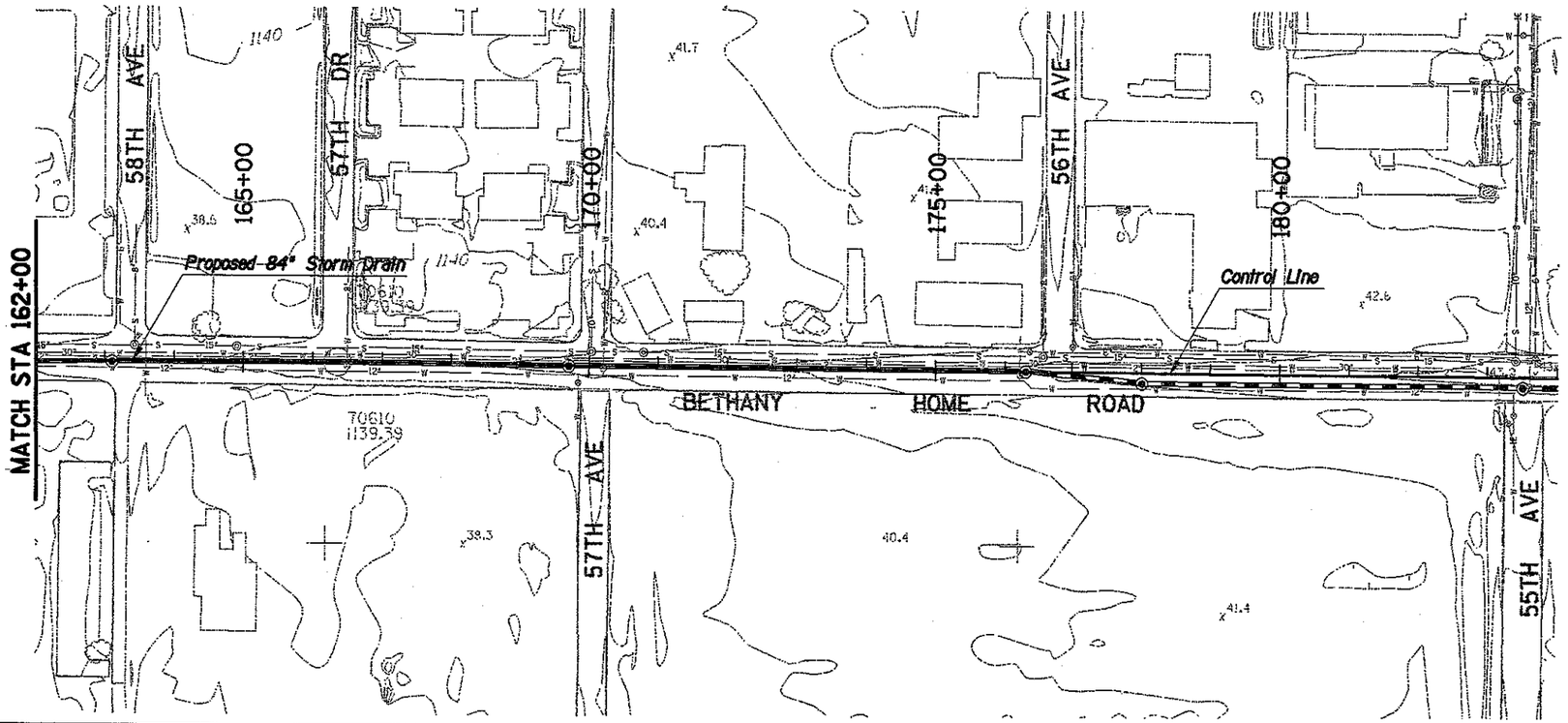
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 140+00 TO 162+00

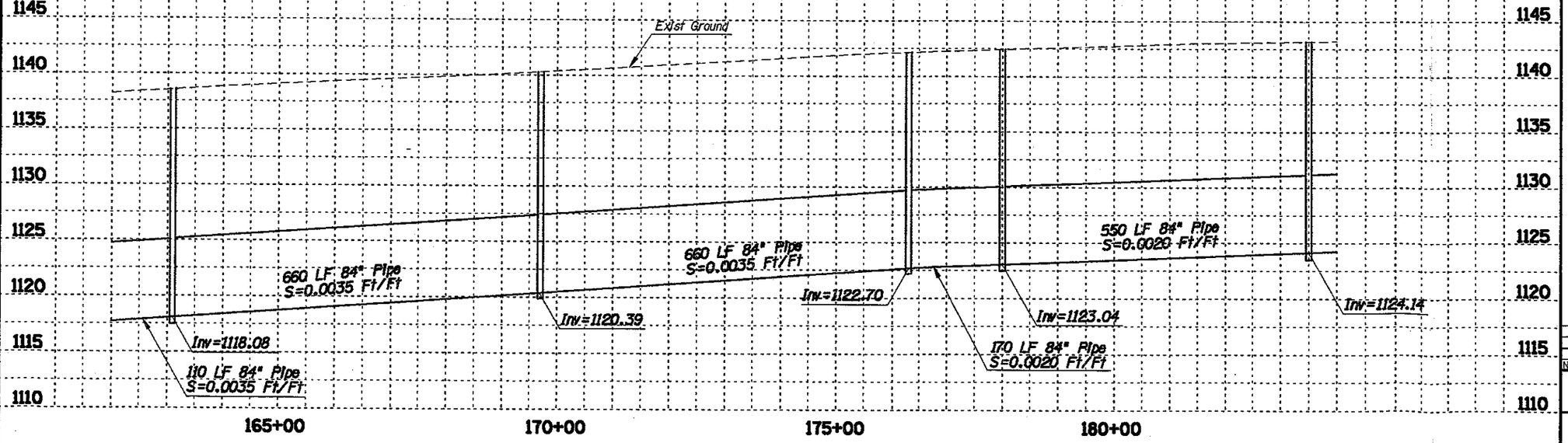
FIGURE	SHEET	OF
9	21	44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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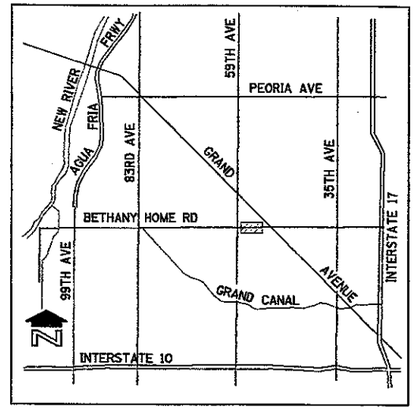
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 51ST AVENUE

MITIGATION OPTION 8, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

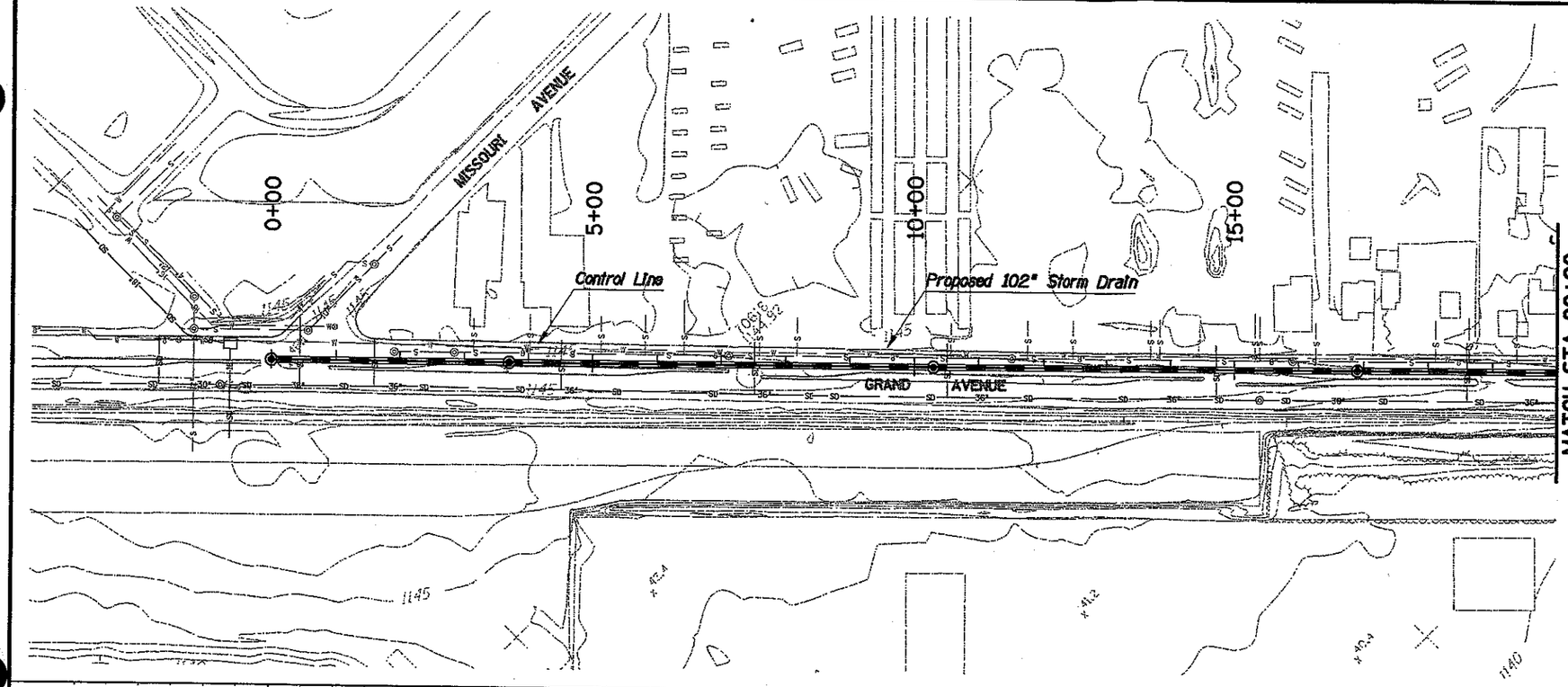
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 160+00 TO 183+50

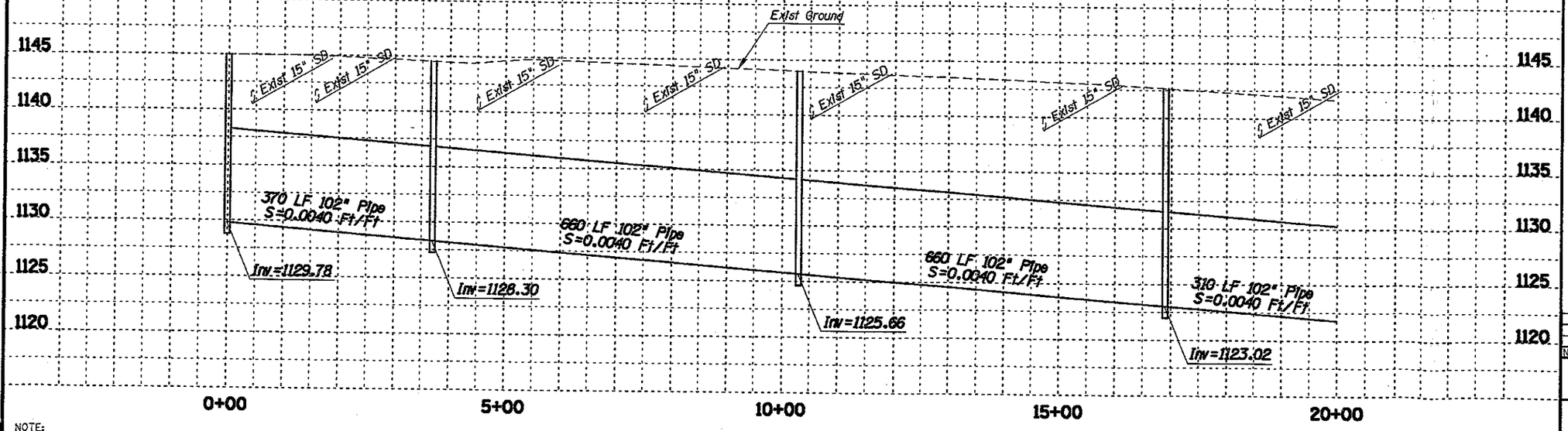
FIGURE	SHEET	OF
9	22	44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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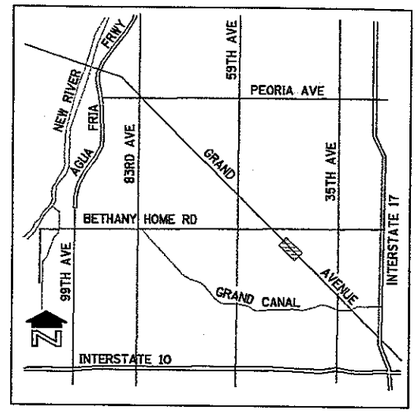
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

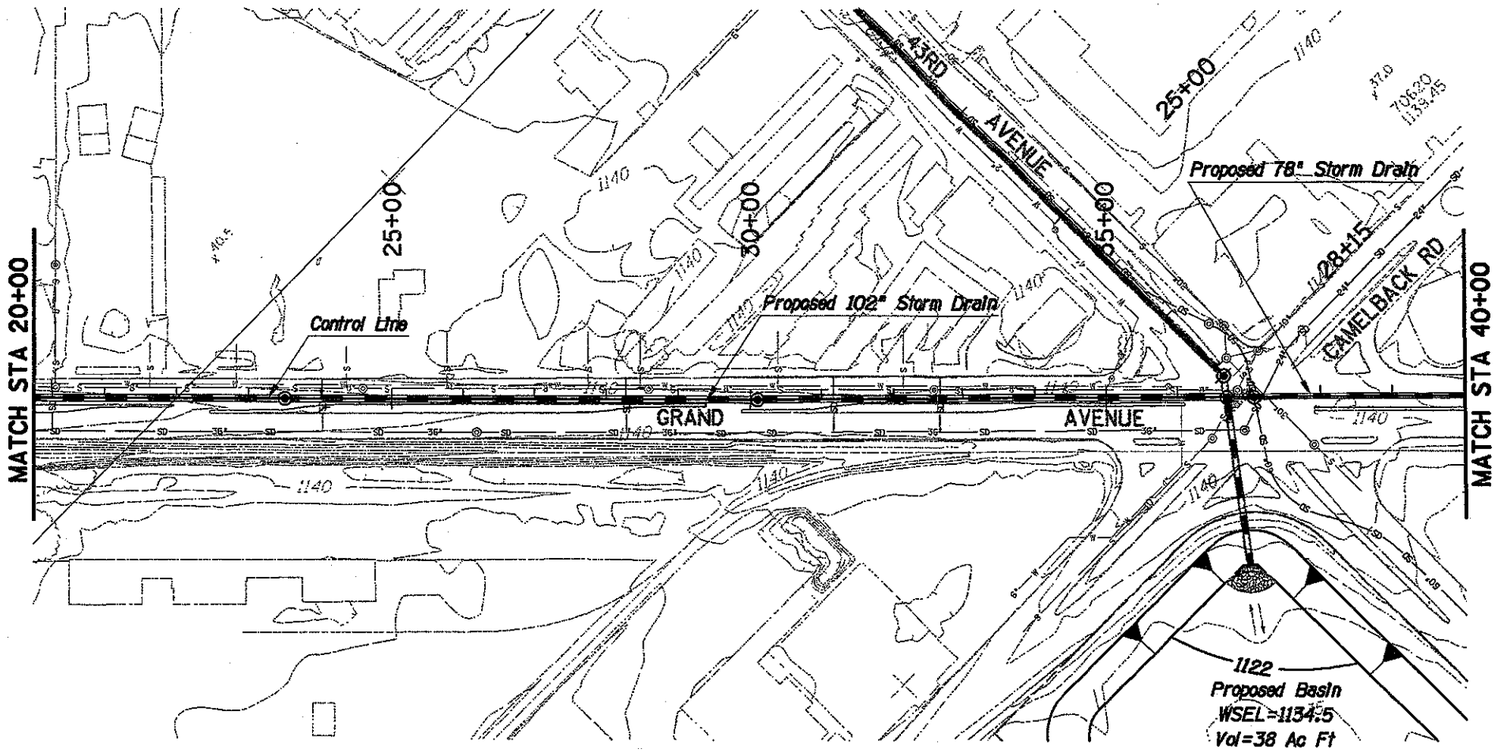
CONCEPT PLAN		BY	DATE
	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 0+00 TO 20+00

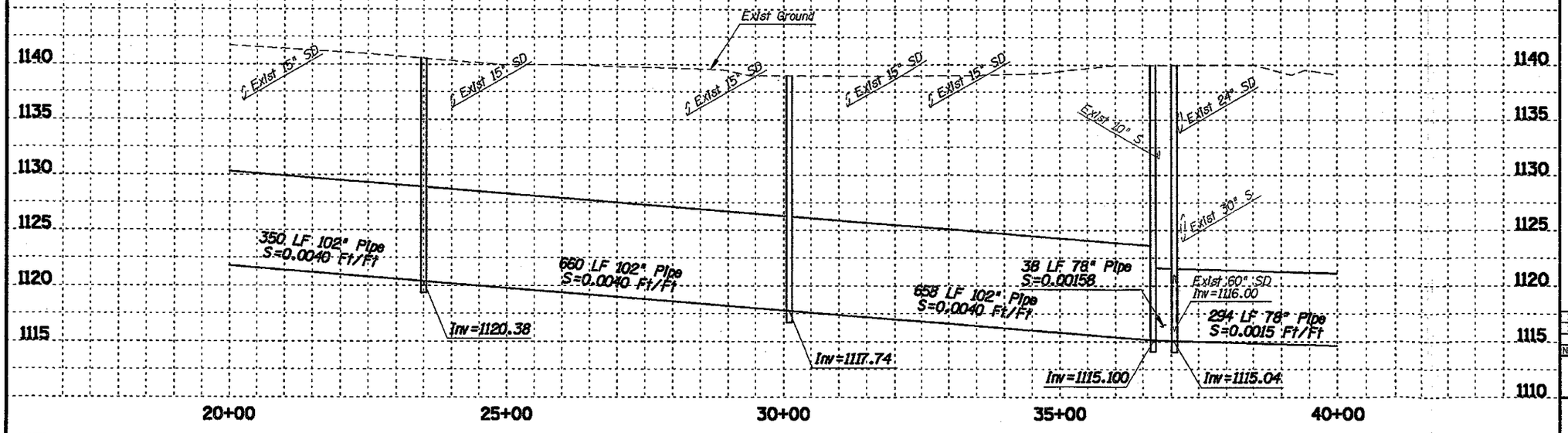
FIGURE	SHEET OF
9	23 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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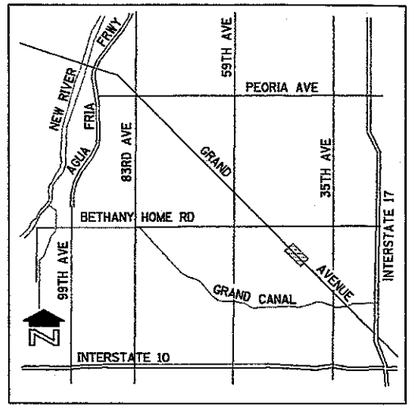
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

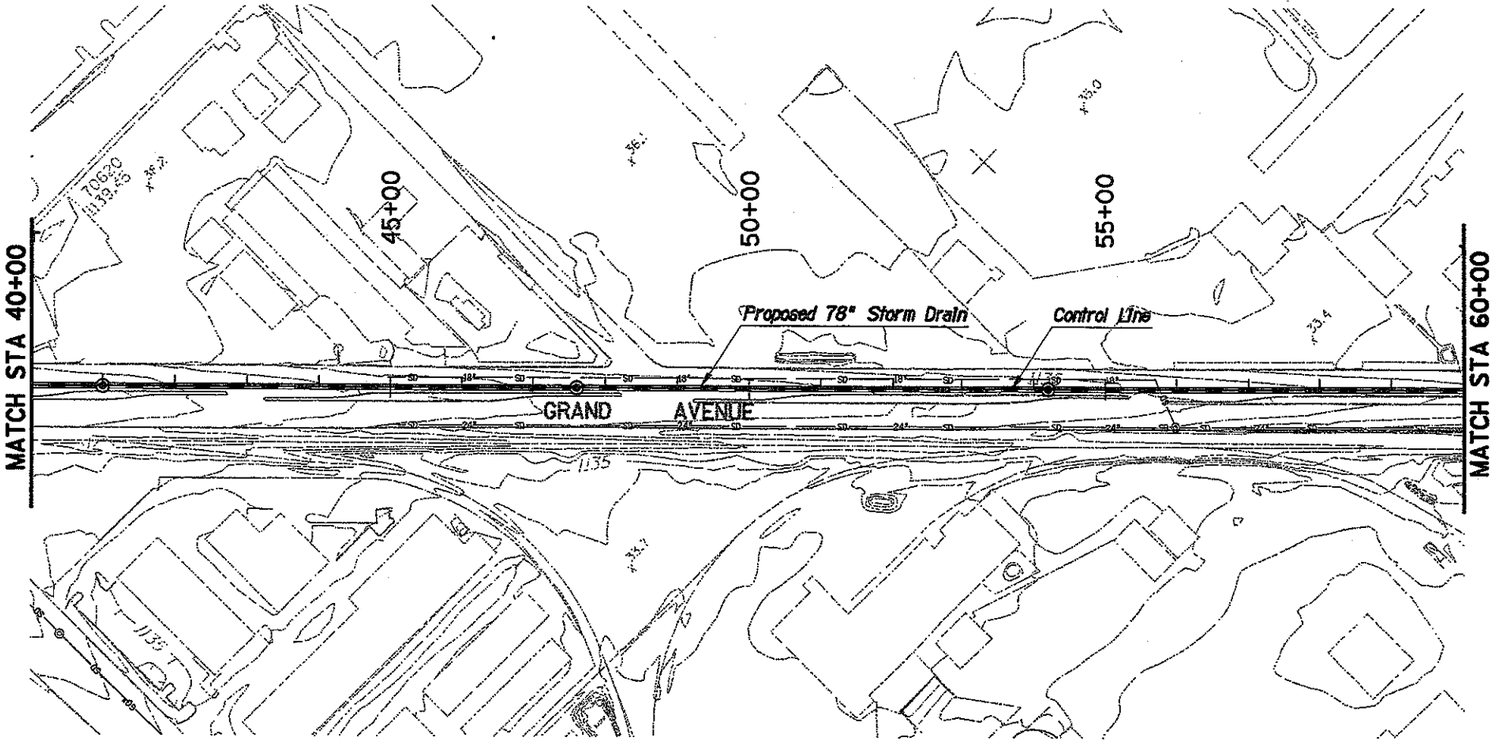
CONCEPT PLAN

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 20+00 TO 40+00

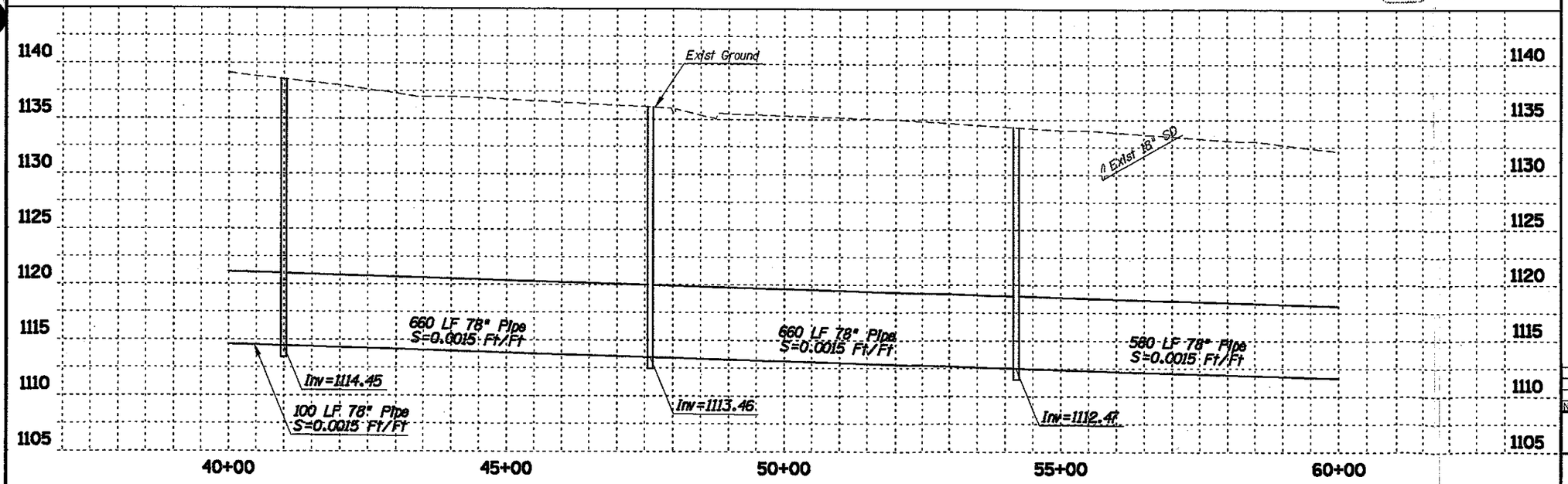
FIGURE 9 | SHEET 24 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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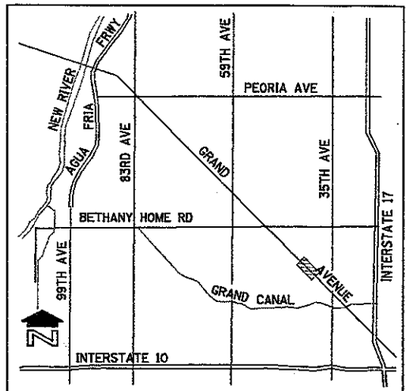
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

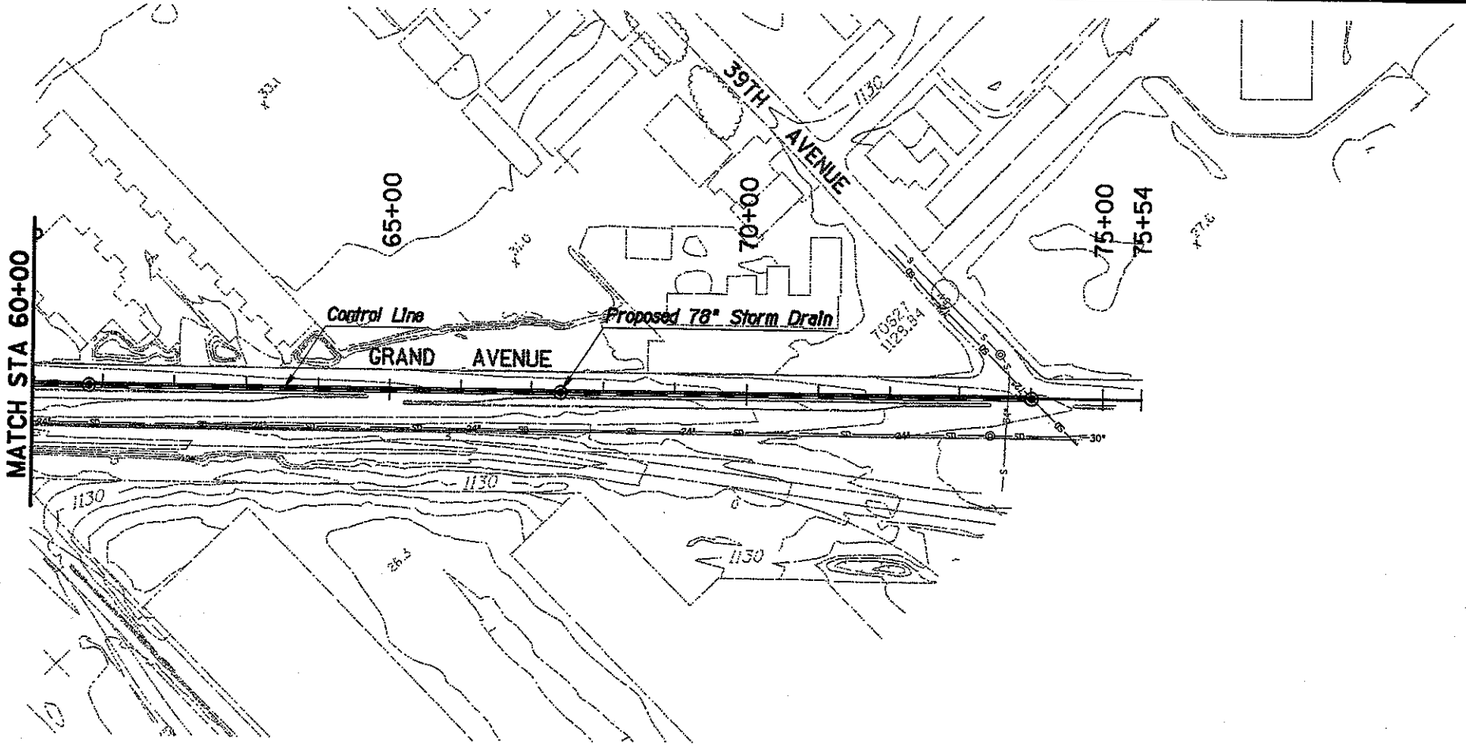
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN		BY	DATE
	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

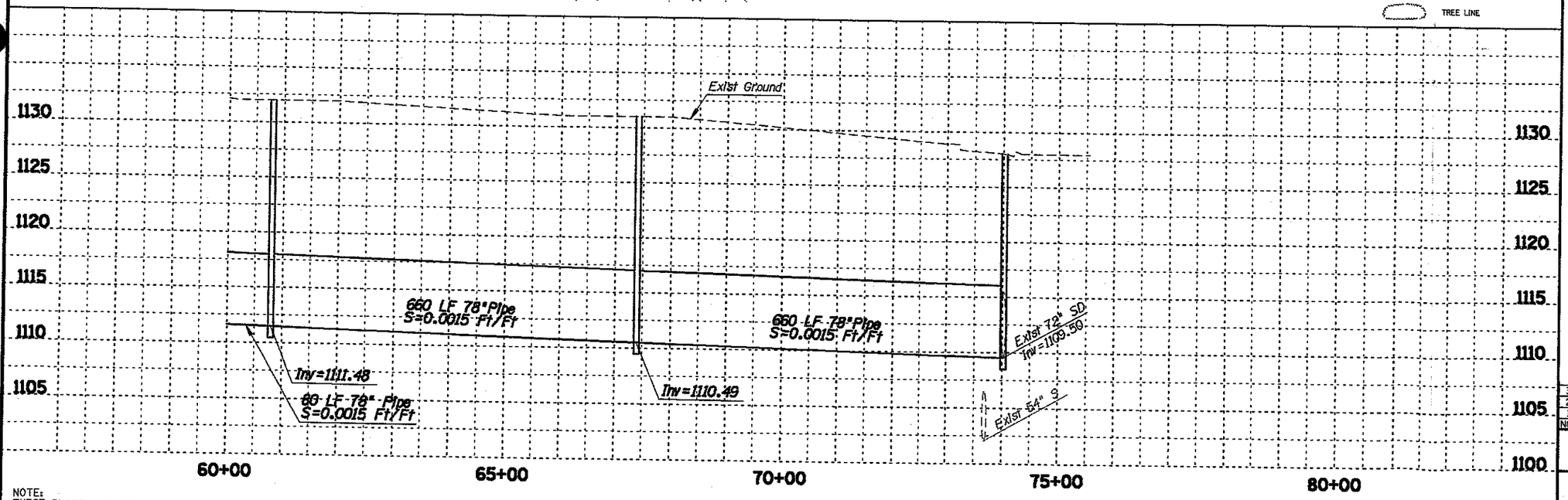
DRAINAGE SYSTEM PLAN STA 40+00 TO 60+00	FIGURE	SHEET OF
	9	25 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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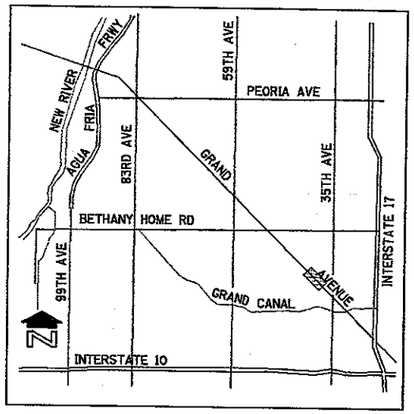
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

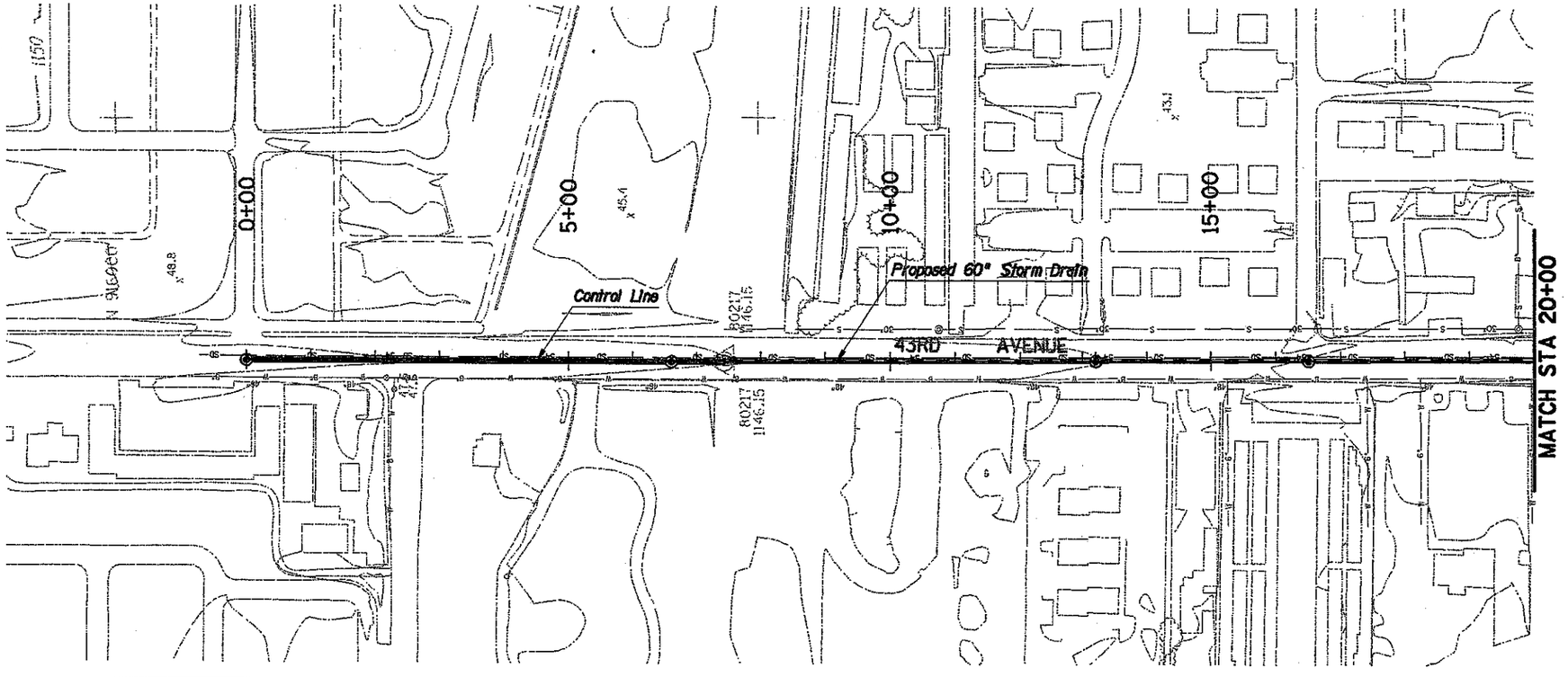
CONCEPT PLAN	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

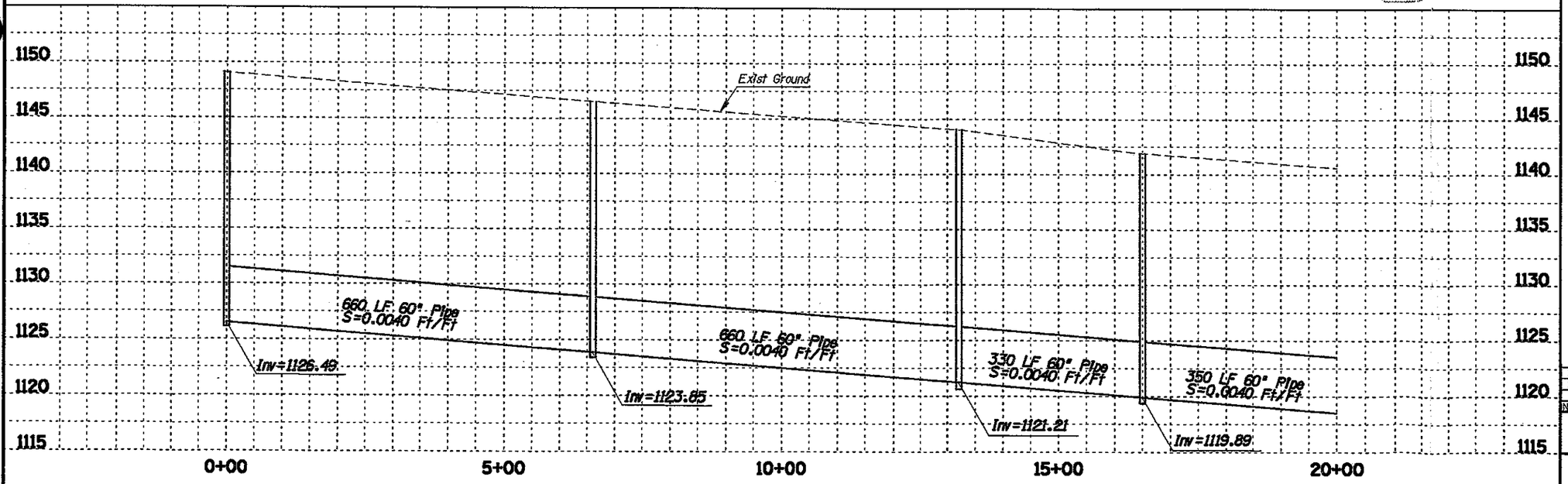
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 60+00 TO 75+00

FIGURE 9 | SHEET OF 26 44

TRACS NO.





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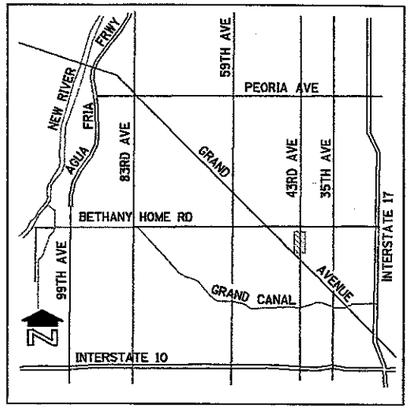
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
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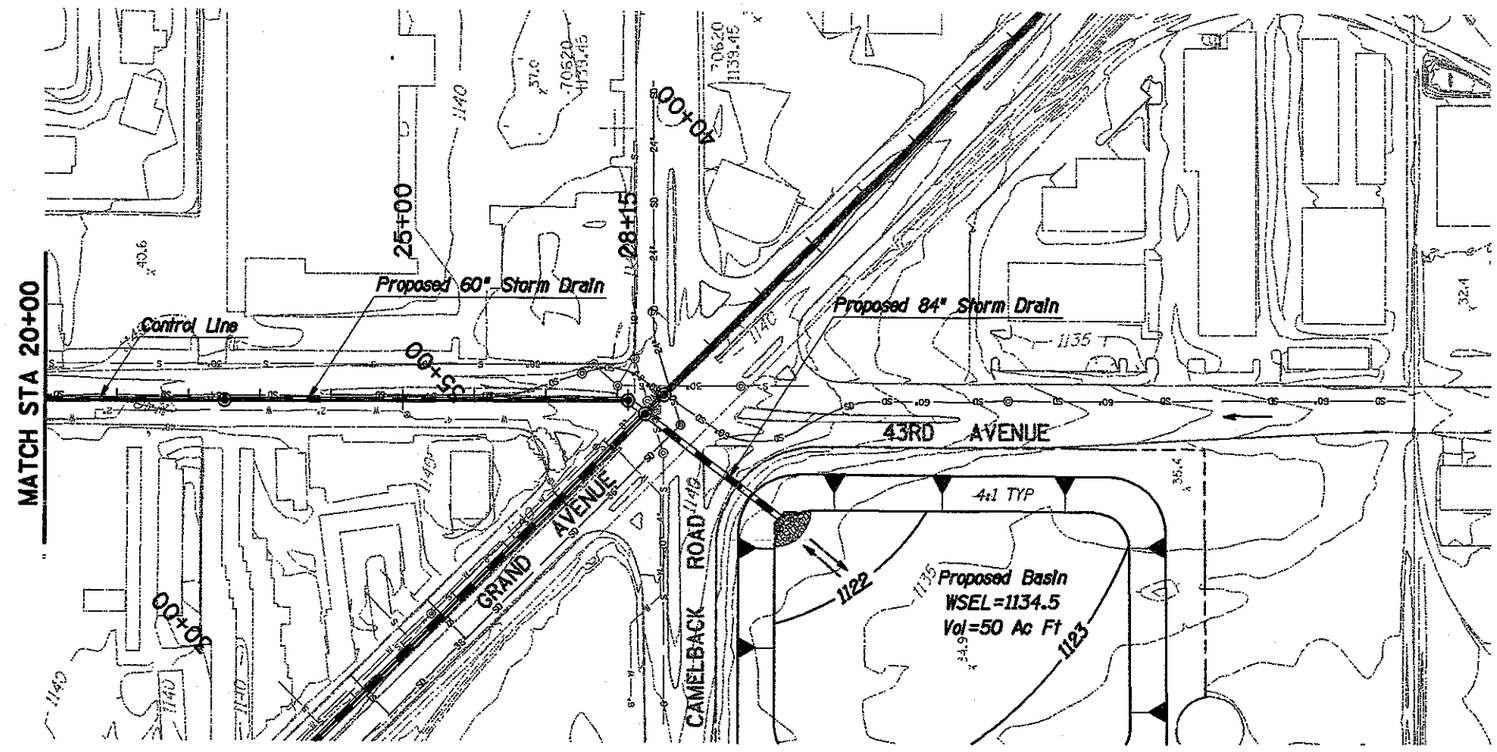
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 0+00 TO 20+00

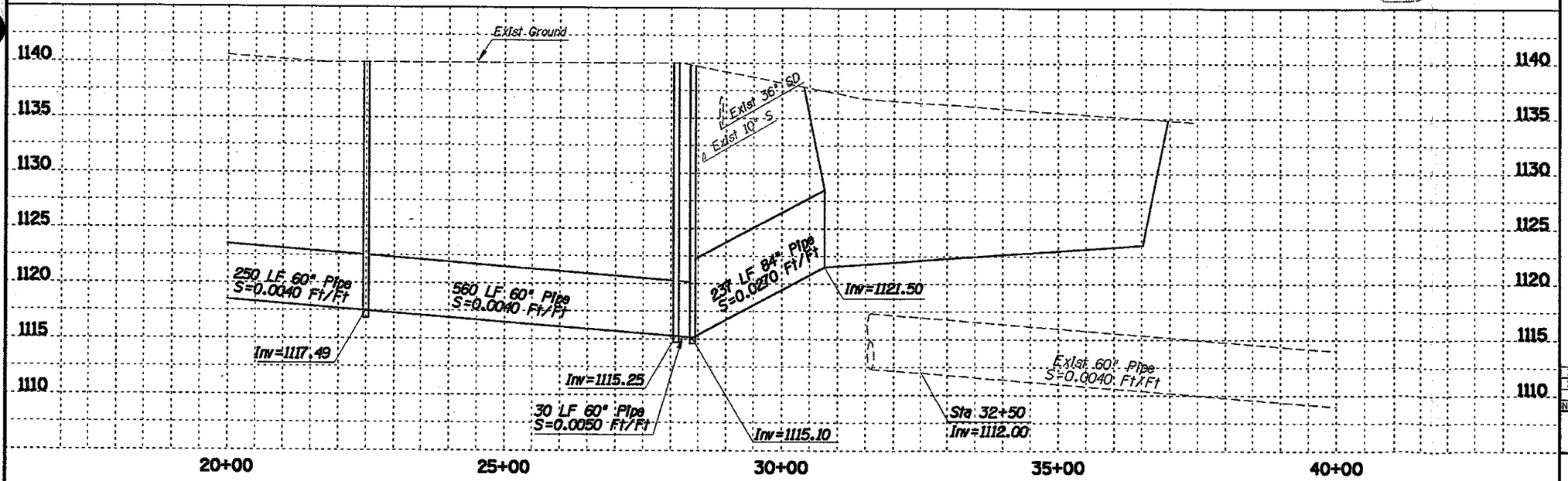
FIGURE 9 | SHEET 27 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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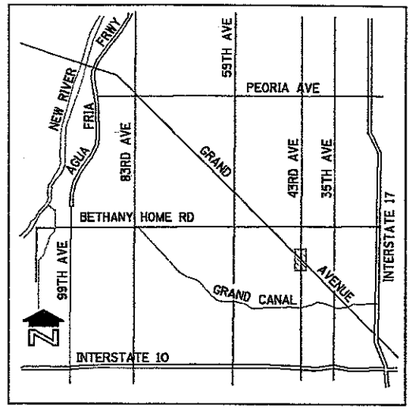
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

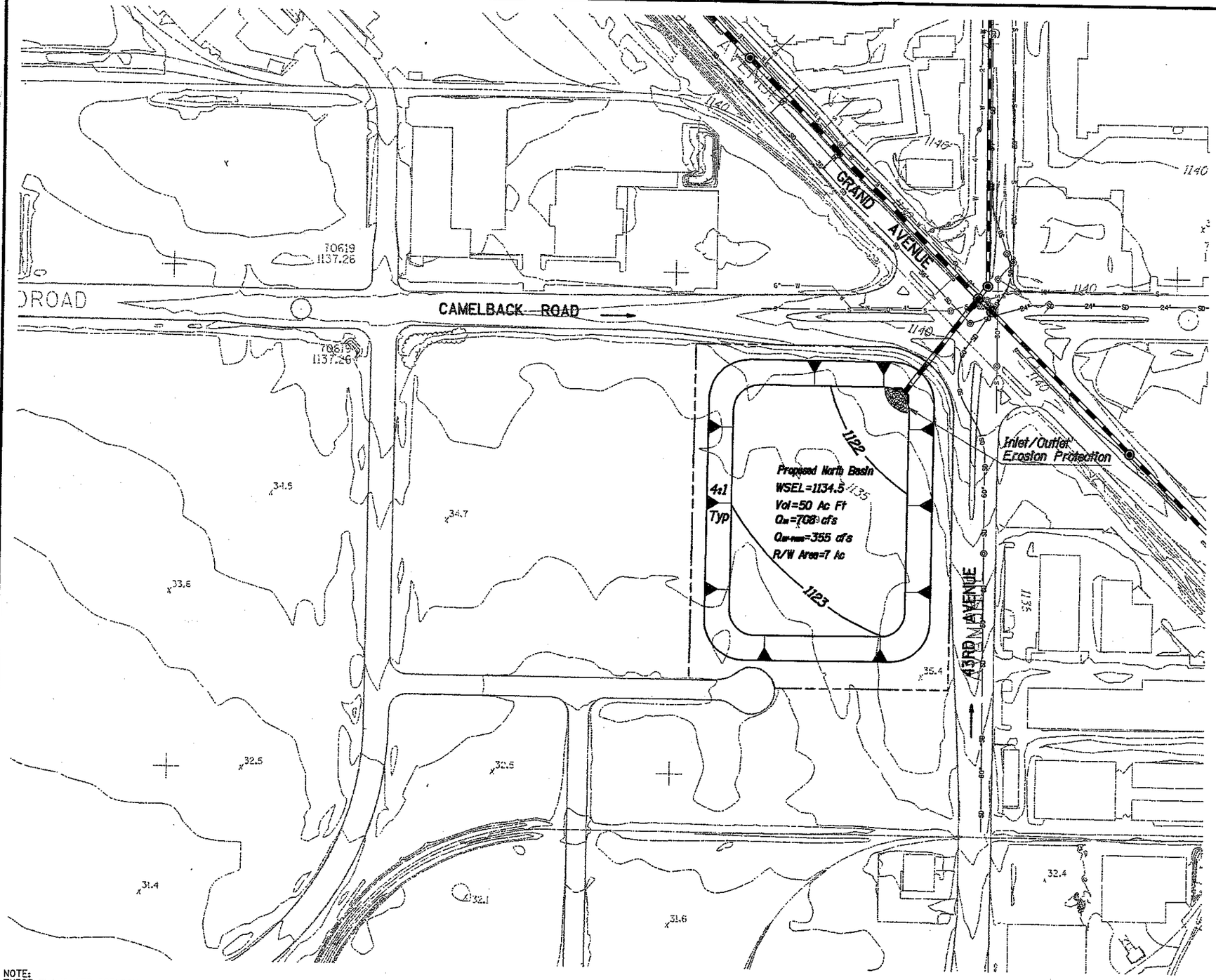
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 20+00 TO 40+00

FIGURE 9 | SHEET OF 28 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
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- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE

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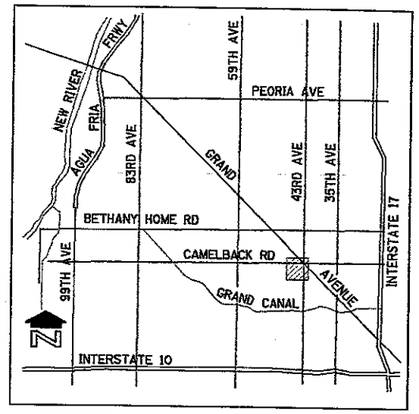
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT 43RD AVENUE

MITIGATION OPTION 4, 10-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
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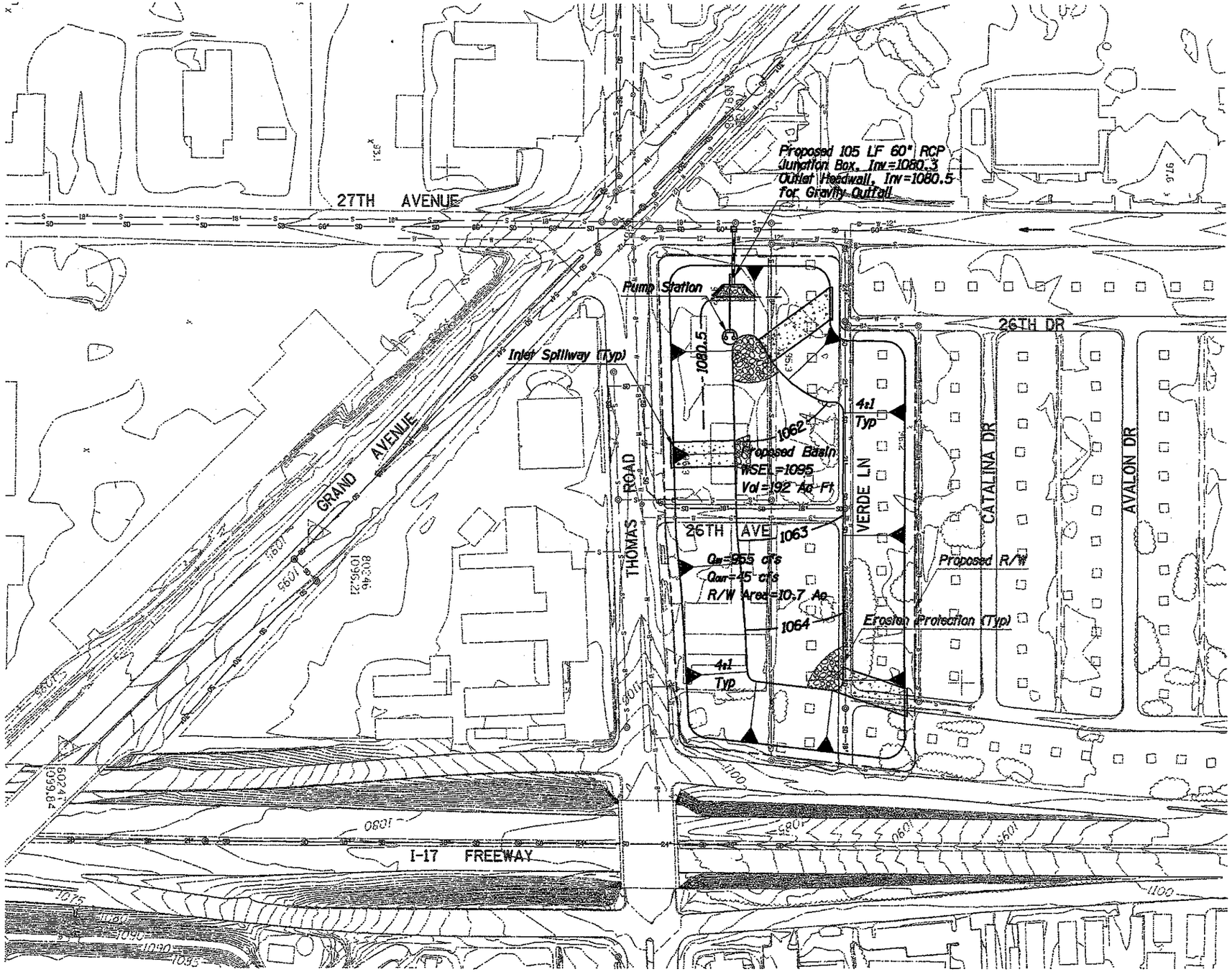
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN

FIGURE 9 SHEET OF 29 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
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- TREE LINE

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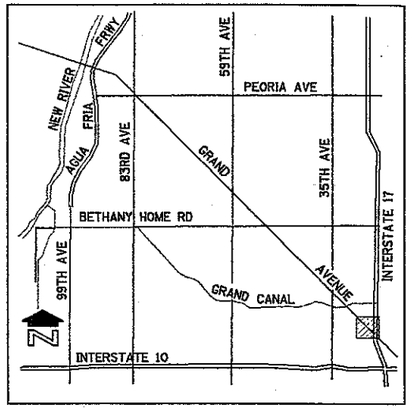
NOTE:
Depiction of Inlet Spillways is Conceptual. Size, Number & Location of Required Spillways to be determined with final design.

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND AVENUE AT INTERSTATE 17

MITIGATION OPTION 1, 5-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
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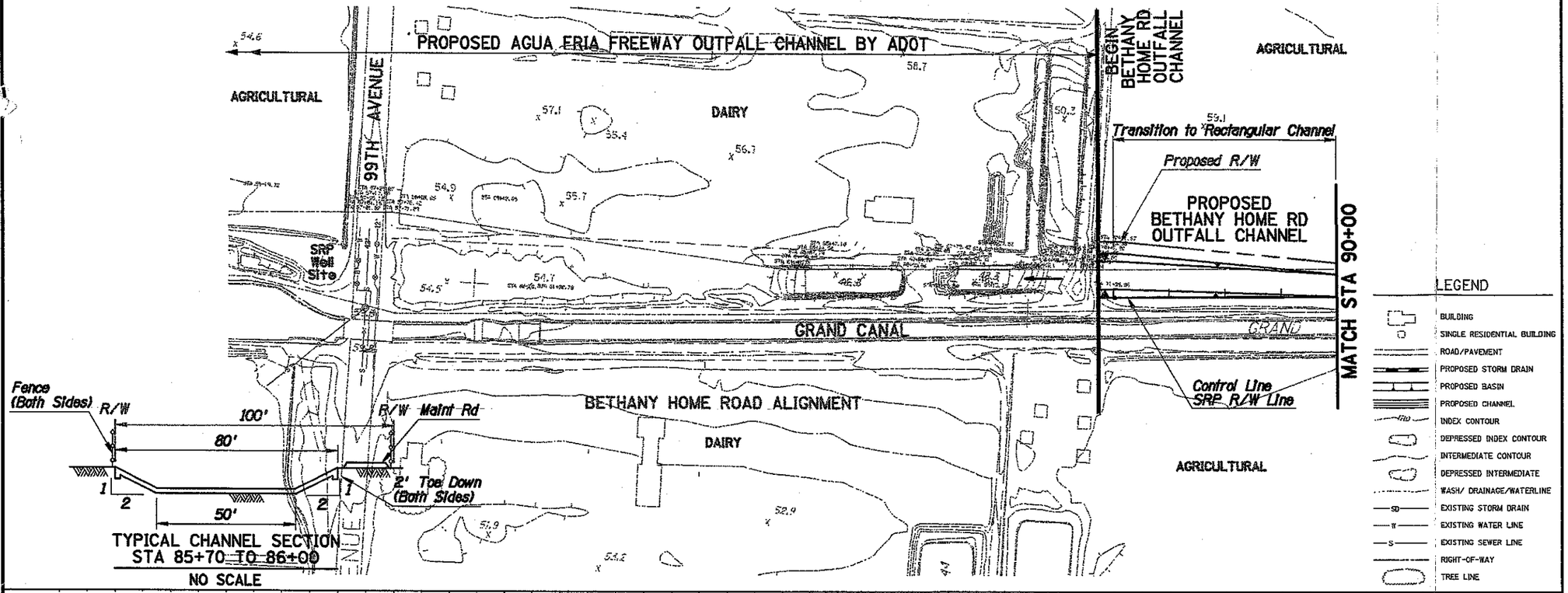
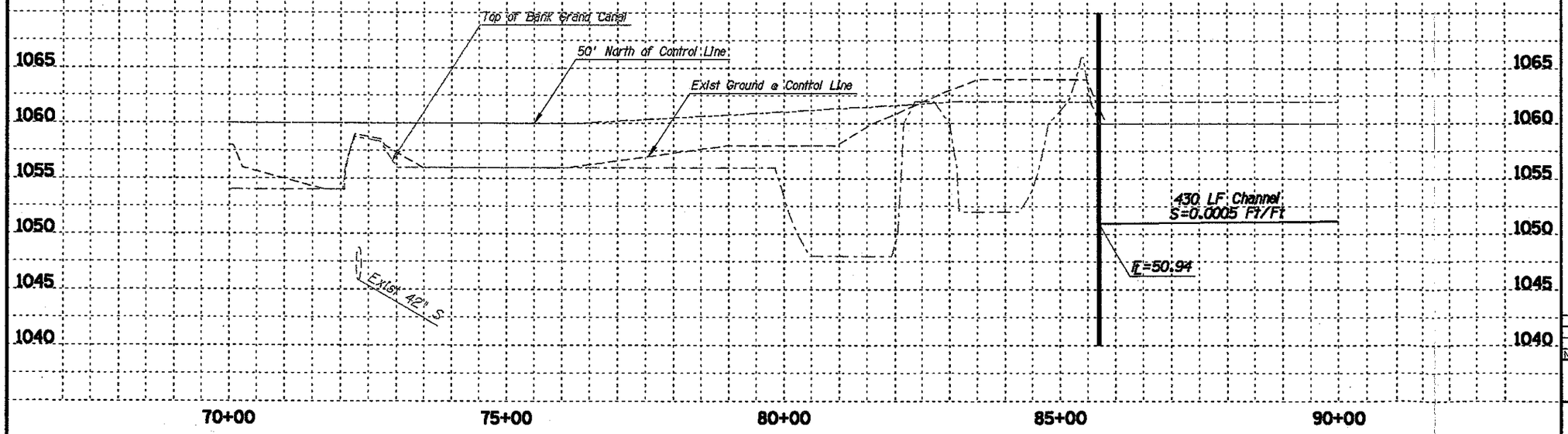
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN | FIGURE 9 | SHEET OF 30 44

TRACS NO.





NOTE:
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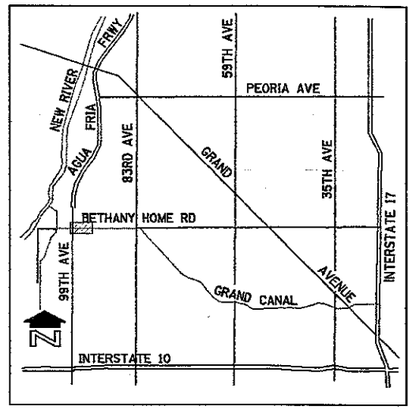
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

N

100 0 100 200

SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

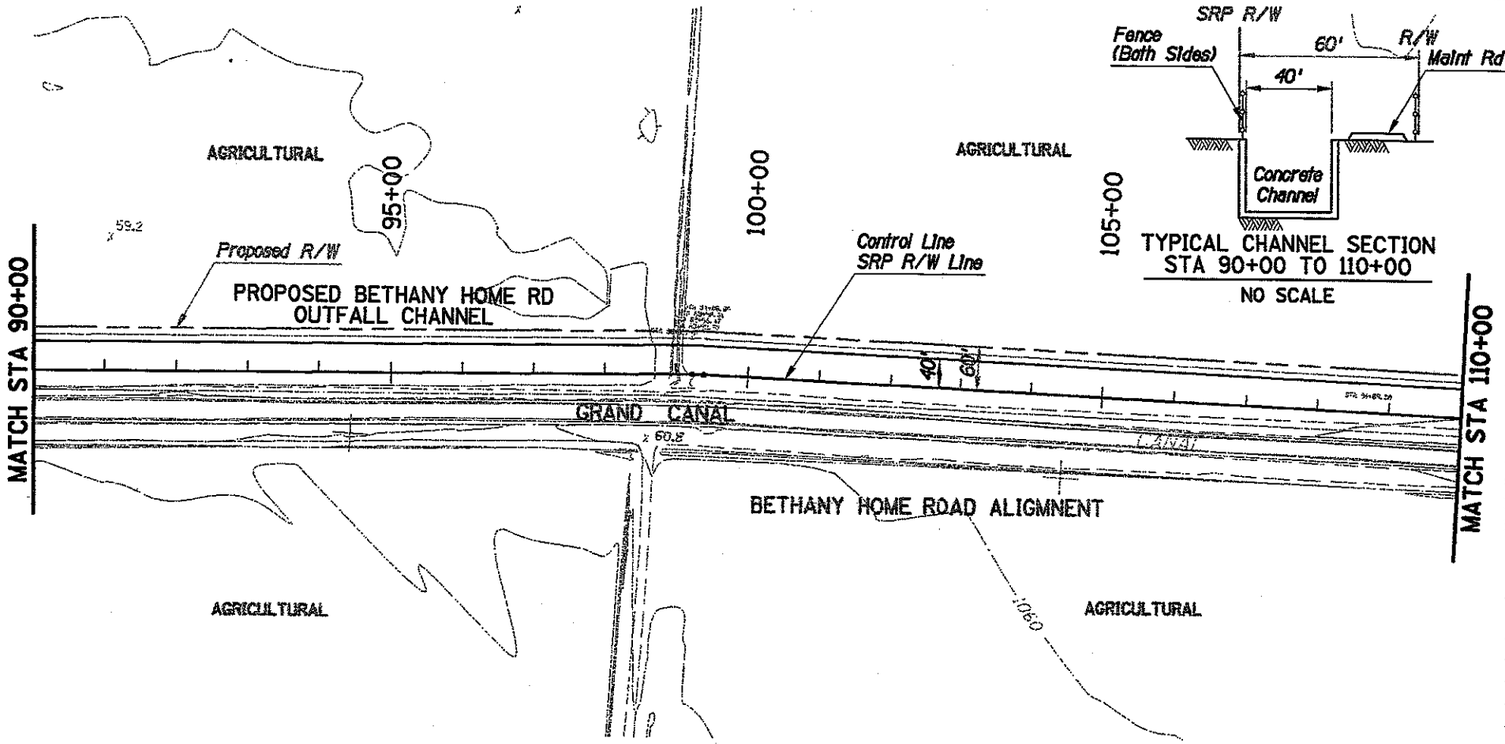
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 85+70 TO 90+00

FIGURE 9 | SHEET 31 OF 44

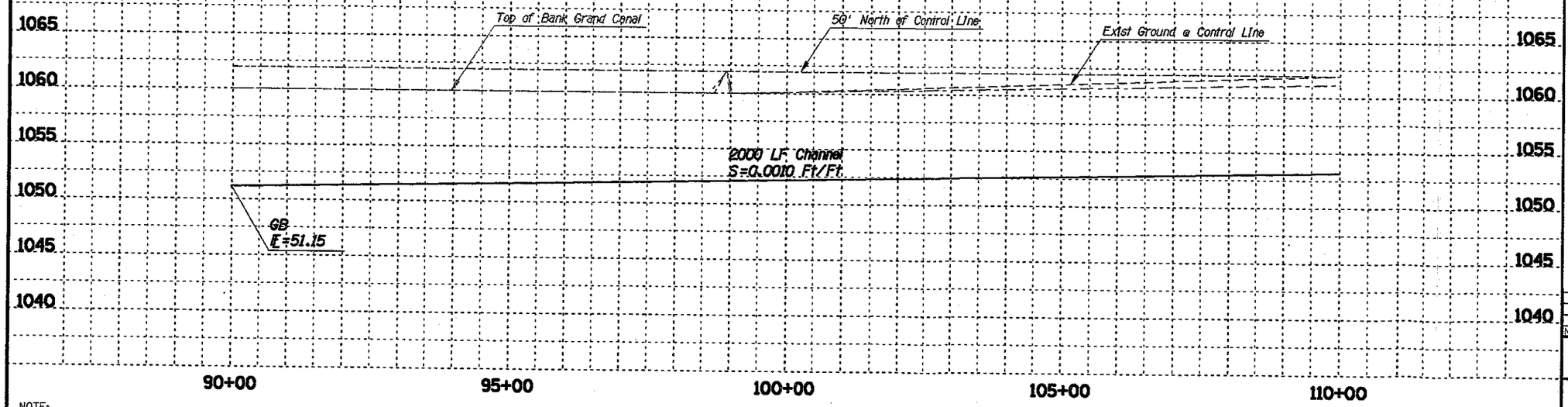
TRACS NO.



TYPICAL CHANNEL SECTION
STA 90+00 TO 110+00
NO SCALE

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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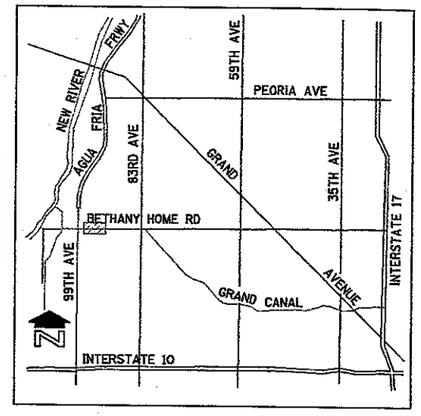
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

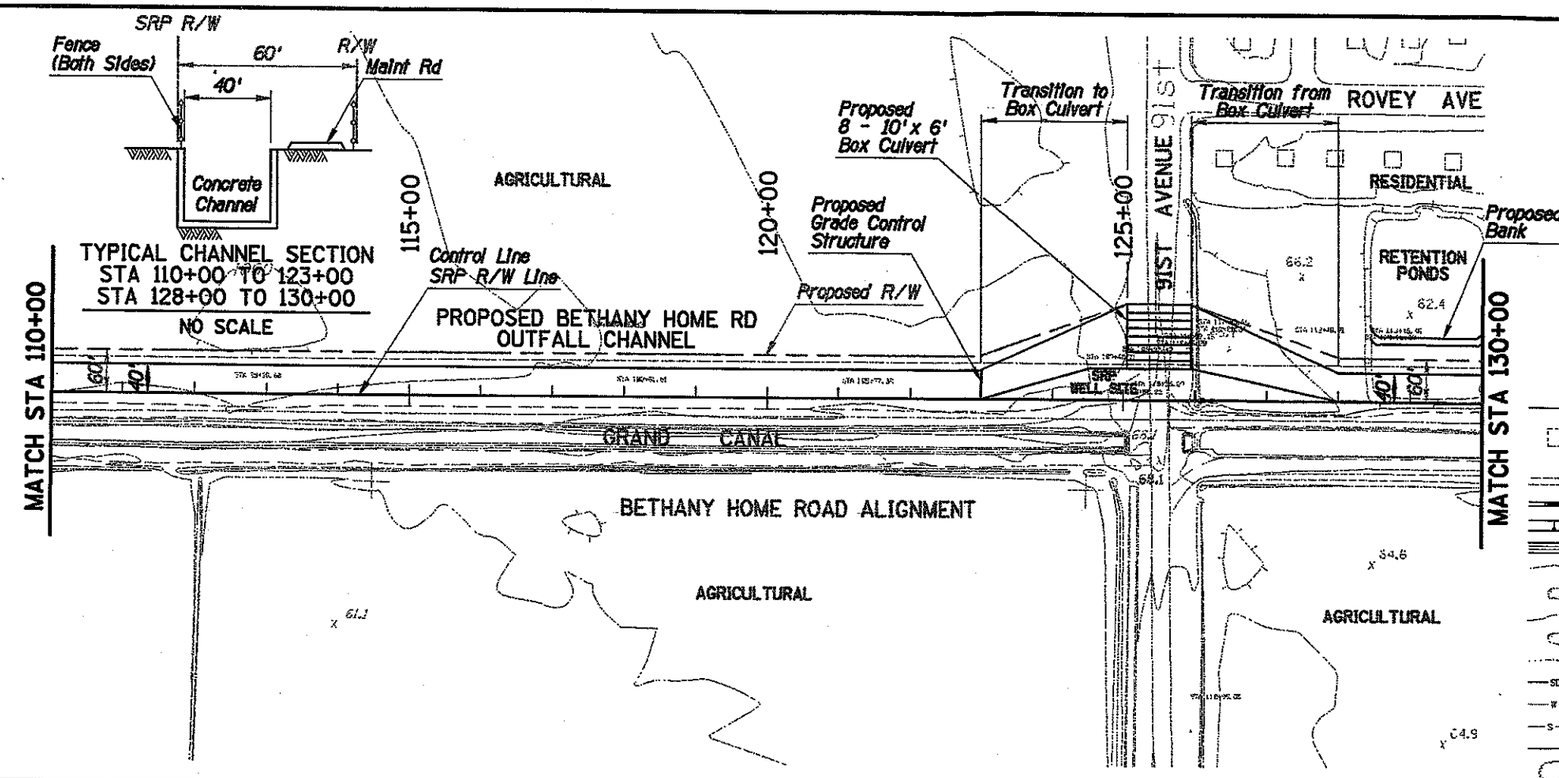
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

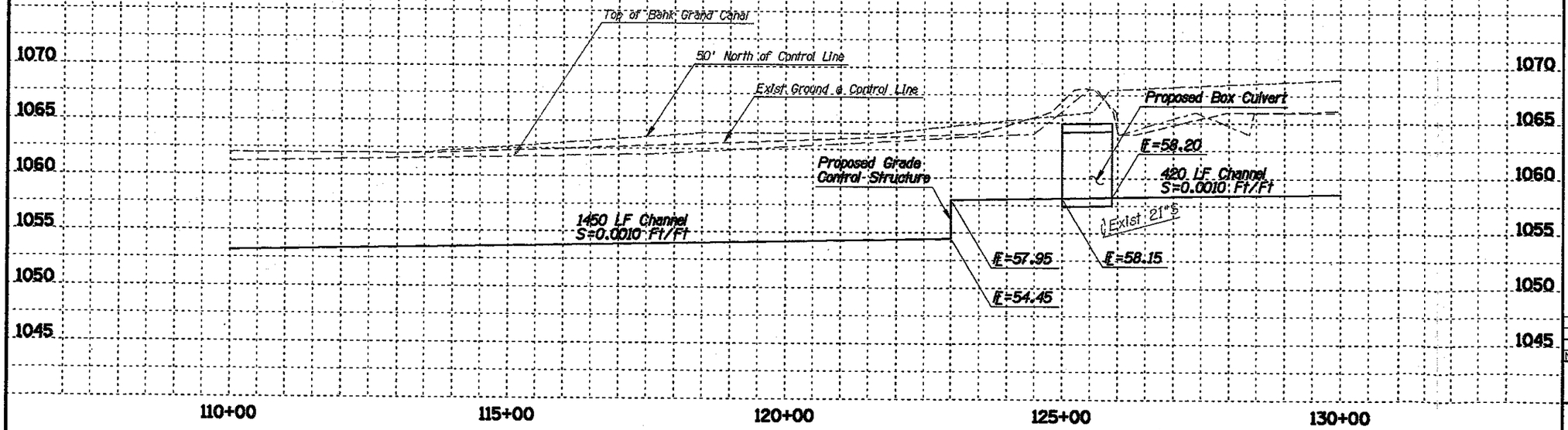
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 90+00 TO 110+00

FIGURE 9 | SHEET OF 32 44

TRACS NO.





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LEGEND

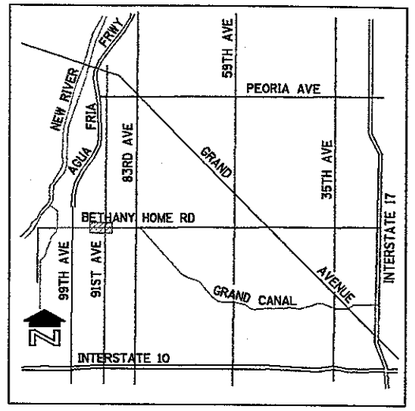
- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

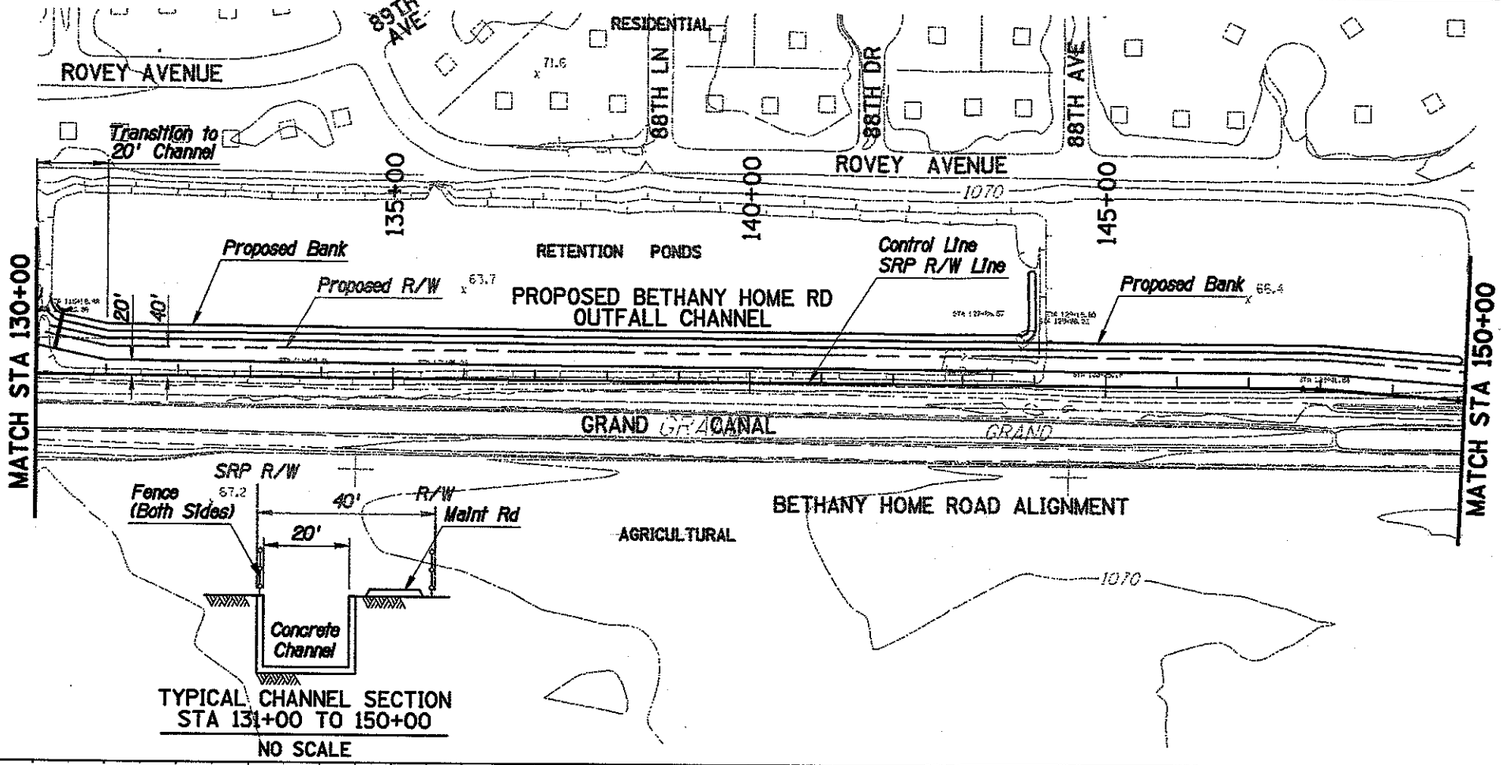
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

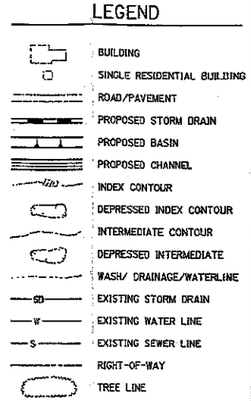
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

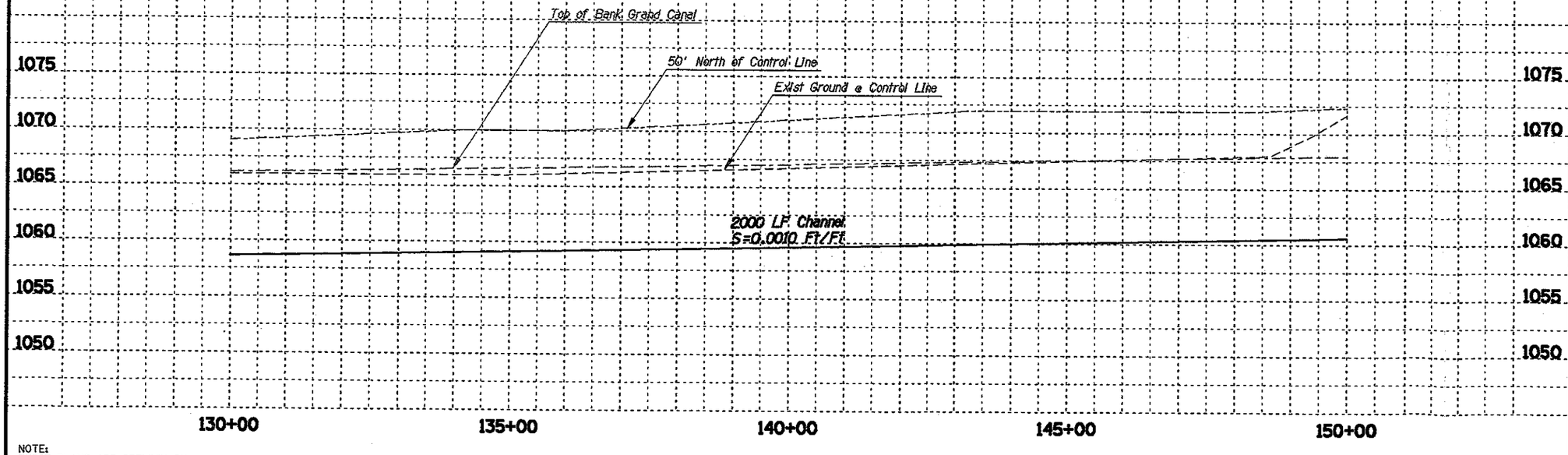
DRAINAGE SYSTEM PLAN
STA 110+00 TO 130+00

FIGURE 9 | SHEET OF 33 44

TRACS NO.







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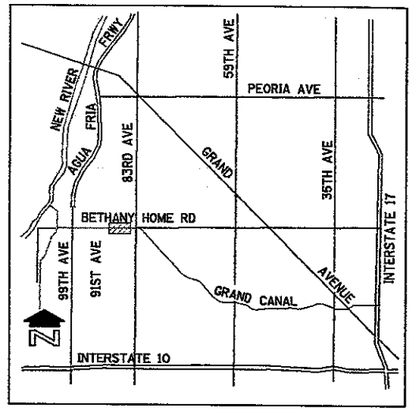
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

N

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

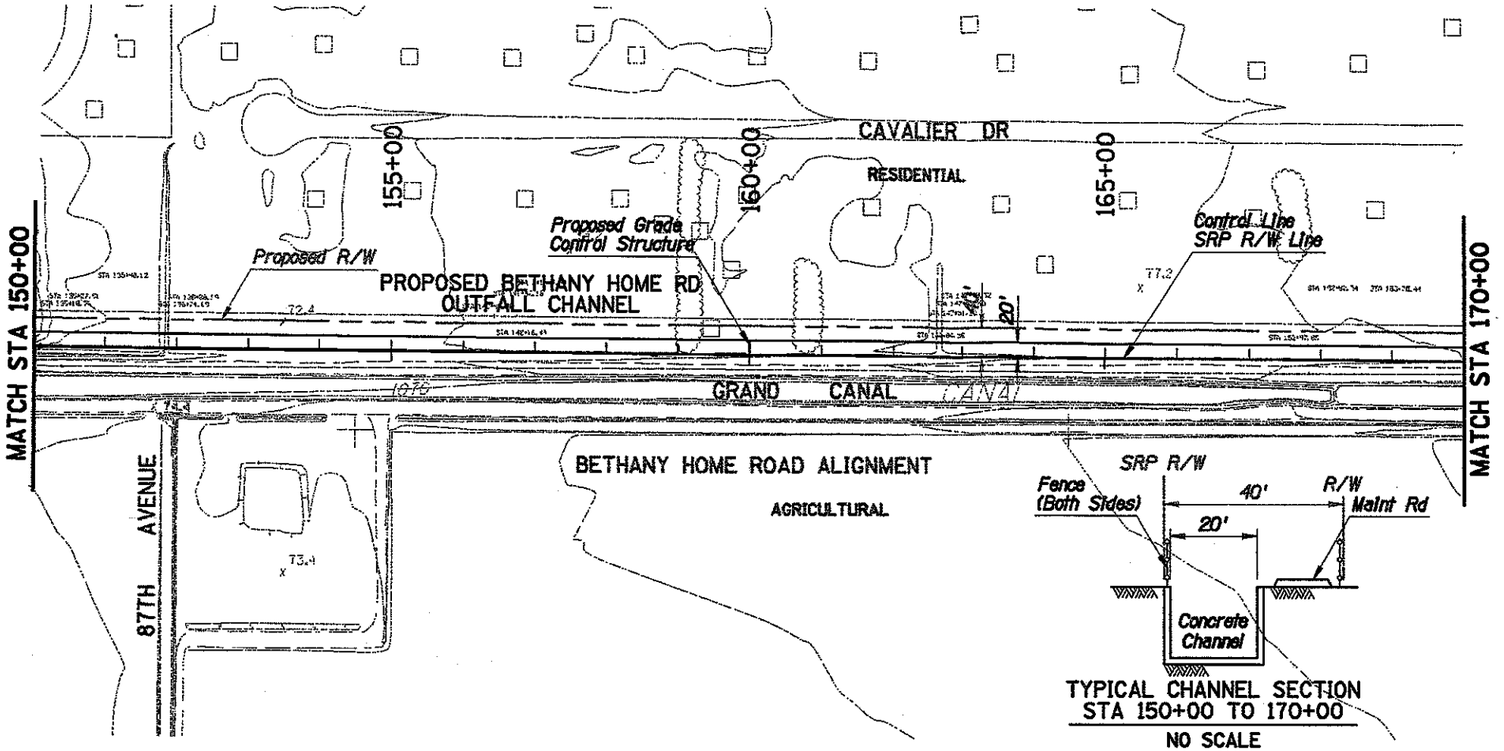
CONCEPT PLAN

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 130+00 TO 150+00

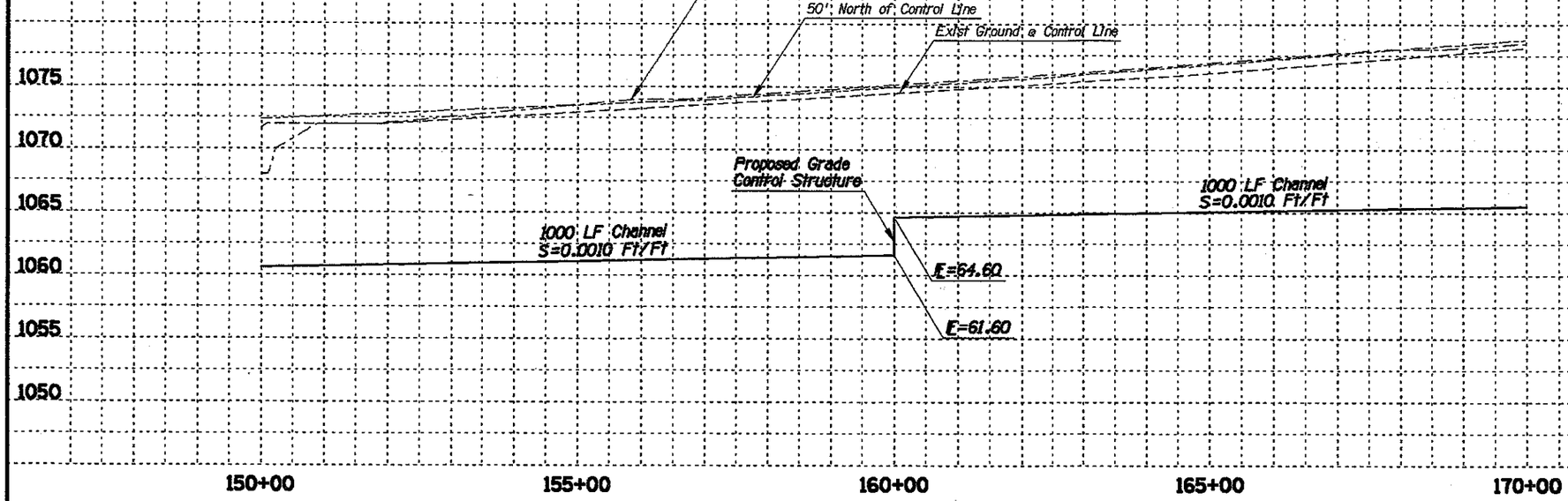
FIGURE 9 | SHEET 34 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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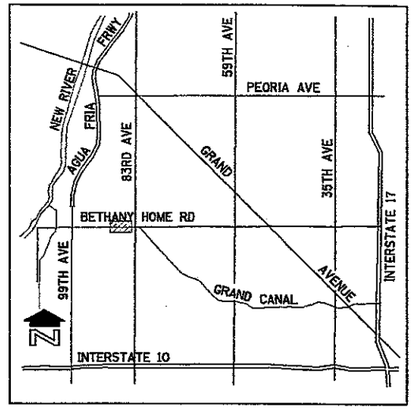
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

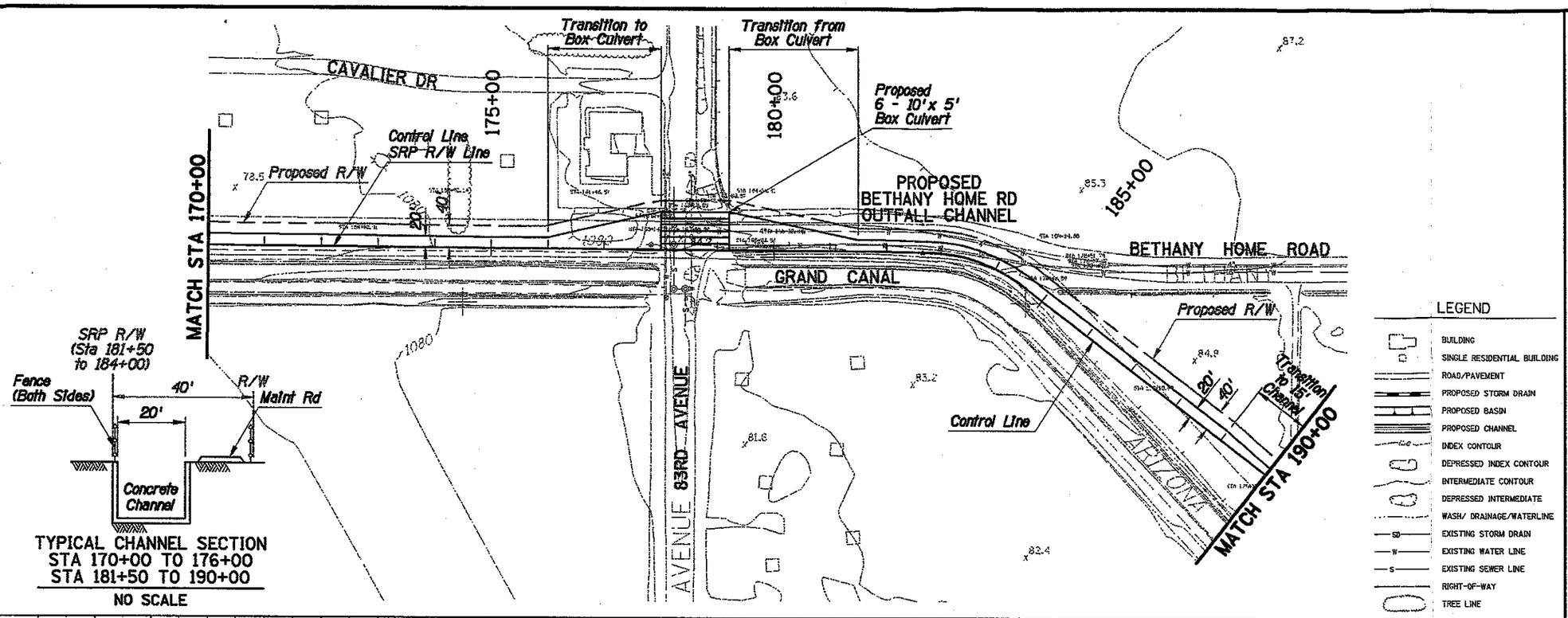
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

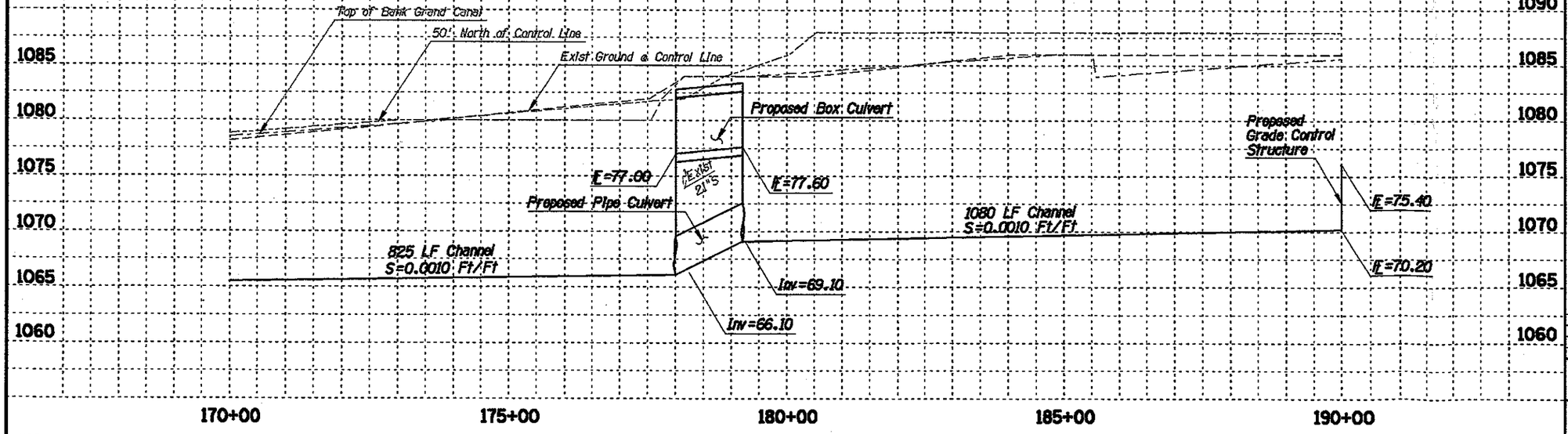
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 150+00 TO 170+00

FIGURE 9 | SHEET 35 OF 44

TRACS NO.





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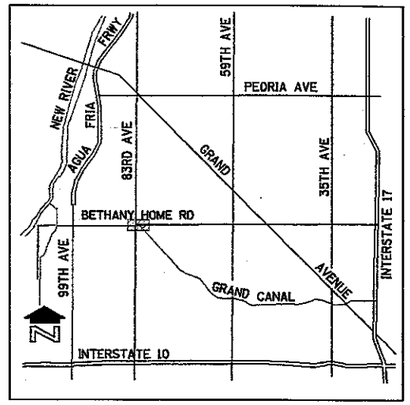
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

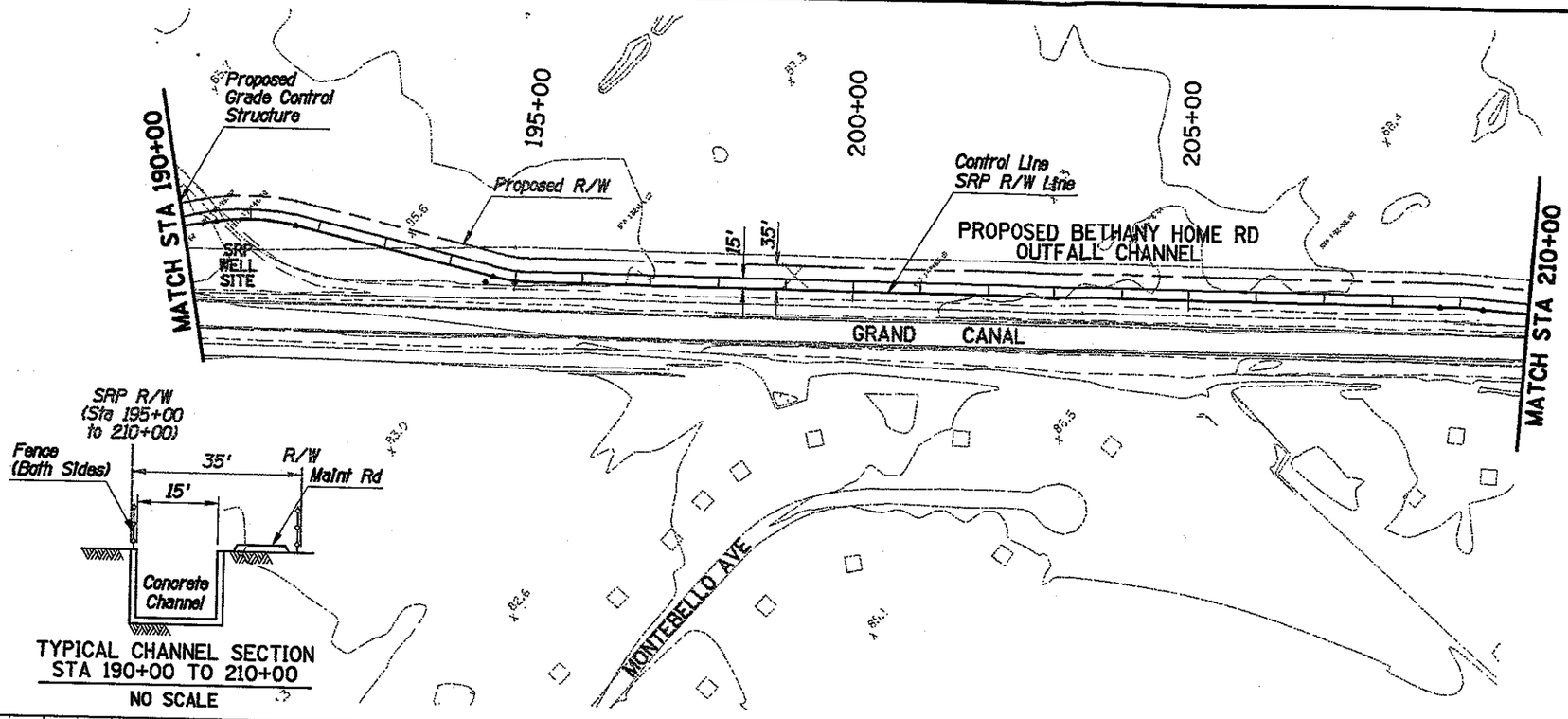
		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 170+00 TO 190+00

FIGURE 9 | SHEET OF 36 44

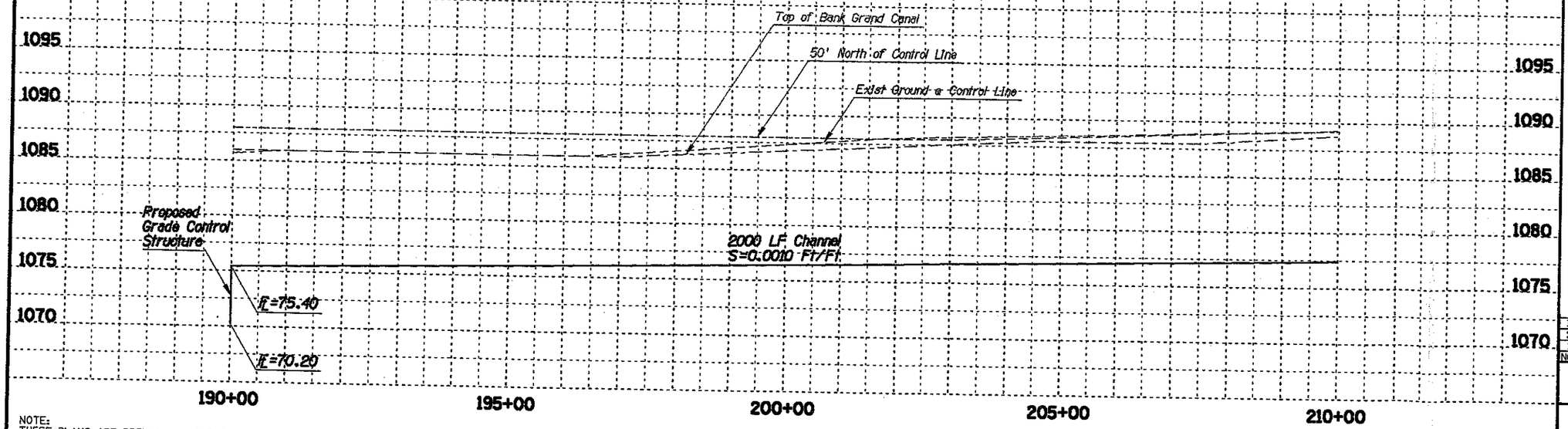
TRACS NO.



TYPICAL CHANNEL SECTION
STA 190+00 TO 210+00
NO SCALE

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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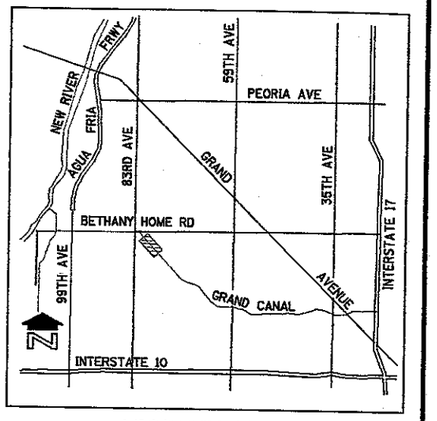
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

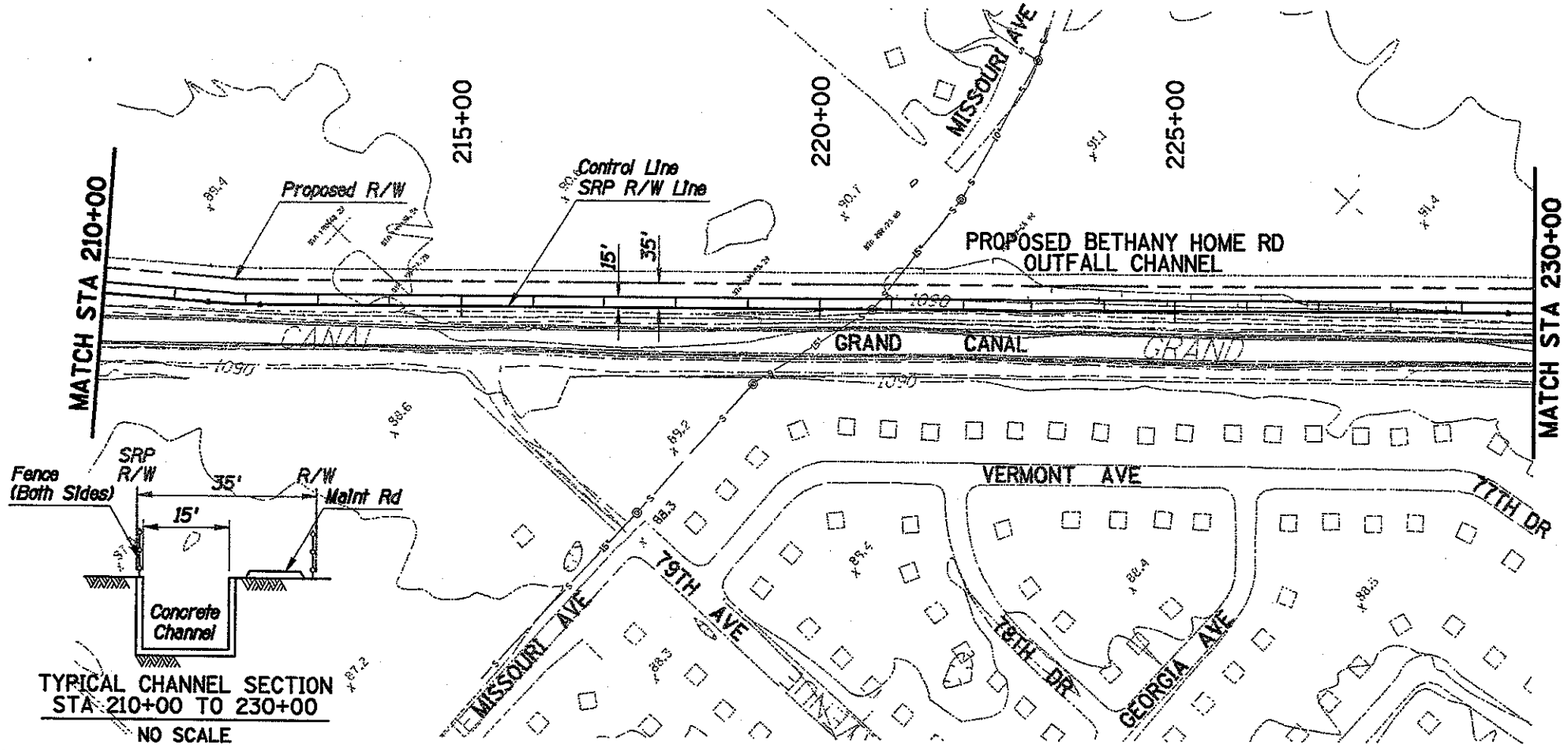
	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 190+00 TO 210+00

FIGURE 9 | SHEET 37 OF 44

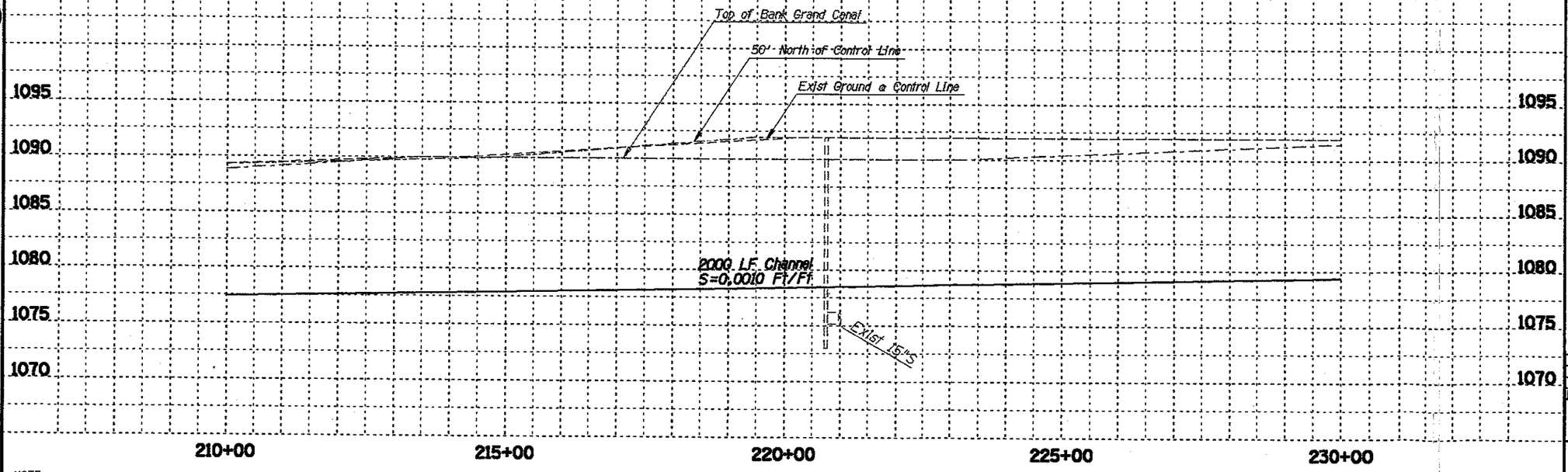
TRACS NO.



TYPICAL CHANNEL SECTION
STA 210+00 TO 230+00
NO SCALE

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD EXISTING STORM DRAIN
- W EXISTING WATER LINE
- S EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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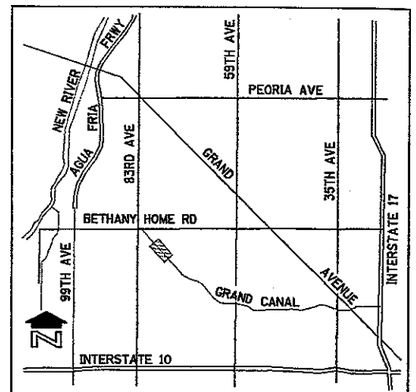
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

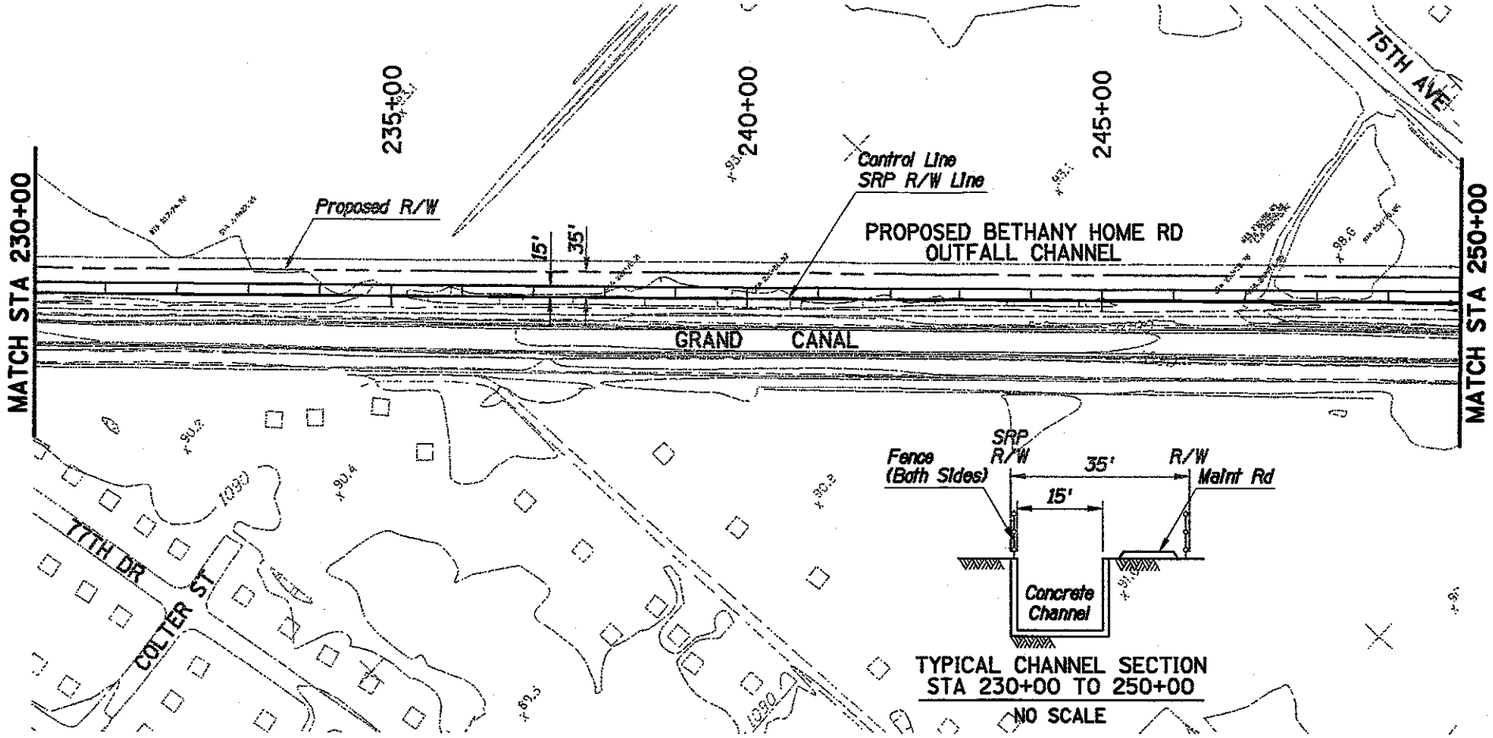
CONCEPT PLAN		BY	DATE
	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 210+00 TO 230+00

FIGURE 9 | SHEET OF 38 44

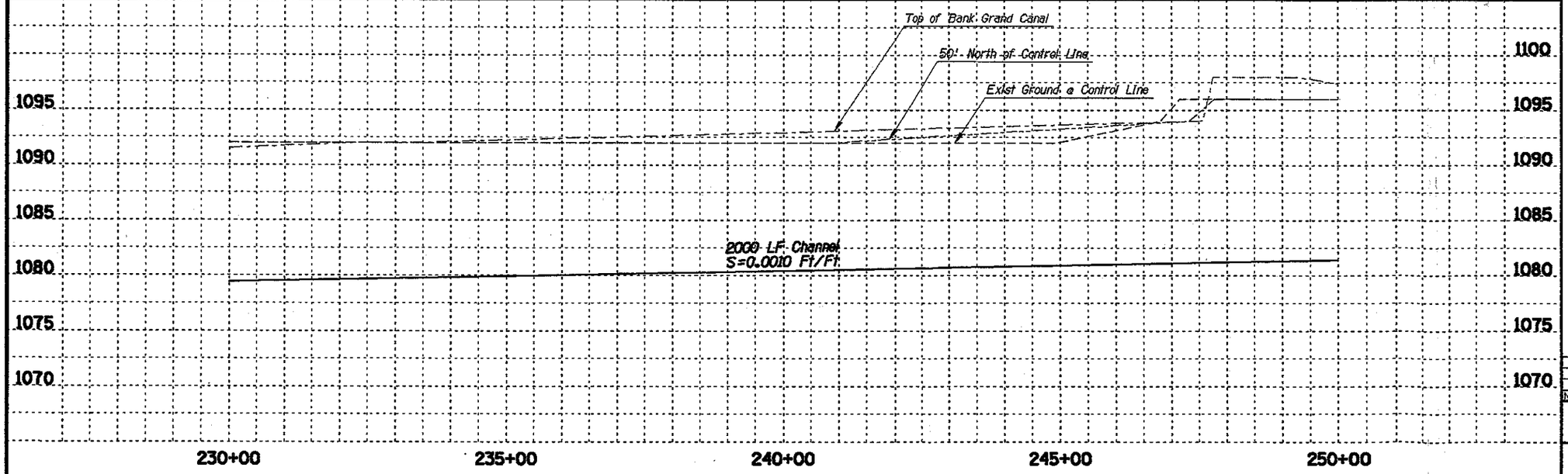
TRACS NO.



TYPICAL CHANNEL SECTION
STA 230+00 TO 250+00
NO SCALE

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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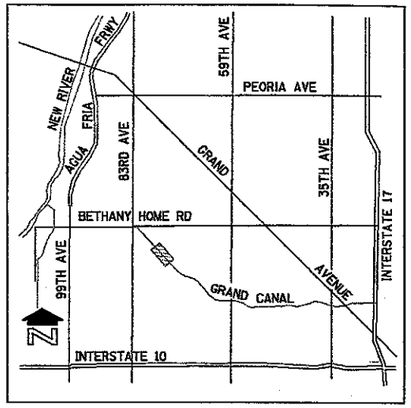
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MARYVALE AREA
DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

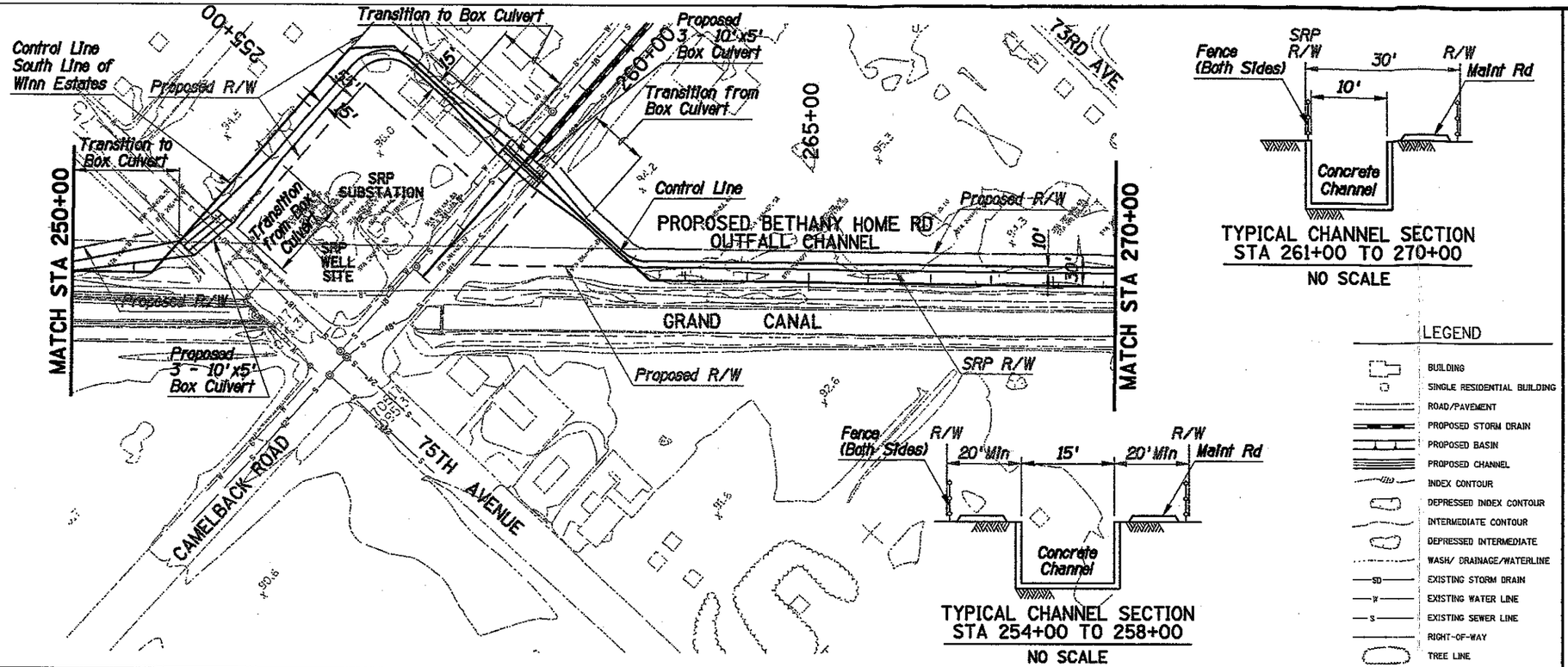
		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

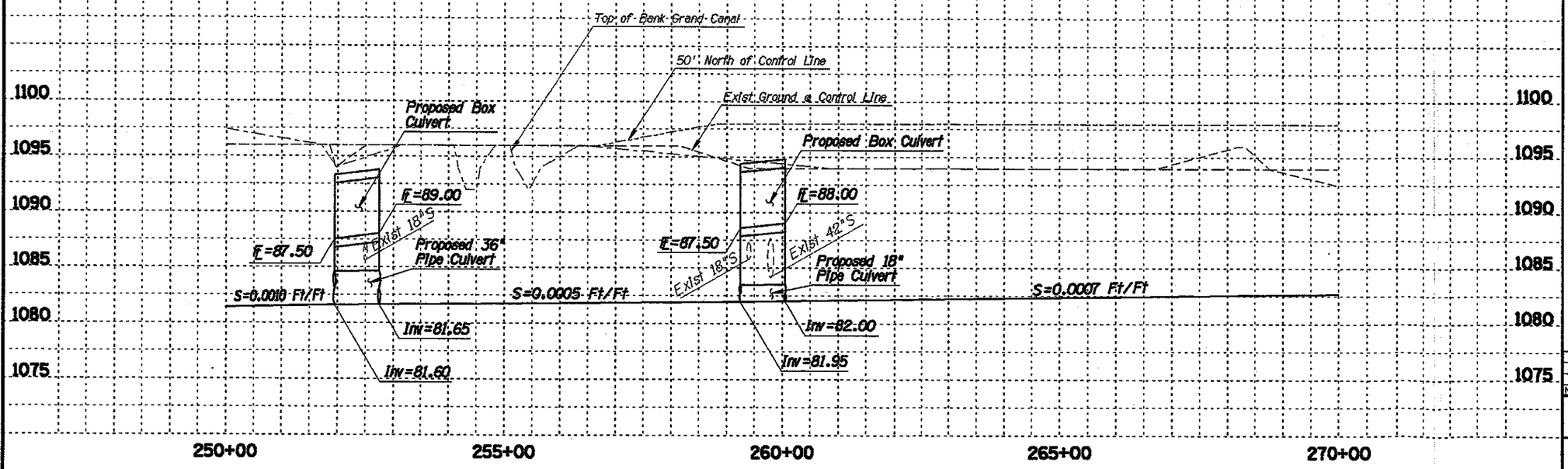
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 230+00 TO 250+00

FIGURE 9 | SHEET OF 39 44

TRACS NO.





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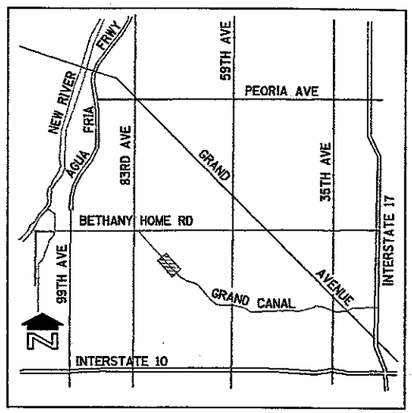
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

	BY	DATE
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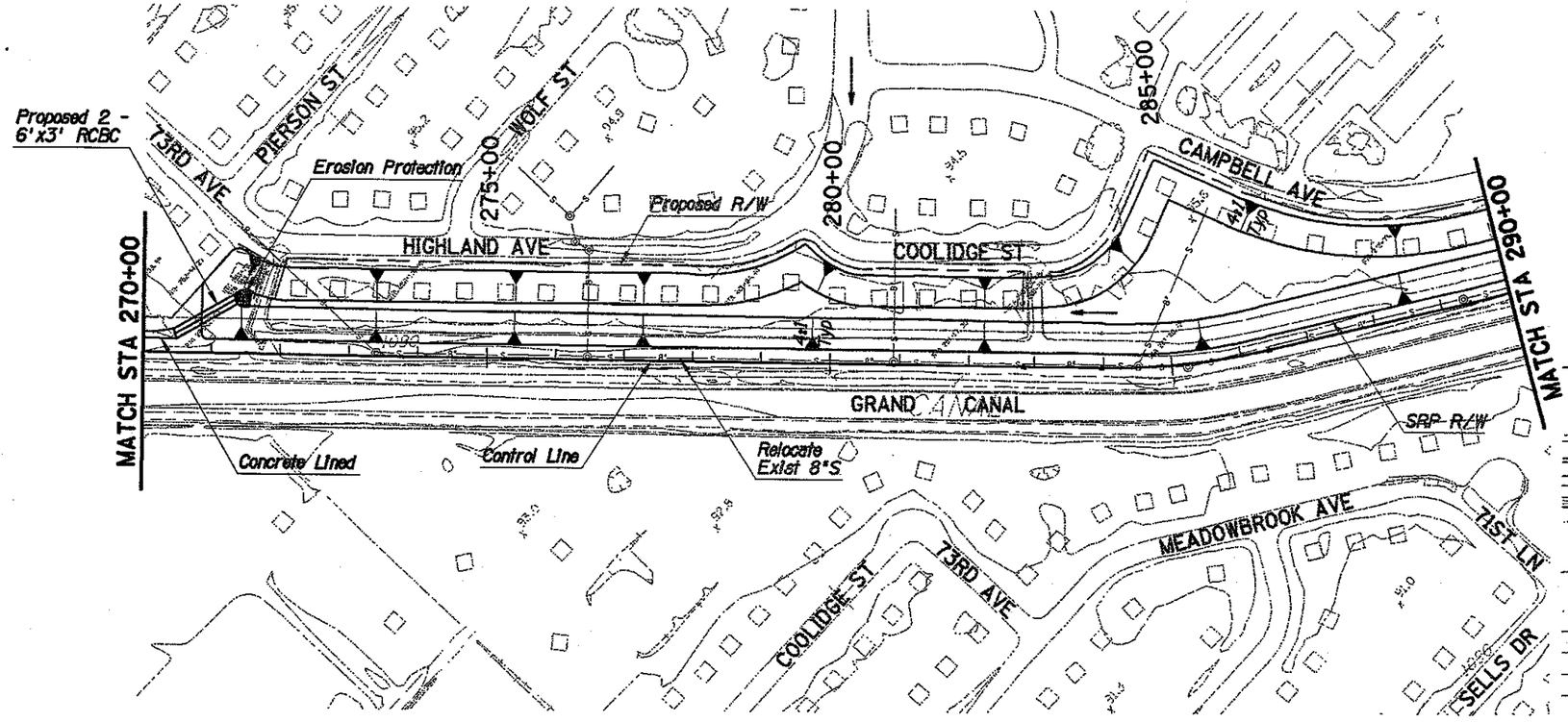
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 250+00 TO 270+00

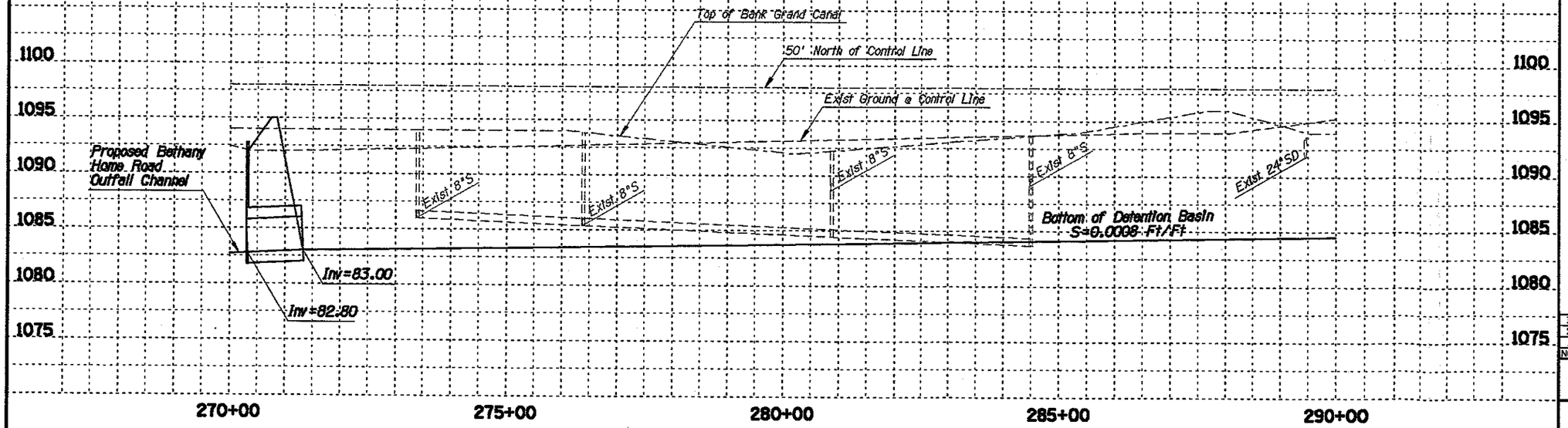
FIGURE 9 | SHEET OF 40 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- SD — EXISTING STORM DRAIN
- W — EXISTING WATER LINE
- S — EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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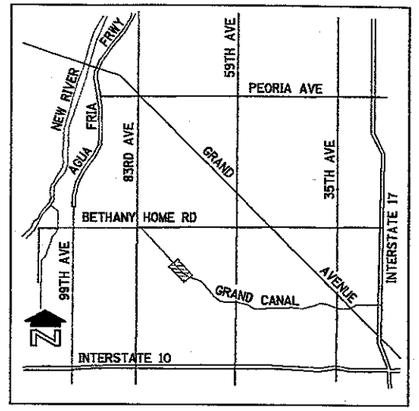
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN

	BY	DATE
DESIGNED	D. PHELPS, S. ZOU	9/97
DRAWN	S. RASMUSSEN, A. LINN	9/97
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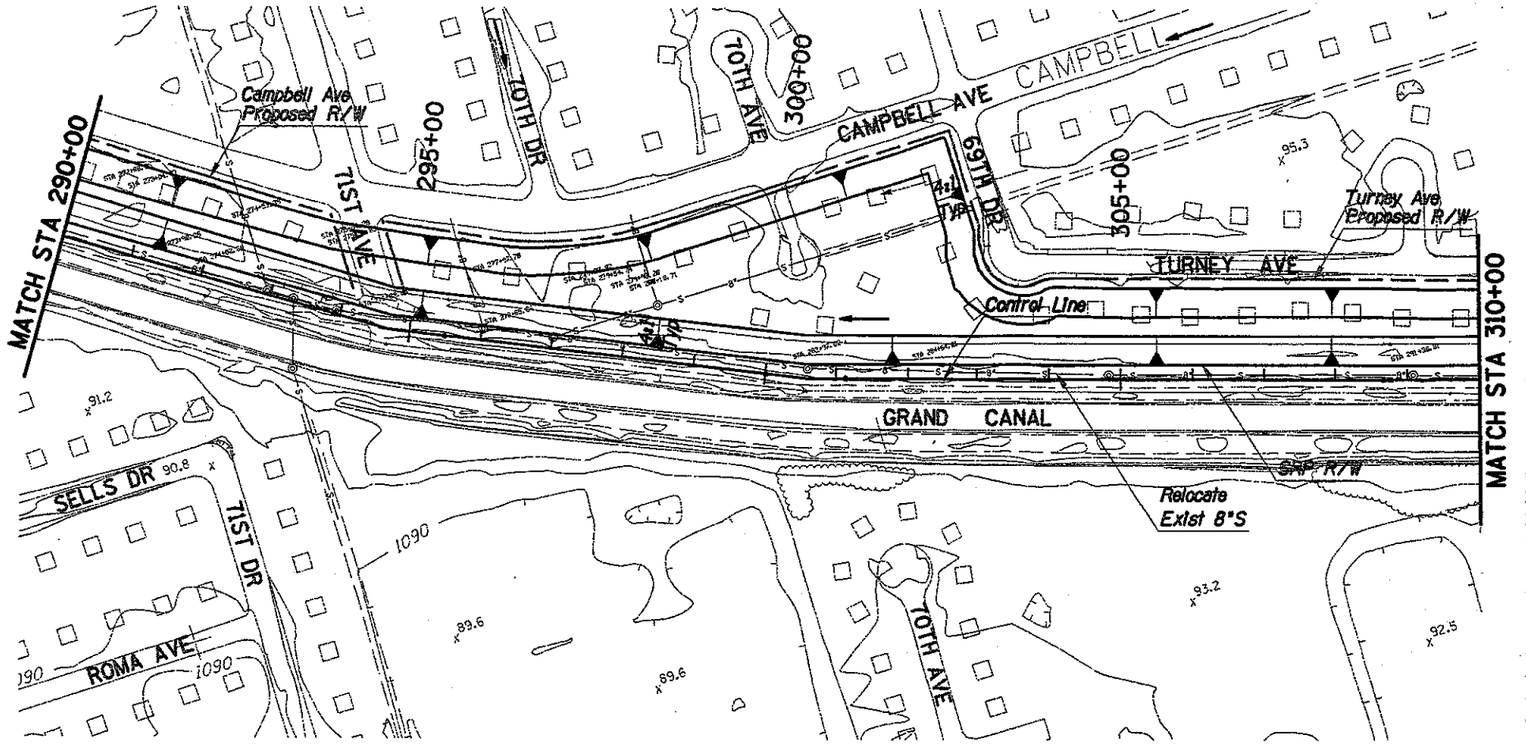
WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 270+00 TO 290+00

FIGURE 9 | SHEET OF 41 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
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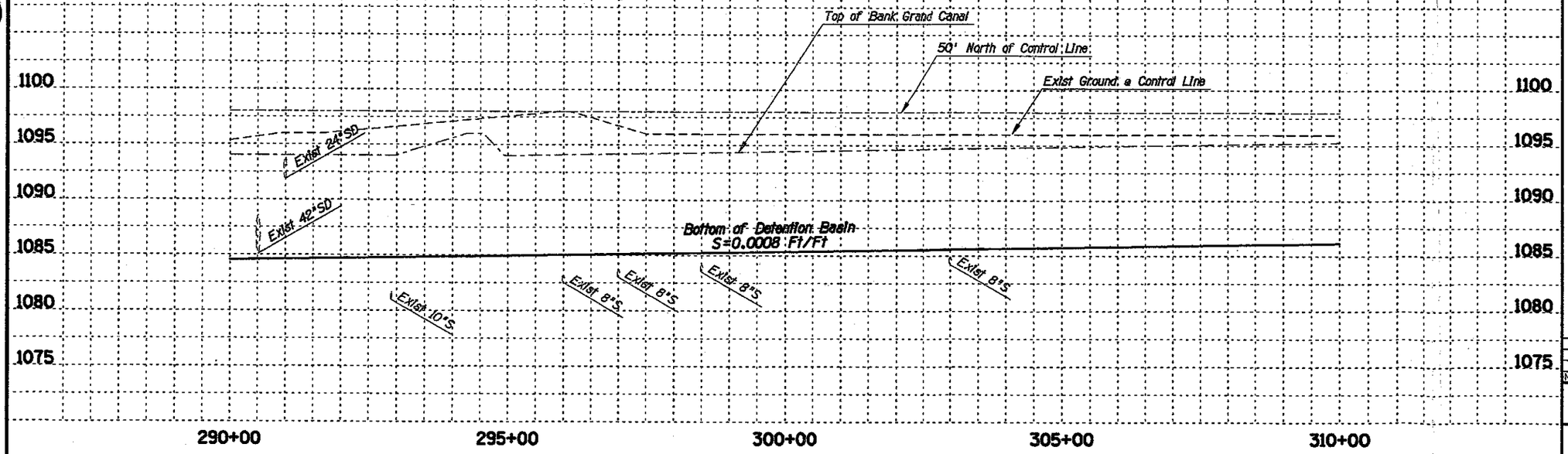
- TREE LINE



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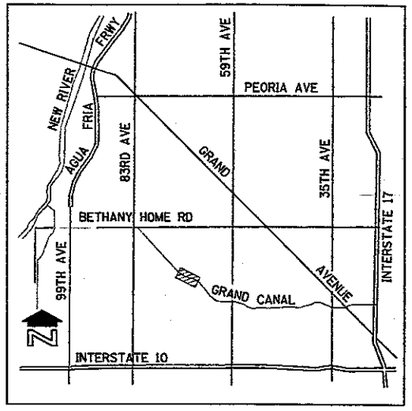
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

- MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

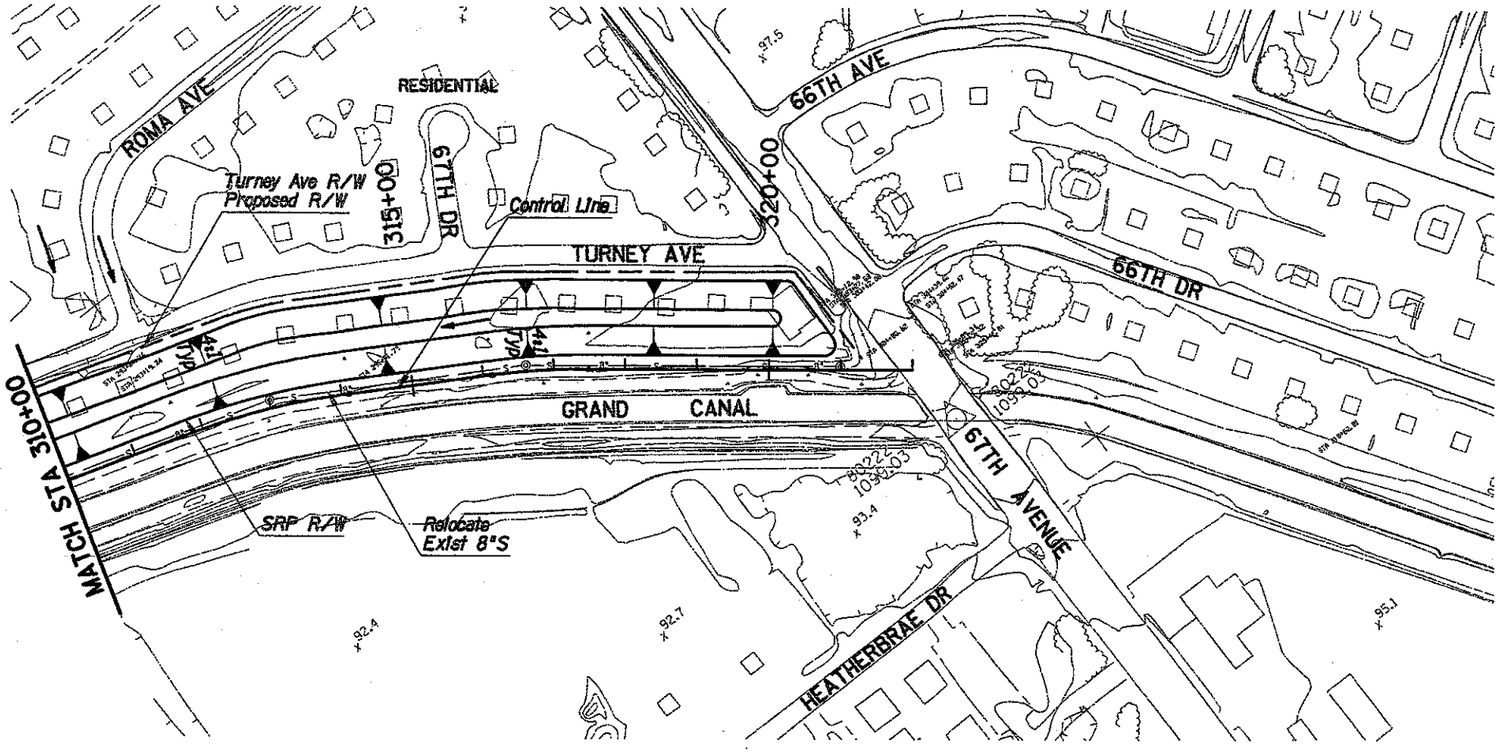
		BY	DATE
CONCEPT PLAN	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
	CHECKED	J. MOODY, A. PATEL	9/97

WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 290+00 TO 310+00

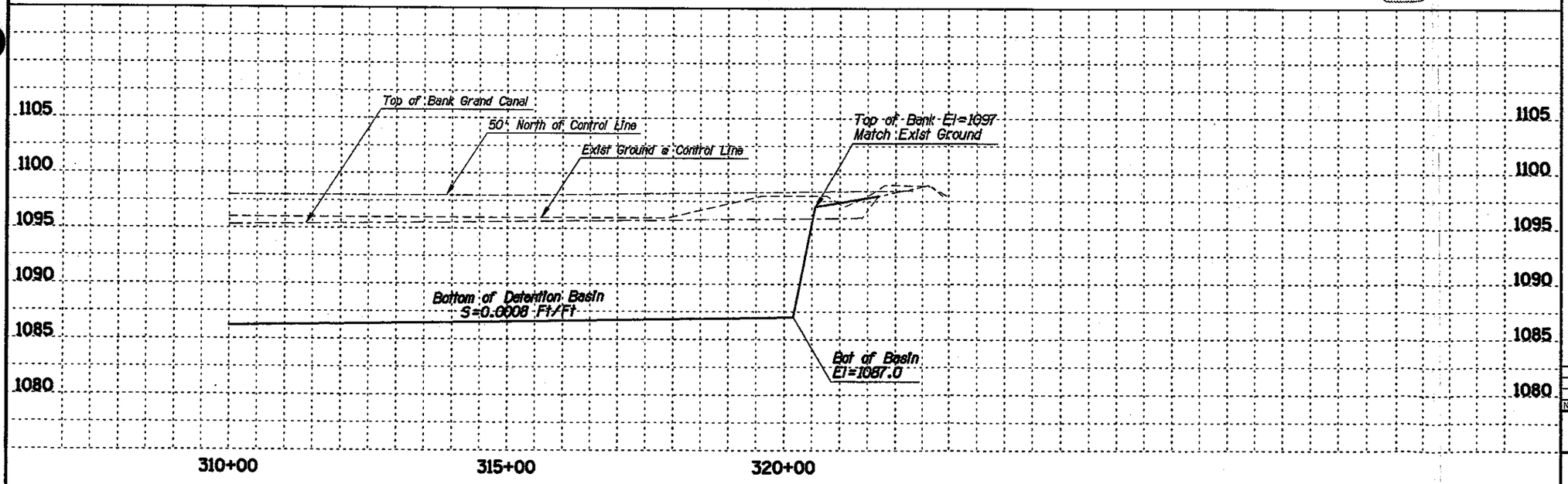
FIGURE 9 | SHEET 42 OF 44

TRACS NO.



LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
- EXISTING SEWER LINE
- RIGHT-OF-WAY
- TREE LINE



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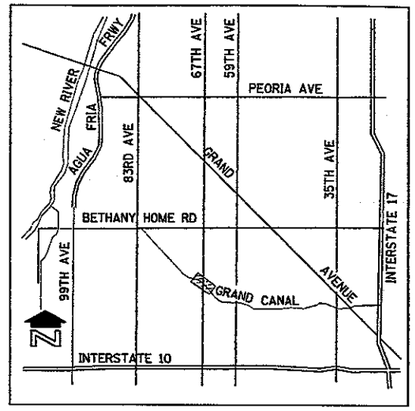
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS



VICINITY MAP

OPTION EVALUATION LEVEL III

GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MITIGATION OPTION 4, 100-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN		BY	DATE
	DESIGNED	D. PHELPS, S. ZOU	9/97
	DRAWN	S. RASMUSSEN, A. LINN	9/97
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WOOD, PATEL & ASSOCIATES, INC.
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PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN
STA 310+00 TO 321+00

FIGURE 9 | SHEET OF 43 44

TRACS NO.

LEGEND

- BUILDING
- SINGLE RESIDENTIAL BUILDING
- ROAD/PAVEMENT
- PROPOSED STORM DRAIN
- PROPOSED BASIN
- PROPOSED CHANNEL
- INDEX CONTOUR
- DEPRESSED INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSED INTERMEDIATE
- WASH/ DRAINAGE/WATERLINE
- EXISTING STORM DRAIN
- EXISTING WATER LINE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

MARYVALE AREA DRAINAGE MASTER STUDY

CONTRACT NO. FCD 93-29

FLOOD MITIGATION OPTIONS

VICINITY MAP

OPTION EVALUATION
LEVEL III

GRAND CANAL AT 31ST AVENUE

MITIGATION OPTION 1, 5-YEAR

100 0 100 200
SCALE IN FEET
CONTOUR INTERVAL = 2 FEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

CONCEPT PLAN		BY	DATE
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	DRAWN	S. RASMUSSEN, A. LINN	9/97
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WOOD, PATEL & ASSOCIATES, INC.
1550 EAST MISSOURI, SUITE 203
PHOENIX, ARIZONA (602) 234-1344

DRAINAGE SYSTEM PLAN	FIGURE 9	SHEET 44	OF 44

TRACS NO.

APPENDIX B

TABLES

Table 1 Level II Cost Comparison

Table 2 Level II Cost Analysis
- 2.01 Grand Avenue at 79th Avenue, Option 1, 10-Year
- 2.02 Grand Avenue at 75th Avenue, Option 1, 100-Year
- 2.03 Grand Avenue at 73rd Avenue, Option 1, 100-Year
- 2.04 Grand Avenue at 73rd Avenue, Option 1, 10-Year
- 2.05 Grand Avenue at 67th Avenue, Option 1, 100-Year
- 2.06 Grand Avenue at 51st Avenue, Option 4, 10-Year
- 2.07 Grand Avenue at 51st Avenue, Option 5, 10-Year
- 2.08 Grand Avenue at 51st Avenue, Option 6, 10-Year
- 2.09 Grand Avenue at 51st Avenue, Option 7, 10-Year
- 2.10 Grand Avenue at 51st Avenue, Option 8, 10-Year
- 2.11 Grand Avenue at 51st Avenue, Option 9, 10-Year
- 2.12 Grand Avenue at 43rd Avenue, Option 4, 10-Year
- 2.13 Grand Avenue at Interstate 17, Option 2, 100-Year
- 2.14 Grand Avenue at Interstate 17, Option 2, 10-Year
- 2.15 Grand Avenue at Interstate 17, Option 1, 5-Year
- 2.16 Grand Canal, 67th Avenue to 87th Avenue, Option 1, 100-Year
- 2.17 Grand Canal, 67th Avenue to 87th Avenue, Option 2, 100-Year
- 2.18 Grand Canal, 67th Avenue to 87th Avenue, Option 4, 100-Year
- 2.19 Grand Canal, 67th Avenue to 87th Avenue, Option 1, 10-Year
- 2.20 Grand Canal, 67th Avenue to 87th Avenue, Option 2, 10-Year
- 2.21 Grand Canal, 67th Avenue to 87th Avenue, Option 3, 10-Year
- 2.22 Grand Canal, 67th Avenue to 87th Avenue, Option 4, 10-Year
- 2.23 Grand Canal, 67th Avenue to 87th Avenue, Option 6, 10-Year
- 2.24 Grand Canal at 31st Avenue, Option 1, 5-Year

Table 3 Level III Cost Comparison

Table 4 Level III Cost Analysis
- 4.01 Grand Avenue at 79th Avenue, Option 1, 10-Year
- 4.02 Grand Avenue at 75th Avenue, Option 1, 10-Year
- 4.03 Grand Avenue at 73rd Avenue, Option 1, 10-Year
- 4.04 Grand Avenue at 67th Avenue, Option 1, 100-Year
- 4.05 Grand Avenue at 51st Avenue (Collection System), Option 6, 10-Year
- 4.06 Grand Avenue at 51st Avenue (Outfall System), Option 8, 10-Year
- 4.07 Grand Avenue at 43rd Avenue, Option 1, 10-Year
- 4.08 Grand Avenue at Interstate 17, Option 1, 5-Year
- 4.09 Grand Canal, 67th Avenue to 87th Avenue, Option 4, 100-Year
- 4.10 Grand Canal at 31st Avenue, Option 1, 5-Year

TABLE 1
LEVEL II COST COMPARISON

November 11, 1997

Maryvale Area Drainage Master Study
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

Flood Mitigation Option	Study Area Location	Estimated Cost	Comments
Grand Avenue			
Option 1, 10-Year	GRAND AVENUE AT 79TH AVENUE	$1,651,000	Recommended For Level III Study
Option 1, 10-Year	GRAND AVENUE AT 75TH AVENUE	$6,752,000	Recommended For Level III Study
Option 1, 100-Year	GRAND AVENUE AT 73RD AVENUE	$9,499,000	
Option 1, 10-Year	GRAND AVENUE AT 73RD AVENUE	$1,522,000	Recommended For Level III Study
Option 1, 100-Year	GRAND AVENUE AT 67TH AVENUE	$2,860,000	Recommended For Level III Study
Option 4, 10-Year	GRAND AVENUE AT 51ST AVENUE	$8,107,000	
Option 5, 10-Year	GRAND AVENUE AT 51ST AVENUE	$3,784,000	
Option 6, 10-Year	GRAND AVENUE AT 51ST AVENUE	$4,827,000	Recommended For Level III Study
Option 7, 10-Year	GRAND AVENUE AT 51ST AVENUE (OUTFALL)	$8,573,000	
Option 8, 10-Year	GRAND AVENUE AT 51ST AVENUE (OUTFALL)	$6,162,000	Recommended For Level III Study
Option 9, 10-Year	GRAND AVENUE AT 51ST AVENUE (OUTFALL)	$10,123,000	
Option 4, 10-Year	GRAND AVENUE AT 43RD AVENUE	$4,648,000	Recommended For Level III Study
Option 2, 100-Year	GRAND AVENUE AT INTERSTATE 17	$21,406,000	
Option 2, 10-Year	GRAND AVENUE AT INTERSTATE 17	$13,809,000	
Option 1, 5-Year	GRAND AVENUE AT INTERSTATE 17	$7,731,000	Recommended For Level III Study
Grand Canal			
Option 1, 100-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$23,051,000	
Option 2, 100-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$27,982,000	
Option 4, 100-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$18,866,000	Recommended For Level III Study
Option 1, 10-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$16,200,000	
Option 2, 10-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$16,571,000	
Option 3, 10-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$21,130,000	
Option 4, 10-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$21,491,000	
Option 6, 10-Year	GRAND CANAL 67TH AVENUE TO 87TH AVENUE	$14,236,000	
Option 1, 5-Year	GRAND CANAL AT 31ST AVENUE	$9,452,000	Recommended For Level III Study

Note: The RID, I-10 Channel, and the Agua Fria Freeway study areas were eliminated in the Level I analysis, and therefore are not shown in this table.

TABLE 2.01
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 79TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	36" RCP storm drain (rural)	$87.00	LF	390	$33,930
2	Headwall (36")	$350.00	CY	9	$3,150
3	Concrete Structure - Junction Box	$350.00	CY	5.2	$1,820
4	Replace/Retrofit 8" SS w/ Ductile Iron	$5,000.00	LS	1	$5,000
5	Basin Excavation	$4.00	CY	131,000	$524,000
				SUBTOTAL	$567,900
			Construction Contigincies	27%	$153,333
			Engineering	7%	$39,753
			Construction Administration	6%	$34,074
				TOTAL	**$795,060**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (12.9 Acres)	$1.50	SF	561,924	$842,886
				SUBTOTAL	$842,886
			Engineering, Legal & Administration	1.5%	$12,643
				TOTAL	**$855,529**
				GRAND TOTAL	***$1,650,589***

TABLE 2.02
LEVEL II COST ANALYSIS

November 7, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 75TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	42" Storm Drain	$91.00	LF	987	$89,817
2	60" Storm Drain	$139.00	LF	327	$45,453
3	Jacking pipe under Grand Avenue	$150,000.00	EA	1	$150,000
4	Headwalls (3)	$350.00	CY	35.1	$12,285
5	Detention Basin Excavation	$4.00	CY	491,873	$1,967,492
				SUBTOTAL	$2,265,047
			Construction Contigincies	27%	$611,563
			Engineering	7%	$158,553
			Construction Administration	6%	$135,903
				TOTAL	**$3,171,066**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	N. Basin Land Acquisition (17.5 Acres)	$3.00	SF	762,300	$2,286,900
2	S. Basin Land Acquisition (8.9 Acres)	$3.00	SF	387,684	$1,163,052
3	Storm Drain Easement 0.6 Acres)	$3.00	SF	26,136	$78,408
				SUBTOTAL	$3,528,360
			Engineering, Legal & Administration	1.5%	$52,925
				TOTAL	**$3,581,285**
				GRAND TOTAL	***$6,752,351***

TABLE 2.03
LEVEL II COST ANALYSIS

November 7, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 100-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 73RD AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	42" Storm Drain	$110.00	LF	100	$11,000
2	Headwall	$350.00	CY	9	$3,150
3	Detention Basin Excavation	$4.00	CY	776,917	$3,107,668
				SUBTOTAL	$3,121,818
			Construction Contigincies	27%	$842,891
			Engineering	7%	$218,527
			Construction Administration	6%	$187,309
				TOTAL	**$4,370,545**

LAND ACQUISITION:

ITEM	DESCRIPTION		UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition	(46.4 Acres)	$2.50	SF	2,021,184	$5,052,960
					SUBTOTAL	$5,052,960
			Engineering, Legal & Administration		1.5%	$75,794
					TOTAL	**$5,128,754**
					GRAND TOTAL	***$9,499,300***

TABLE 2.04
LEVEL II COST ANALYSIS

November 7, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 73RD AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	42" Storm Drain	$110.00	LF	100	$11,000
2	Headwall	$350.00	CY	9	$3,150
3	Detention Basin Excavation	$4.00	CY	130,164	$520,656
				SUBTOTAL	$534,806
			Construction Contigincies	27%	$144,398
			Engineering	7%	$37,436
			Construction Administration	6%	$32,088
				TOTAL	**$748,728**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (7.0 Acres)	$2.50	SF	304,920	$762,300
				SUBTOTAL	$762,300
		Engineering, Legal & Administration		1.5%	$11,435
				TOTAL	**$773,735**
				GRAND TOTAL	***$1,522,463***

TABLE 2.05
LEVEL II COST ANALYSIS

November 7, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 100-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 67TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Detention Basin Excavation	$4.00	CY	441,900	$1,767,600
2	Pumping Facility (36,000 gpm)	$275,000.00	LS	1	$275,000
				SUBTOTAL	$2,042,600
				Construction Contigincies 27%	$551,502
				Engineering 7%	$142,982
				Construction Administration 6%	$122,556
				TOTAL	**$2,859,640**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (0 Acres)	$0.00	SF	0	$0
				SUBTOTAL	$0
				Engineering, Legal & Administration 1.5%	$0
				TOTAL	**$0**
				GRAND TOTAL	***$2,859,640***

TABLE 2.06
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 4, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139.00	LF	2,200	$305,800
2	72" RCP storm drain	$165.00	LF	5,500	$907,500
3	96" RCP storm drain	$279.00	LF	5,600	$1,562,400
4	108" RCP storm drain	$317.00	LF	2,500	$792,500
5	Basin Excavation (2)	$4.00	CY	260,000	$1,040,000
6	Concrete Structure - Junction Box (3)	$350.00	CY	99	$34,650
7	Headwalls (2-60")	$350.00	CY	27.8	$9,730
8	Jacking Under Grand Avenue (72")	$200,000.00	EA	1.0	$200,000
				SUBTOTAL	$4,852,580
			Construction Contigincies	27%	$1,310,197
			Engineering	7%	$339,681
			Construction Administration	6%	$291,155
				TOTAL	**$6,793,612**

LAND ACQUISITION:

ITEM	DESCRIPTION		UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition	(15.8 Acres)	$1.00	SF	688,248	$688,248
2	Basin Land Acquisition	(13.9 Acres)	$1.00	SF	605,484	$605,484
					SUBTOTAL	$1,293,732
				Engineering, Legal & Administration	1.5%	$19,406
					TOTAL	**$1,313,138**
					GRAND TOTAL	***$8,106,750***

TABLE 2.07
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 5, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	48" RCP storm drain	$116.00	LF	600	$69,600
2	84" RCP storm drain	$230.00	LF	6,947	$1,597,810
3	96" RCP storm drain	$279.00	LF	2,775	$774,225
4	Concrete Structure - Junction Box	$350.00	CY	33	$11,550
5	Jacking Under Grand Avenue (96")	$250,000.00	EA	1	$250,000
				SUBTOTAL	$2,703,185
			Construction Contigincies	27%	$729,860
			Engineering	7%	$189,223
			Construction Administration	6%	$162,191
				TOTAL	**$3,784,459**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (0.0 Acres)		SF	0	$0
				SUBTOTAL	$0
			Engineering, Legal & Administration	1.5%	$0
				TOTAL	**$0**
				GRAND TOTAL	***$3,784,459***

TABLE 2.08
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 6, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	48" RCP storm drain	$116.00	LF	363	$42,108
2	60" RCP storm drain	$139.00	LF	3,175	$441,325
3	84" RCP storm drain	$230.00	LF	6,947	$1,597,810
4	96" RCP storm drain	$279.00	LF	290	$80,910
5	Basin Excavation (1)	$4.00	CY	155,000	$620,000
6	Concrete Structure - Junction Box (1)	$350.00	CY	33	$11,550
7	Headwall (1-60")	$350.00	CY	13.9	$4,865
8	Jacking Under Grand Ave (60")	$150,000.00	EA	1	$150,000
				SUBTOTAL	$2,948,568
			Construction Contigincies	27%	$796,113
			Engineering	7%	$206,400
			Construction Administration	6%	$176,914
				TOTAL	**$4,127,995**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (15.8 Acres)	$1.00	SF	688,248	$688,248
				SUBTOTAL	$688,248
			Engineering, Legal & Administration	1.5%	$10,324
				TOTAL	**$698,572**
				GRAND TOTAL	***$4,826,567***

TABLE 2.09
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 7, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	108" RCP storm drain	$317.00	LF	10,950	$3,471,150
2	120" RCP storm drain	$393.00	LF	6,750	$2,652,750
				SUBTOTAL	$6,123,900
			Construction Contigincies	27%	$1,653,453
			Engineering	7%	$428,673
			Construction Administration	6%	$367,434
				TOTAL	**$8,573,460**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (0.0 Acres)		SF	0	$0
				SUBTOTAL	$0
			Engineering, Legal & Administration	1.5%	$0
				TOTAL	**$0**
				GRAND TOTAL	***$8,573,460***

TABLE 2.10
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 8, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	84" RCP storm drain	$230.00	LF	10,950	$2,518,500
2	96" RCP storm drain	$279.00	LF	6,750	$1,883,250
				SUBTOTAL	$4,401,750
			Construction Contigincies	27%	$1,188,473
			Engineering	7%	$308,123
			Construction Administration	6%	$264,105
				TOTAL	**$6,162,450**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (0.0 Acres)		SF	0	$0
				SUBTOTAL	$0
		Engineering, Legal & Administration		1.5%	$0
				TOTAL	**$0**
				GRAND TOTAL	***$6,162,450***

TABLE 2.11
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 9, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	84" RCP storm drain	$230.00	LF	17,700	$4,071,000
2	Headwall (1-60")	$350.00	CY	13.9	$4,865
3	Basin Excavation	$4.00	CY	500,000	$2,000,000
				SUBTOTAL	$6,075,865
			Construction Contigincies	27%	$1,640,484
			Engineering	7%	$425,311
			Construction Administration	6%	$364,552
				TOTAL	**$8,506,211**

LAND ACQUISITION:

ITEM	DESCRIPTION		UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition	(29.3 Acres)	$1.25	SF	1,274,130	$1,592,663
					SUBTOTAL	$1,592,663
			Engineering, Legal & Administration		1.5%	$23,890
					TOTAL	**$1,616,552**
					GRAND TOTAL	***$10,122,763***

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TABLE 2.12
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 4, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 43RD AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	36" RCP storm drain	$105.00	LF	168	$17,640
2	72" RCP storm drain	$165.00	LF	2,815	$464,475
3	78" RCP storm drain	$183.00	LF	3,732	$682,956
4	84" RCP storm drain	$230.00	LF	269	$61,870
5	102" RCP storm drain	$298.00	LF	3,668	$1,093,064
6	Concrete Structure - Junction Box (1)	$350.00	CY	35	$12,250
7	Headwalls (1-36" & 1-84")	$350.00	CY	26	$9,100
8	Jacking under Grand Ave & SPRR (96")	$250,000.00	EA	1	$250,000
9	Basin Excavation	$4.00	CY	72,000	$288,000
				SUBTOTAL	$2,879,355
			Construction Contigincies	27%	$777,426
			Engineering	7%	$201,555
			Construction Administration	6%	$172,761
				TOTAL	**$4,031,097**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (6.2 Acres)	$2.25	SF	270,072	$607,662
				SUBTOTAL	$607,662
			Engineering, Legal & Administration	1.5%	$9,115
				TOTAL	**$616,777**
				GRAND TOTAL	***$4,647,874***

TABLE 2.13
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 2, 100-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT INTERSTATE 17

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139.00	LF	105	$14,595
2	72" RCP storm drain	$165.00	LF	760	$125,400
3	Outlet Headwalls (1-60" & 2-72")	$350.00	CY	59.7	$20,895
4	Basin Excavation	$4.00	CY	1,069,000	$4,276,000
5	Pump station (3-60Hp C-3501-1430)	$276,000.00	EA	1	$276,000
				SUBTOTAL	$4,712,890
			Construction Contigincies	27%	$1,272,480
			Engineering	7%	$329,902
			Construction Administration	6%	$282,773
				TOTAL	**$6,598,046**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Residential Land Acquisition	$78,000.00	EA	83	$6,474,000
2	Multi & Comm Land Acquisition (North)	$3,282,200.00	EA	1	$3,282,200
3	Commercial Land Acquisition (South)	$4,833,000.00	EA	1	$4,833,000
				SUBTOTAL	$14,589,200
			Engineering, Legal & Administration	1.5%	$218,838
				TOTAL	**$14,808,038**
				GRAND TOTAL	***$21,406,084***

TABLE 2.14
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 2, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT INTERSTATE 17

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139.00	LF	105	$14,595
2	72" RCP storm drain	$165.00	LF	760	$125,400
3	Outlet Headwalls (1-60" & 2-72")	$350.00	CY	59.7	$20,895
4	Basin Excavation	$4.00	CY	490,000	$1,960,000
5	Pump station (3-60Hp C-3501-1430)	$276,000.00	EA	1	$276,000
				SUBTOTAL	$2,396,890
			Construction Contigincies	27%	$647,160
			Engineering	7%	$167,782
			Construction Administration	6%	$143,813
				TOTAL	**$3,355,646**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Residential Land Acquisition	$78,000.00	EA	28	$2,184,000
2	Multi & Comm Land Acquisition (North)	$3,282,200.00	EA	1	$3,282,200
3	Commercial Land Acquisition (South)	$4,833,000.00	EA	1	$4,833,000
				SUBTOTAL	$10,299,200
			Engineering, Legal & Administration	1.5%	$154,488
				TOTAL	**$10,453,688**
				GRAND TOTAL	***$13,809,334***

TABLE 2.15
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 5-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT INTERSTATE 17

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139.00	LF	105	$14,595
2	Outlet Headwalls (1-60")	$350.00	CY	12.2	$4,270
3	Basin Excavation	$4.00	CY	339,000	$1,356,000
4	Pump station (2-60Hp C-3501-1430)	$184,000.00	EA	1	$184,000
				SUBTOTAL	$1,558,865
			Construction Contigincies	27%	$420,894
			Engineering	7%	$109,121
			Construction Administration	6%	$93,532
				TOTAL	**$2,182,411**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Residential Land Acquisition	$78,000.00	EA	28	$2,184,000
2	Multi & Comm Land Acquisition (North)	$3,282,200.00	EA	1	$3,282,200
				SUBTOTAL	$5,466,200
			Engineering, Legal & Administration	1.5%	$81,993
				TOTAL	**$5,548,193**
				GRAND TOTAL	***$7,730,604***

TABLE 2.16
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 100-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	375,000	$1,125,000
2	Concrete Rectangular Channel	$300.00	CY	28,590	$8,577,000
3	Concrete Box Culverts	$350.00	CY	2,248	$786,800
4	Concrete Headwalls	$350.00	CY	156	$54,600
5	Concrete Structures (Drops)	$350.00	CY	215	$75,250
6	Fencing	$15.50	LF	34,200	$530,100
7	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
8	Demolition of Houses	$5,000.00	LOT	63	$315,000
				SUBTOTAL	$11,663,750
			Construction Contigincies	27%	$3,149,213
			Engineering	7%	$816,463
			Construction Administration	6%	$699,825
				TOTAL	**$16,329,250**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	243,549	$852,422
2	Channel Land Acquistion	$1.50	SF	150,914	$226,371
3	Residential Land Acquisition	$88,000.00	Lot	63	$5,544,000
				SUBTOTAL	$6,622,793
			Engineering, Legal & Administration	1.5%	$99,342
				TOTAL	**$6,722,134**
				GRAND TOTAL	***$23,051,384***

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TABLE 2.17
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 2, 100-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	375,000	$1,125,000
2	Concrete Rectangular Channel	$300.00	CY	28,590	$8,577,000
3	Concrete Box Culverts	$350.00	CY	2,248	$786,800
4	Concrete Headwalls	$350.00	CY	156	$54,600
5	Concrete Structures (Drops)	$350.00	CY	215	$75,250
6	Fencing	$15.50	LF	34,200	$530,100
7	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
8	Demolition of Houses	$5,000.00	LOT	63	$315,000
9	78" RCP stormdrain	$183.00	LF	5,280	$966,240
10	84" RCP stormdrain	$230.00	LF	5,280	$1,214,400
11	90" RCP stormdrain	$254.00	LF	5,280	$1,341,120
				SUBTOTAL	$15,185,510
		Construction Contigincies		27%	$4,100,088
		Engineering		7%	$1,062,986
		Construction Administration		6%	$911,131
				TOTAL	**$21,259,714**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	243,549	$852,422
2	Channel Land Acquistion	$1.50	SF	150,914	$226,371
3	Residential Land Acquisition	$88,000.00	Lot	63	$5,544,000
				SUBTOTAL	$6,622,793
		Engineering, Legal & Administration		1.5%	$99,342
				TOTAL	**$6,722,134**
				GRAND TOTAL	***$27,981,848***

TABLE 2.18
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 4, 100-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	217,730	$653,190
2	Basin Excivation	$4.00	CY	122,145	$488,580
3	Concrete Rectangular Channel	$300.00	CY	17,227	$5,168,100
4	Concrete Box Culverts	$350.00	CY	1,780	$623,000
5	Concrete Headwalls	$350.00	CY	149	$52,150
6	Concrete Structures (Drops)	$350.00	CY	180	$63,000
7	Fencing	$15.50	LF	34,200	$530,100
8	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
9	Demolition of Houses	$5,000.00	LOT	72	$360,000
				SUBTOTAL	$8,138,120
			Construction Contigincies	27%	$2,197,292
			Engineering	7%	$569,668
			Construction Administration	6%	$488,287
				TOTAL	**$11,393,368**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	243,935	$853,773
2	Channel Land Acquistion	$1.50	SF	115,243	$172,865
3	Residential Land Acquisition - detention b.	$88,000.00	LOT	9	$792,000
4	Residential Land Acquisition	$88,000.00	LOT	63	$5,544,000
				SUBTOTAL	$7,362,637
			Engineering, Legal & Administration	1.5%	$110,440
				TOTAL	**$7,473,077**
				GRAND TOTAL	***$18,866,445***

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TABLE 2.19
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	147,594	$442,782
2	Concrete Rectangular Channel	$300.00	CY	17,513	$5,253,900
3	Concrete Box Culverts	$350.00	CY	875	$306,250
4	Concrete Headwalls	$350.00	CY	93	$32,550
5	Concrete Structures (Drops)	$350.00	CY	91	$31,850
6	Fencing	$15.50	LF	34,200	$530,100
7	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
8	Demolition of Houses	$5,000.00	LOT	63	$315,000
				SUBTOTAL	$7,112,432
			Construction Contigincies	27%	$1,920,357
			Engineering	7%	$497,870
			Construction Administration	6%	$426,746
				TOTAL	**$9,957,405**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	137,150	$480,025
2	Channel Land Acquistion	$1.50	SF	84,113	$126,170
3	Residential Land Acquisition	$88,000.00	Lot	63	$5,544,000
				SUBTOTAL	$6,150,195
			Engineering, Legal & Administration	1.5%	$92,253
				TOTAL	**$6,242,447**
				GRAND TOTAL	***$16,199,852***

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TABLE 2.20
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 2, 10-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	157,574	$472,722
2	Concrete Rectangular Channel	$300.00	CY	17,974	$5,392,200
3	Concrete Box Culverts	$350.00	CY	989	$346,150
4	Concrete Headwalls	$350.00	CY	99	$34,650
5	Concrete Structures (Drops)	$350.00	CY	103	$36,050
6	Fencing	$15.50	LF	34,200	$530,100
7	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
8	Demolition of Houses	$5,000.00	LOT	63	$315,000
				SUBTOTAL	$7,326,872
			Construction Contigincies	27%	$1,978,255
			Engineering	7%	$512,881
			Construction Administration	6%	$439,612
				TOTAL	**$10,257,621**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	157,225	$550,288
2	Channel Land Acquistion	$1.50	SF	84,113	$126,170
3	Residential Land Acquisition	$88,000.00	Lot	63	$5,544,000
				SUBTOTAL	$6,220,457
			Engineering, Legal & Administration	1.5%	$93,307
				TOTAL	**$6,313,764**
				GRAND TOTAL	***$16,571,385***

TABLE 2.21
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 3, 10-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	147,594	$442,782
2	Concrete Rectangular Channel	$300.00	CY	17,513	$5,253,900
3	Concrete Box Culverts	$350.00	CY	875	$306,250
4	Concrete Headwalls	$350.00	CY	93	$32,550
5	Concrete Structures (Drops)	$350.00	CY	91	$31,850
6	Fencing	$15.50	LF	34,200	$530,100
7	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
8	Demolition of Houses	$5,000.00	LOT	63	$315,000
9	78" RCP stormdrain	$183.00	LF	5,280	$966,240
10	84" RCP stormdrain	$230.00	LF	5,280	$1,214,400
11	90" RCP stormdrain	$254.00	LF	5,280	$1,341,120
				SUBTOTAL	$10,634,192
			Construction Contigincies	27%	$2,871,232
			Engineering	7%	$744,393
			Construction Administration	6%	$638,052
				TOTAL	**$14,887,869**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	137,150	$480,025
2	Channel Land Acquistion	$1.50	SF	84,113	$126,170
3	Residential Land Acquisition	$88,000.00	Lot	63	$5,544,000
				SUBTOTAL	$6,150,195
			Engineering, Legal & Administration	1.5%	$92,253
				TOTAL	**$6,242,447**
				GRAND TOTAL	***$21,130,316***

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TABLE 2.22
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 4, 10-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	157,574	$472,722
2	Concrete Rectangular Channel	$300.00	CY	17,947	$5,384,100
3	Concrete Box Culverts	$350.00	CY	989	$346,150
4	Concrete Headwalls	$350.00	CY	99	$34,650
5	Concrete Structures (Drops)	$350.00	CY	103	$36,050
6	Fencing	$15.50	LF	34,200	$530,100
7	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
8	Demolition of Houses	$5,000.00	LOT	63	$315,000
9	78" RCP stormdrain	$183.00	LF	5,280	$966,240
10	84" RCP stormdrain	$230.00	LF	5,280	$1,214,400
11	90" RCP stormdrain	$254.00	LF	5,280	$1,341,120
				SUBTOTAL	$10,840,532
		Construction Contigincies		27%	$2,926,944
		Engineering		7%	$758,837
		Construction Administration		6%	$650,432
				TOTAL	**$15,176,745**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	157,225	$550,288
2	Channel Land Acquistion	$1.50	SF	84,113	$126,170
3	Residential Land Acquisition	$88,000.00	Lot	63	$5,544,000
				SUBTOTAL	$6,220,457
		Engineering, Legal & Administration		1.5%	$93,307
				TOTAL	**$6,313,764**
				GRAND TOTAL	***$21,490,509***

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TABLE 2.23
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 6, 10-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO 87TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3.00	CY	46,686	$140,058
2	Basin Excivation	$4.00	CY	105,000	$420,000
3	Concrete Rectangular Channel	$300.00	CY	12,551	$3,765,300
4	Concrete Box Culverts	$350.00	CY	412	$144,200
5	Concrete Headwalls	$350.00	CY	68	$23,800
6	Concrete Structures (Drops)	$350.00	CY	42	$14,700
7	Fencing	$15.50	LF	34,200	$530,100
8	Utility Relocation - Bethany Home Rd	$200,000.00	LS	1	$200,000
9	Demolition of Houses	$5,000.00	LOT	67	$335,000
				SUBTOTAL	$5,573,158
			Construction Contigincies	27%	$1,504,753
			Engineering	7%	$390,121
			Construction Administration	6%	$334,389
				TOTAL	**$7,802,421**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	105,378	$368,823
2	Channel Land Acquistion	$1.50	SF	49,338	$74,007
3	Residential Land Acquisition - surge basin	$88,000.00	LOT	4	$352,000
4	Residential Land Acquisition	$88,000.00	LOT	63	$5,544,000
				SUBTOTAL	$6,338,830
			Engineering, Legal & Administration	1.5%	$95,082
				TOTAL	**$6,433,912**
				GRAND TOTAL	***$14,236,334***

TABLE 2.24
LEVEL II COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 5-YEAR

STUDY AREA LOCATION: GRAND CANAL AT 31ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP equalizer pipe (4)	$139.00	LF	760	$105,640
2	72" RCP storm drain outfall	$165.00	LF	90	$14,850
3	Headwalls (3)	$350.00	CY	73.1	$25,585
4	Basin Excavation	$4.00	CY	281,000	$1,124,000
5	Connect 36" SD to 60" equalizer pipes	$5,000.00	LS	1	$5,000
				SUBTOTAL	$1,275,075
			Construction Contigincies	27%	$344,270
			Engineering	7%	$89,255
			Construction Administration	6%	$76,505
				TOTAL	**$1,785,105**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (20.4 Acres)	$8.50	SF	888,624	$7,553,304
				SUBTOTAL	$7,553,304
			Engineering, Legal & Administration	1.5%	$113,300
				TOTAL	**$7,666,604**
				GRAND TOTAL	***$9,451,709***

TABLE 3
LEVEL III RECOMMENDATIONS FOR PRE-DESIGN STUDY

November 11, 1997

Maryvale Area Drainage Master Study
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

Flood Mitigation Option	Study Area Location	Estimated Cost	Acquisition of Maryvale ADMS Ponding Area	Acquisition of FEMA Ponding Area
Grand Avenue				
Option 1, 10-Year	GRAND AVENUE AT 79TH AVENUE	$1,754,000	$8,547,000	$3,077,000
Option 1, 10-Year	GRAND AVENUE AT 75TH AVENUE	$6,778,000	$6,215,000	$14,486,000
Option 1, 10-Year	GRAND AVENUE AT 73RD AVENUE	$1,650,000	$2,458,000	$951,000
Option 1, 100-Year	GRAND AVENUE AT 67TH AVENUE	$2,894,000	$6,360,000	$19,206,000
Option 6, 10-Year *	GRAND AVENUE AT 51ST AVENUE	$5,120,000	$7,334,000	$0
Option 8, 10-Year *	GRAND AVENUE AT 51ST AVENUE (OUTFALL)	$7,118,000		
Option 4, 10-Year	GRAND AVENUE AT 43RD AVENUE	$4,494,000	Not Applicable	Buyout Not Calculated
Option 1, 5-Year	GRAND AVENUE AT INTERSTATE 17	$7,802,000	$15,675,000	$0
Grand Canal				
Option 4, 100-Year	GRAND CANAL 67TH AVE. TO AGUA FRIA FREEWAY	$21,224,000	$34,650,000	$49,225,000
Option 1, 5-Year	GRAND CANAL AT 31ST AVENUE	$9,413,000	$2,043,000	Buyout Not Calculated

* Combined cost of flood mitigation for the Grand Avenue at 51st Avenue Study Area will require implementing Option 6 together with Option 8. Combined cost for this mitigation is expected to be $12,238,000.

Note: The RID, I-10 Channel, and the Agua Fria Freeway study areas were eliminated in the Level I analysis, and therefore are not shown in this table.

TABLE 4.01
LEVEL III COST ANALYSIS

November 7, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 79TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	36" RCP storm drain (rural)	$87.00	LF	390	$33,930
2	Headwall (36")	$350.00	CY	9	$3,150
3	Concrete Structure - Junction Box	$50,000.00	EA	1	$50,000
4	Replace/Retrofit 8" SS w/ Ductile Iron	$5,000.00	LS	1	$5,000
5	Basin Excavation	$4.00	CY	131,000	$524,000
6	Basin Inlet Spillway	$200.00	CY	200	$40,000
				SUBTOTAL	$656,080
		Construction Contigincies		24%	$157,459
		Engineering		7%	$45,926
		Construction Administration		6%	$39,365
				TOTAL	**$898,830**

LAND ACQUISITION:

ITEM	DESCRIPTION		UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition	(12.9 Acres)	$1.50	SF	561,924	$842,886
					SUBTOTAL	$842,886
		Engineering, Legal & Administration			1.5%	$12,643
					TOTAL	**$855,529**
					GRAND TOTAL	***$1,754,359***

TABLE 4.02
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 75TH AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	42" Storm Drain	$91.00	LF	987	$89,817
2	60" Storm Drain	$139.00	LF	327	$45,453
3	Jacking pipe under Grand Avenue	$150,000.00	EA	1	$150,000
4	Headwalls (3)	$350.00	CY	35.1	$12,285
5	Detention Basin Excavation	$4.00	CY	479,300	$1,917,200
6	Basin Inlet Spillway	$200.00	CY	350	$70,000
				SUBTOTAL	$2,284,755
		Construction Contigincies		24%	$548,341
		Engineering		7%	$159,933
		Construction Administration		6%	$137,085
				TOTAL	**$3,130,114**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	N. Basin Land Acquisition (16.7 Acres)	$3.00	SF	727,452	$2,182,356
2	S. Basin Land Acquisition (10.2 Acres)	$3.00	SF	444,312	$1,332,936
3	Storm Drain Easement 0.6 Acres)	$3.00	SF	26,136	$78,408
				SUBTOTAL	$3,593,700
		Engineering, Legal & Administration		1.5%	$53,906
				TOTAL	**$3,647,606**
				GRAND TOTAL	***$6,777,720***

TABLE 4.03
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 73RD AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	42" Storm Drain	$110.00	LF	100	$11,000
2	Headwall	$350.00	CY	9	$3,150
3	Detention Basin Excavation	$4.00	CY	130,164	$520,656
				SUBTOTAL	$534,806
			Construction Contigincies	24%	$128,353
			Engineering	7%	$37,436
			Construction Administration	6%	$32,088
				TOTAL	**$732,684**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (8.3 Acres)	$2.50	SF	361,548	$903,870
				SUBTOTAL	$903,870
		Engineering, Legal & Administration		1.5%	$13,558
				TOTAL	**$917,428**
				GRAND TOTAL	***$1,650,112***

TABLE 4.04
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 100-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 67TH AVENUE
(Enlarge Northern - Orangewood Basin)

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Detention Basin Excavation	$4.00	CY	441,900	$1,767,600
2	Pumping Facility (36,000 gpm)	$275,000.00	LS	1	$275,000
3	Basin Inlet Spillway	$200.00	CY	350	$70,000
				SUBTOTAL	$2,112,600
			Construction Contigincies	24%	$507,024
			Engineering	7%	$147,882
			Construction Administration	6%	$126,756
				TOTAL	**$2,894,262**

LAND ACQUISITION:

ITEM	DESCRIPTION		UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition	(See below)	$0.00	SF	0	$0
					SUBTOTAL	$0
			Engineering, Legal & Administration		1.5%	$0
					TOTAL	**$0**
					GRAND TOTAL	***$2,894,262***

NOTE: This option entails enlarging and deepening the Northern / Orangewood 10-year basin. The Flood Control District of Maricopa County owns the parcel for the proposed basin enlargement.

TABLE 4.05
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 6, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE - Collection System

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139	LF	1,930	$268,270
2	72" RCP storm drain	$165	LF	670	$110,550
3	84" RCP storm drain	$230	LF	7,250	$1,667,500
4	108" RCP storm drain	$317	LF	650	$206,050
5	Basin Excavation (1)	$4	CY	155,000	$620,000
6	Concrete Structure - Junction Box (1)	$50,000	EA	1	$50,000
7	Headwall (1-60")	$350	CY	13.9	$4,865
8	Jacking Under Grand Ave (60")	$150,000	EA	2	$300,000
				SUBTOTAL	$3,227,235
			Construction Contigincies	24%	$774,536
			Engineering	7%	$225,906
			Construction Administration	6%	$193,634
				TOTAL	**$4,421,312**

LAND ACQUISITION:

ITEM	DESCRIPTION		UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition	(15.8 Acres)	$1.00	SF	688,248	$688,248
					SUBTOTAL	$688,248
				Engineering, Legal & Administration	1.5%	$10,324
					TOTAL	**$698,572**
					GRAND TOTAL	***$5,119,884***

TABLE 4.06
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 8, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 51ST AVENUE - Outfall System

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	84" RCP storm drain	$230	LF	2,700	$621,000
2	96" RCP storm drain	$279	LF	5,130	$1,431,270
3	108" RCP storm drain	$317	LF	9,915	$3,143,055
				SUBTOTAL	$5,195,325
			Construction Contigincies	24%	$1,246,878
			Engineering	7%	$363,673
			Construction Administration	6%	$311,720
				TOTAL	**$7,117,595**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (0.0 Acres)	$1.00	SF	0	$0
				SUBTOTAL	$0
			Engineering, Legal & Administration	1.5%	$0
				TOTAL	**$0**
				GRAND TOTAL	***$7,117,595***

TABLE 4.07
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 4, 10-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT 43RD AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139	LF	2,840	$394,760
2	78" RCP storm drain	$183	LF	3,770	$689,910
3	102" RCP storm drain	$298	LF	3,670	$1,093,660
4	Concrete Structure - Junction Box (1)	$50,000	EA	1	$50,000
5	Headwall (1-84")	$350	CY	16	$5,600
6	Jacking under Grand Ave & SPRR (96")	$250,000	EA	1	$250,000
7	Basin Excavation	$4	CY	72,000	$288,000
				SUBTOTAL	$2,771,930
			Construction Contigincies	24%	$665,263
			Engineering	7%	$194,035
			Construction Administration	6%	$166,316
				TOTAL	**$3,797,544**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (7.0 Acres)	$2.25	SF	304,920	$686,070
				SUBTOTAL	$686,070
			Engineering, Legal & Administration	1.5%	$10,291
				TOTAL	**$696,361**
				GRAND TOTAL	***$4,493,905***

TABLE 4.08
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 5-YEAR

STUDY AREA LOCATION: GRAND AVENUE AT INTERSTATE 17

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP storm drain	$139	LF	105	$14,595
2	Outlet Headwalls (1-60")	$350	CY	12.2	$4,270
3	Basin Excavation	$4	CY	339,000	$1,356,000
4	Pump station (2-60Hp C-3501-1430)	$184,000	LS	1	$184,000
5	Basin Inlet Spillway	$200	CY	370	$74,000
				SUBTOTAL	$1,632,865
			Construction Contigincies	24%	$391,888
			Engineering	7%	$114,301
			Construction Administration	6%	$97,972
				TOTAL	**$2,237,025**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Residential Land Acquisition	$78,590	EA	28	$2,200,520
2	Multi & Comm Land Acquisition (North)	$3,282,200	EA	1	$3,282,200
				SUBTOTAL	$5,482,720
			Engineering, Legal & Administration	1.5%	$82,241
				TOTAL	**$5,564,961**
				GRAND TOTAL	***$7,801,986***

TABLE 4.09
LEVEL III COST ANALYSIS

November 11, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 4, 100-YEAR

STUDY AREA LOCATION: GRAND CANAL 67TH AVENUE TO AGUA FRIA FREEWAY

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excivation	$3	CY	189,175	$567,525
2	Basin Excivation	$4	CY	181,210	$724,840
3	Concrete Rectangular Channel	$300	CY	20,086	$6,025,800
4	Concrete Trapezoidal Channel	$200	CY	758	$151,600
5	Concrete Box Culverts	$350	CY	1,938	$678,300
6	Concrete Headwalls	$350	CY	185	$64,750
7	Concrete Structures (Drops)	$350	CY	128	$44,800
8	Fencing	$15.50	LF	38,200	$592,100
9	Utility Relocation - Bethany Home Rd	$200,000	LS	1	$200,000
10	Demolition of Houses	$5,000	LOT	72	$360,000
				SUBTOTAL	$9,409,715
			Construction Contigincies	24%	$2,258,332
			Engineering	7%	$658,680
			Construction Administration	6%	$564,583
				TOTAL	**$12,891,310**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Land Acquistion	$3.50	SF	507,961	$1,777,864
2	Channel Land Acquistion	$1.50	SF	64,078	$96,117
3	Residential Land Acquisition - detention b:	$88,000	LOT	72	$6,336,000
				SUBTOTAL	$8,209,981
			Engineering, Legal & Administration	1.5%	$123,150
				TOTAL	**$8,333,130**
				GRAND TOTAL	***$21,224,440***

TABLE 4.10
LEVEL III COST ANALYSIS

November 6, 1997

MARYVALE AREA DRAINAGE MASTER STUDY
Flood Control District of Maricopa County

Contract FCD 93-29
W/P # 94154

FLOOD MITIGATION OPTIONS
OPTION 1, 5-YEAR

STUDY AREA LOCATION: GRAND CANAL AT 31ST AVENUE

MAJOR ELEMENTS:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	60" RCP equalizer pipe (4)	$139.00	LF	760	$105,640
2	72" RCP storm drain outfall	$165.00	LF	90	$14,850
3	Headwalls (3)	$350.00	CY	73.1	$25,585
4	Basin Excavation	$4.00	CY	281,000	$1,124,000
5	Connect 36" SD to 60" equalizer pipes	$5,000.00	LS	1	$5,000
				SUBTOTAL	$1,275,075
			Construction Contigincies	24%	$306,018
			Engineering	7%	$89,255
			Construction Administration	6%	$76,505
				TOTAL	**$1,746,853**

LAND ACQUISITION:

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Land Acquisition (20.4 Acres)	$8.50	SF	888,624	$7,553,304
				SUBTOTAL	$7,553,304
			Engineering, Legal & Administration	1.5%	$113,300
				TOTAL	**$7,666,604**
				GRAND TOTAL	***$9,413,456***

APPENDIX C

HYDRAULIC CALCULATIONS

C1 Grand Avenue at 51st Avenue, Mitigation Options 6 & 8, 10-Year
C2 Grand Avenue at 43rd Avenue, Mitigation Option 4, 10-Year
C3 Grand Canal, Bethany Home Road Outfall Channel, Mitigation Option 4, 100-Year

APPENDIX C

Hydraulic Calculation C-1

- *Grand Avenue at 51st Avenue - Mitigation Option 6, 10-Year*
- *Grand Avenue at 51st Avenue - Mitigation Option 8, 10-Year*

The flood mitigation of Grand Avenue at 51st Avenue requires a combination of a collection system and an outfall system. Mitigation *Option 6, 10-Year* and Mitigation *Option 8, 10-Year* are the recommended options as described in Section 8.2.5.

The Hydraulic Grade Line (HGL) calculations presented on the following pages are for the collection system storm drain in 51st Avenue and Grand Avenue. In addition, the outfall system HGL calculations for the storm drain in Bethany Home Road are included. Refer to Figure 8, Sheets 8 and 10 for an overview of the system. A preliminary design of the system including the correlated stations and invert elevations is shown on Figure 9, Sheets 6 through 22.

Wood, Patel & Associates, Inc.

TABLE C.1
STORM DRAIN HYDRAULIC GRADE LINE COMPUTATION WORKSHEET

Project: Maryvale ADMP GRAND AVE @51st AVE, OPTIONS 6 & 8, 10-year
File: Q:\MVLADMP\LEVEL II\Grand Ave\51st - Grand Ave\HGL.wb2
Print Date: 06-Nov-97 Input Data Revision: 23-Sep.-97
Engineer: SAZ
Description: Computation of EGL and HGL for storm drain system
Reference: Drainage Design Manual for Maricopa County, Arizona
Volume II, Hydraulics, January, 1996
Formulas Revised: August 22, 1997

Notes:
1. This spreadsheet is developed to compute storm drain hydraulic grade line based on the above mentioned reference.
All Equations used and minor loss coefficients shall be referred to this reference.
2. The blue areas are user input blocks, the grey areas are computed values, and the dark grey areas are check cells.
3. The recommended flow type for storm drain systems by the reference is pressure flow. Therefore, open channel flow computation is only an approximation here.
The hydraulic grade line at the outfall is assumed to be the invert elevation plus the pipe diameter. If the tailwater elevation is different from this value, the user should change this number manually.
4. The station is located at the immediate downstream of a change point.
5. If the number of rows of the spreadsheet is not enough for a project, the user can copy (do not insert any rows in the middle of the spreadsheet) more rows to the bottom of the spreadsheet and copy the formulas by rows to the new area.
6. Column F are the suggested pipe diameters computed by the spreadsheet with increment of 6 inches. User can select different values than the suggested.
7. Manning's n values in Column H can be selected from Table 4.1.
8. Column M are the summation of Kt values for each section, and the individual Kt values are from Tables 4.2 to 4.4 based on the transition types: a) gradual enlargement,
b) sudden enlargement, c) contraction, the D2/D1 ratio in Column R, the velocity in Column S, and other related information on these tables.
9. Column N are the summation of Kb values including some manhole losses for each section, and the individual bend Kb values are from Figure 4.7.
10. Columns O, P, and Q are input data for computation of junction losses: Q3 is the lateral flow, D3 is the pipe diameter of the lateral flow,
and theta is the angle between the main flow pipe and the lateral flow pipe.
11. Column AD are minor losses other than the types considered in the spreadsheet. The user should calculate these values and input them directly.
12. If users find any error or have any suggestion, please contact Wood, Patel & Associates.

BETHANY HOME ROAD STORM DRAIN - 51st Ave. to 83rd Ave.

Storm Sewer Line Station Location	Pipe #	Station	Pipe Diameter Sheet Suggested (in)	Pipe Diameter User Selected (in)	n	Natural Ground Elevation (ft)	Invert Elev. (ft)	Pipe Slope	Design Q (cfs)	Transitn Loss Coeff. Sum(Kt)	Bend Loss Coeff. Sum(Kb)	Junction Losses Q3 (cfs)	Junction Losses D3 (in)	Junction Losses Theta (deg.)	D2/D1	Vel. (ft/s)	Full Area (sq ft)	Station Interval (ft)	Pipe Length (ft)	V^2/(2g) (ft)	K	Sf (ft/ft)	Losses hf (ft)	Losses ht (ft)	Losses hb (ft)	Losses hj (ft)	Losses Others (ft)	Total Losses (ft)	Hydraulic Grade Line Elevation (ft)	Energy Grade Line Elevation (ft)	Pressure Flow Check	"Overflow" Check	Comments	Depth to Hydraulic Grade Line (ft)	Depth to Invert (ft)
Outfall @83 Ave		6+50	120	108	0.012	1085.50	1070.50	0.00250	838.0	1.00	0.20	0.00	0	0	1.00	5.00	63.62			0.39				2.31	0.54	0.00	0.00	0.00	1079.50	1079.89	OK	OK			
79th Ave.		32+60	120	108	0.012	1095.00	1077.03	0.00250	838.0	0.00	0.15	0.00	0	0	1.00	13.17	63.62	2610.00	2610.0	2.69	0.0042	0.0038	10.01	0.00	0.37	0.00	0.00	12.85	1090.05	1092.74	OK	OK		5.0	18.0
75th Ave.		52+40	120	108	0.012	1102.20	1081.98	0.00250	805.0	0.00	0.15	0.00	0	0	1.00	12.65	63.62	1980.00	1980.0	2.49	0.0042	0.0035	7.01	0.00	0.29	0.00	0.00	7.38	1097.63	1100.12	OK	OK		4.6	20.2
72nd Dr.		72+20	114	108	0.012	1110.50	1086.93	0.00250	714.0	0.00	0.10	0.00	0	0	1.00	11.22	63.62	1980.00	1980.0	1.96	0.0042	0.0028	5.51	0.00	0.20	0.00	0.00	5.81	1103.97	1105.93	OK	OK		6.5	23.6
71st Ave.		78+80	114	108	0.012	1112.50	1088.58	0.00250	714.0	0.00	0.15	0.00	0	0	1.00	11.22	63.62	660.00	660.0	1.96	0.0042	0.0028	1.84	0.00	0.24	0.00	0.00	2.03	1106.00	1107.96	OK	OK		6.5	23.9
67th Ave.		105+20	102	108	0.012	1122.50	1097.82	0.00350	643.0	0.09	0.20	0.00	0	0	1.13	10.11	63.62	2640.00	2640.0	1.59	0.0042	0.0023	5.96	0.00	0.33	0.00	0.00	6.20	1112.57	1114.16	OK	OK		9.9	24.7
63rd Ave.		130+10	96	96	0.012	1128.70	1106.53	0.00350	515.0	0.00	0.20	0.00	0	0	1.00	10.25	50.27	2490.00	2490.0	1.63	0.0042	0.0027	6.76	0.00	0.26	0.00	0.00	7.09	1119.62	1121.25	OK	OK		9.1	22.2
59th Ave.		156+50	90	96	0.012	1137.20	1115.77	0.00350	464.0	0.09	0.15	0.00	0	0	1.14	9.23	50.27	2640.00	2640.0	1.32	0.0042	0.0022	5.82	0.01	0.22	0.00	0.00	6.08	1126.00	1127.33	OK	OK		11.2	21.4
56th Ave.		176+30	84	84	0.012	1142.30	1122.70	0.00350	373.0	0.00	0.20	0.00	0	0	1.00	9.69	38.48	1980.00	1980.0	1.46	0.0042	0.0029	5.75	0.00	0.29	0.00	0.00	5.98	1131.85	1133.31	OK	OK		10.5	19.6
Near 56th Ave.		178+00	96	84	0.012	1142.50	1123.04	0.00200	373.0	0.00	0.25	0.00	0	0	1.00	9.69	38.48	170.00	170.0	1.46	0.0042	0.0029	0.49	0.00	0.30	0.00	0.00	0.79	1132.63	1134.09	OK	OK		9.9	19.5
55th Ave.		183+50	90	84	0.012	1143.20	1124.14	0.00200	340.0	0.00	0.10	0.00	0	0	1.00	8.83	38.48	550.00	550.0	1.21	0.0042	0.0024	1.33	0.00	0.12	0.00	0.00	1.63	1134.51	1135.72	OK	OK		8.7	19.1
Near 53rd Dr.		196+70	90	84	0.012	1145.00	1126.78	0.00200	340.0	0.23	0.05	0.00	0	0	1.40	8.83	38.48	1320.00	1320.0	1.21	0.0042	0.0024	3.18	0.15	0.03	0.00	0.00	3.30	1137.81	1139.02	OK	OK		7.2	18.2
51st Ave.		210+20	60	60	0.012	1149.50	1129.48	0.00200	120.0	0.20	1.00	0.00	0	0	1.00	6.11	19.63	1350.00	1350.0	0.58	0.0042	0.0018	2.44	0.02	0.49	0.00	0.00	2.61	1141.06	1141.64	OK	OK		8.4	20.0
Near Surge Basin		216+00	60	60	0.012	1148.00	1130.64	0.00200	110.0	0.50	0.05	0.00	0	0		5.60	19.63	580.00	580.0	0.49	0.0042	0.0015	0.88			0.00	0.00	1.39	1142.54	1143.03	OK	OK		5.5	17.4

BETHANY HOME ROAD STORM DRAIN - Grand Ave. (Surge Basin to 55th Ave.)

Storm Sewer Line Station Location	Pipe #	Station	Pipe Diameter Sheet Suggested (in)	Pipe Diameter User Selected (in)	n	Natural Ground Elevation (ft)	Invert Elev. (ft)	Pipe Slope	Design Q (cfs)	Transitn Loss Coeff. Sum(Kt)	Bend Loss Coeff. Sum(Kb)	Junction Losses Q3 (cfs)	Junction Losses D3 (in)	Junction Losses Theta (deg.)	D2/D1	Vel. (ft/s)	Full Area (sq ft)	Station Interval (ft)	Pipe Length (ft)	V^2/(2g) (ft)	K	Sf (ft/ft)	Losses hf (ft)	Losses ht (ft)	Losses hb (ft)	Losses hj (ft)	Losses Others (ft)	Total Losses (ft)	Hydraulic Grade Line Elevation (ft)	Energy Grade Line Elevation (ft)	Pressure Flow Check	"Overflow" Check	Comments	Depth to Hydraulic Grade Line (ft)	Depth to Invert (ft)
Surge Basin		48+70	108	108	0.012	1145.00	1129.00	0.00093	390.0	1.00	0.00	0.00	0	0	1.00	1.00	63.62			0.02				0.57	0.00	0.00	0.00	0.00	1144.00	1144.02	OK	OK			
Surge Junction		44+20	108	108	0.012	1149.50	1129.50	0.00093	390.0	0.00	1.00	0.00	0	0	1.00	6.13	63.62	450.00	540.0	0.58	0.0042	0.0008	0.45	0.00	0.61	0.00	0.00	1.02	1144.45	1145.03	OK	OK		5.1	20.0
Combine Junction		43+20	84	108	0.012	1149.20	1130.00	0.00455	400.0	0.16	0.75	0.00	0	0	1.29	6.29	63.62	100.00	110.0	0.61	0.0042	0.0009	0.10	0.02	0.56	0.00	0.00	0.71	1145.13	1145.74	OK	OK		4.1	19.2
E. 53rd Ave.		25+75	84	84	0.012	1149.80	1133.49	0.00200	266.0	0.00	0.20	0.00	0	0	1.00	6.91	38.48	1745.00	1745.0	0.74	0.0042	0.0015	2.58	0.00	0.15	0.00	0.00	3.15	1148.15	1148.89	OK	OK		1.6	16.3
53rd Ave.		24+75	84	84	0.012	1150.00	1133.71	0.00200	266.0	0.00	0.15	0.00	0	0	1.00	6.91	38.48	100.00	110.0	0.74	0.0042	0.0015	0.16	0.00	0.09	0.00	0.00	0.31	1148.46	1149.21	OK	OK		1.5	16.3
E. 55th Ave.		7+70	78	84	0.012	1152.20	1137.12	0.00200	240.0	0.00	0.25	0.00	0	0	1.00	6.24	38.48	1705.00	1705.0	0.60	0.0042	0.0012	2.05	0.00	0.13	0.00	0.00	2.14	1150.74	1151.34	OK	OK		1.5	15.1
55th Ave.		5+60	78	84	0.012	1152.30	1137.54	0.00200	220.0	0.00	0.15	0.00	0	0	1.00	5.72	38.48	210.00	210.0	0.51	0.0042	0.0010	0.21	0.00	0.06	0.00	0.00	0.34	1151.18	1151.68	OK	OK		1.1	14.8
55th Ave. Inlet		0+00	72	84	0.012	1152.40	1138.66	0.00200	200.0	0.00	0.00	0.00	0	0		5.20	38.48	560.00	560.0	0.42	0.0042	0.0008	0.47			0.00	0.00	0.53	1151.79	1152.21	OK	OK		0.6	13.7

BETHANY HOME ROAD STORM DRAIN - 51st Ave. (Bethany Home Road to Maryland Ave.)

Storm Sewer Line Station Location	Pipe #	Station	Pipe Diameter Sheet Suggested (in)	Pipe Diameter User Selected (in)	n	Natural Ground Elevation (ft)	Invert Elev. (ft)	Pipe Slope	Design Q (cfs)	Transitn Loss Coeff. Sum(Kt)	Bend Loss Coeff. Sum(Kb)	Junction Losses Q3 (cfs)	Junction Losses D3 (in)	Junction Losses Theta (deg.)	D2/D1	Vel. (ft/s)	Full Area (sq ft)	Station Interval (ft)	Pipe Length (ft)	V^2/(2g) (ft)	K	Sf (ft/ft)	Losses hf (ft)	Losses ht (ft)	Losses hb (ft)	Losses hj (ft)	Losses Others (ft)	Total Losses (ft)	Hydraulic Grade Line Elevation (ft)	Energy Grade Line Elevation (ft)	Pressure Flow Check	"Overflow" Check	Comments	Depth to Hydraulic Grade Line (ft)	Depth to Invert (ft)
Combine Junction		25+80	84	84	0.012	1149.20	1130.00	0.00250	294.0	0.00	0.75	0.00	0	0	1.00	6.30	38.48			0.62				0.00	0.68	0.00	0.00	0.00	1145.13	1145.75	OK	OK			
Cavalier Dr.		19+00	84	84	0.012	1149.50	1131.70	0.00250	294.0	0.00	0.05	0.00	0	0	1.00	7.64	38.48	680.00	680.0	0.91	0.0042	0.0018	1.23	0.00	0.04	0.00	0.00	1.91	1146.75	1147.65	OK	OK		2.8	17.8
Marlette Ave.		7+10	78	84	0.012	1151.50	1134.67	0.00250	280.0	0.00	0.10	0.00	0	0	1.17	7.28	38.48	1190.00	1190.0	0.82	0.0042	0.0016	1.95	0.00	0.13	0.00	0.00	1.99	1148.82	1149.64	OK	OK		2.7	16.8
Maryland Ave.		0+40	78	72	0.012	1155.00	1136.35	0.00250	260.0	0.00	0.05	0.00	0	0		9.20	28.27	670.00	670.0	1.31	0.0042	0.0032	2.15			0.00	0.00	2.28	1150.61	1151.92	OK	OK		4.4	18.7

APPENDIX C

Hydraulic Calculation C-2

- *Grand Avenue at 43rd Avenue - Mitigation Option 4, 10-Year*

The recommended flood mitigation option for Grand Avenue at 43rd Avenue is *Option 4, 10-Year*. This option is described in Section 8.2.6 and depicted on Figure 8, Sheet 12.

This option utilizes a storm drain system to mitigate the 10-year storm. The hydraulic analysis shown on the following pages document the HGL calculation for the storm drain pipes in 43rd Avenue and Grand Avenue. Refer to Figure 4, Sheets 23 through 29 for a preliminary design of the system.

Wood, Patel & Associates, Inc.

TABLE C.2
STORM DRAIN HYDRAULIC GRADE LINE COMPUTATION WORKSHEET

Project: Maryvale ADMS Grand Ave. at 43rd Ave., Option 4, 10-year.
File: Q:\MVLADMP\LEVEL II\Grand Ave\43rd - Camelback\HGL\HGL.wb2
Print Date: 06-Nov-97 Input Data Revision: 23-Sep.-97
Engineer: SAZ Input Data Revision: 14-Oct-97
Description: Computation of EGL and HGL for storm drain system
Reference: Drainage Design Manual for Maricopa County, Arizona
Volume II, Hydraulics, January, 1996
Formulas Revised: August 22, 1997

Notes:
1. This spreadsheet is developed to compute storm drain hydraulic grade line based on the above mentioned reference.
All Equations used and minor loss coefficients shall be referred to this reference.
2. The blue areas are user input blocks, the grey areas are computed values, and the dark grey areas are check cells.
3. The recommended flow type for storm drain systems by the reference is pressure flow. Therefore, open channel flow computation is only an approximation here.
The hydraulic grade line at the outfall is assumed to be the invert elevation plus the pipe diameter. If the tailwater elevation is different from this value, the user should change this number manually.
4. The station is located at the immediate downstream of a change point.
5. If the number of rows of the spreadsheet is not enough for a project, the user can copy (do not insert any rows in the middle of the spreadsheet) more rows to the bottom of the spreadsheet and copy the formulas by rows to the new area.
6. Column F are the suggested pipe diameters computed by the spreadsheet with increment of 6 inches. User can select different values than the suggested.
7. Manning's n values in Column H can be selected from Table 4.1.
8. Column M are the summation of Kt values for each section, and the individual Kt values are from Tables 4.2 to 4.4 based on the transition types: a) gradual enlargement,
b) sudden enlargement, c) contraction, the D2/D1 ratio in Column R, the velocity in Column S, and other related information on these tables.
9. Column N are the summation of Kb values including some manhole losses for each section, and the individual bend Kb values are from Figure 4.7.
10. Columns O, P, and Q are input data for computation of junction losses: Q3 is the lateral flow, D3 is the pipe diameter of the lateral flow,
and theta is the angle between the main flow pipe and the lateral flow pipe.
11. Column AD are minor losses other than the types considered in the spreadsheet. The user should calculate these values and input them directly.
12. If users find any error or have any suggestion, please contact Wood, Patel & Associates.

43RD AVENUE STORM DRAIN - Indian School Road to Missouri Avenue

Storm Sewer Line Station Location	Pipe #	Station	Pipe Diameter		n	Natural Ground Elevation	Invert Elev.	Pipe Slope	Design Q	Transitn Loss Coeff.	Bend Loss Coeff.	Junction Losses			D2/D1	Vel.	Full Area	Station Interval	Pipe Length	V^2/(2g)	K	Sf	Losses					Total Losses	Hydraulic Grade Line Elevation	Energy Grade Line Elevation	Pressure Flow Check	"Overflow" Check	Comments	Depth to Hydraulic Grade Line	Depth to Invert
			Sheet Suggested (in)	User Selected (in)		(ft)	(ft)		(cfs)	Sum(Kt)	Sum(Kb)	Q3 (cfs)	D3 (in)	Theta (deg.)		(ft/s)	(sq ft)	(ft)	(ft)	(ft)		(ft/ft)	hf (ft)	ht (ft)	hb (ft)	hj (ft)	Others (ft)		(ft)	(ft)				(ft)	(ft)
Indian School Rd.		80+95	48	60	0.012	1115.00	1096.10	0.00337	90.0	0.00	0.20	0.00	0	0	1.00	5.00	19.63			0.39				0.00	0.07	0.00	0.00	0.00	1114.50	1114.89	OK	OK			
Campbell Ave.	Exist	54+55	48	60	0.012	1127.00	1105.00	0.00337	90.0	0.00	0.20	0.00	0	0	1.00	4.58	19.63	2640.00	2640.0	0.33	0.0042	0.0010	2.68	0.00	0.07	0.00	0.00	2.75	1117.31	1117.64	OK	OK		9.7	22.0
To Existing Pipe	Exist	28+80	48	60	0.012	1139.50	1115.04	0.00390	90.0	0.30	0.50	0.00	0	0	0.77	4.58	19.63	2575.00	2575.0	0.33	0.0042	0.0010	2.62	0.44	0.89	0.00	0.00	2.68	1119.99	1120.32	OK	OK		19.5	24.5
Surge Junction		28+40	96	78	0.012	1139.80	1115.10	0.00150	355.0	0.50	1.20	0.00	0	0	1.30	10.70	33.18	40.00	40.0	1.78	0.0042	0.0039	0.16	0.08	1.93	0.00	0.00	1.48	1121.60	1121.80	Open	OK	Reduce D	18.2	24.7
Camelback Rd.		28+10	66	60	0.012	1140.00	1115.25	0.00500	200.0	0.50	0.20	0.00	0	0	1.00	10.19	19.63	30.00	30.0	1.61	0.0042	0.0050	0.15	0.00	0.32	0.00	0.00	2.17	1122.36	1123.97	OK	OK		17.6	24.8
Missouri Ave.		0+00	66	60	0.012	1149.00	1126.50	0.00400	200.0	0.00	0.20	0.00	0	0		10.19	19.63	2810.00	2810.0	1.61	0.0042	0.0050	14.11			0.00	0.00	14.43	1136.79	1138.40	OK	OK		12.2	22.5

GRAND AVENUE STORM DRAIN - 39th Avenue to Missouri Avenue

Storm Sewer Line Station Location	Pipe #	Station	Pipe Diameter		n	Natural Ground Elevation	Invert Elev.	Pipe Slope	Design Q	Transitn Loss Coeff.	Bend Loss Coeff.	Junction Losses			D2/D1	Vel.	Full Area	Station Interval	Pipe Length	V^2/(2g)	K	Sf	Losses					Total Losses	Hydraulic Grade Line Elevation	Energy Grade Line Elevation	Pressure Flow Check	"Overflow" Check	Comments	Depth to Hydraulic Grade Line	Depth to Invert
			Sheet Suggested (in)	User Selected (in)		(ft)	(ft)		(cfs)	Sum(Kt)	Sum(Kb)	Q3 (cfs)	D3 (in)	Theta (deg.)		(ft/s)	(sq ft)	(ft)	(ft)	(ft)		(ft/ft)	hf (ft)	ht (ft)	hb (ft)	hj (ft)	Others (ft)		(ft)	(ft)				(ft)	(ft)
39th Ave.		74+00	84	78	0.012	1128.00	1109.50	0.00150	265.0	0.00	0.20	0.00	0	0	1.00	8.00	33.18			0.99				0.00	0.20	0.00	0.00	0.00	1126.00	1126.99	OK	OK			
Exist-Pipe Junctn		37+10	84	78	0.012	1140.00	1115.04	0.00150	265.0	0.00	0.50	0.00	0	0	1.00	7.99	33.18	3690.00	3690.0	0.99	0.0042	0.0022	8.03	0.00	0.89	0.00	0.00	8.22	1134.23	1135.22	OK	OK		5.8	25.0
Surge Junction		36+70	96	78	0.012	1140.00	1115.10	0.00150	355.0	0.16	1.00	0.00	0	0	0.76	10.70	33.18	40.00	40.0	1.78	0.0042	0.0039	0.16	0.05	1.46	0.00	0.00	1.04	1134.49	1136.26	OK	OK		5.5	24.9
Manhole		16+90	96	102	0.012	1142.50	1123.02	0.00400	550.0	0.00	0.75	0.00	0	0	1.00	9.69	56.75	1980.00	1980.0	1.46	0.0042	0.0022	4.44	0.00	0.58	0.00	0.00	5.95	1140.75	1142.21	OK	OK		1.7	19.5
Missouri Ave.		0+00	84	102	0.012	1145.00	1129.78	0.00400	400.0	0.00	0.30	0.00	0	0		7.05	56.75	1690.00	1690.0	0.77	0.0042	0.0012	2.00			0.00	0.00	2.58	1144.02	1144.79	OK	OK		1.0	15.2

APPENDIX C

Hydraulic Calculation C-3

• Agua Fria Freeway Outfall Channel
Bethany Home Road Outfall Channel - Mitigation Option 4, 100-Year

The flood mitigation of the Grand Canal ponding areas is proposed to include a concrete lined channel extending from 73rd Avenue to the Agua Fria Freeway outfall channel. The recommended option, Mitigation *Option 4, 100-Year* is described in Section 8.3.2 and depicted on Figure 8, Sheet 18.

The HEC-RAS summary output and profile shown on the following pages depict the hydraulic data for the entire reach of the proposed channels. This includes the Agua Fria Freeway (AFF) outlet channel from New River to the AFF and the Bethany Home Road outfall channel from the AFF to 73rd Avenue. A preliminary design of the Bethany Home Road outfall channel including stations and elevations, is shown on Figure 8, Sheets 34 through 43.

TABLE C.3
HEC-RAS Output for Bethany Home Road Outfall Channel, from New River to 67th Avenue

HEC-RAS Plan: BHROC, 100-4 River: Grand Canal Chan Reach: New R. to 67th

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
New R. to 67th	27000	540	1082.70	1093.76	1087.18	1094.13	0.000351	4.88	110.62	10.00	0.26
New R. to 67th	26105	540	1082.07	1093.48	1086.56	1093.82	0.000326	4.73	114.05	10.00	0.25
New R. to 67th	26005	540	1082.00	1093.69	1084.07	1093.72	0.000013	1.45	371.81	31.80	0.07
New R. to 67th	25965	Culvert									
New R. to 67th	25925	540	1081.95	1093.44	1084.02	1093.47	0.000013	1.48	365.36	31.80	0.08
New R. to 67th	25800	800	1081.90	1093.02	1086.35	1093.37	0.000239	4.80	166.74	15.00	0.25
New R. to 67th	25400	800	1081.70	1092.93	1086.15	1093.28	0.000233	4.75	168.40	15.00	0.25
New R. to 67th	25275	800	1081.65	1093.11	1084.35	1093.19	0.000029	2.19	364.49	31.80	0.11
New R. to 67th	25235	Culvert									
New R. to 67th	25195	800	1081.60	1092.57	1084.29	1092.65	0.000033	2.29	348.80	31.80	0.12
New R. to 67th	25000	800	1081.40	1092.17	1085.85	1092.55	0.000259	4.95	161.48	15.00	0.27
New R. to 67th	22200	1545	1078.60	1089.55	1085.49	1090.92	0.000925	9.41	164.23	15.00	0.50
New R. to 67th	19000	1545	1075.40	1082.30	1082.30	1085.76	0.003101	14.93	103.47	15.00	1.00
New R. to 67th	18999	1545	1070.20	1083.32	1077.10	1084.28	0.000587	7.85	196.85	15.00	0.38
New R. to 67th	18900	1545	1070.10	1083.60	1075.80	1084.11	0.000244	5.72	270.03	20.00	0.27
New R. to 67th	18400	2260	1069.55	1082.71	1076.89	1083.86	0.000556	8.59	263.21	20.00	0.42
New R. to 67th	18150	2260	1069.30	1082.59	1076.64	1083.71	0.000543	8.50	265.77	20.00	0.41
New R. to 67th	17925	2260	1069.10	1083.29	1072.45	1083.39	0.000022	2.46	916.97	64.60	0.12
New R. to 67th	17865	Culvert									
New R. to 67th	17805	2260	1066.30	1078.38	1069.65	1078.51	0.000035	2.90	780.48	64.60	0.15
New R. to 67th	17600	2260	1066.10	1076.48	1073.43	1078.32	0.001035	10.89	207.60	20.00	0.60
New R. to 67th	16000	2260	1064.60	1071.92	1071.92	1075.62	0.002665	15.43	146.49	20.00	1.00
New R. to 67th	15999	2260	1061.60	1072.46	1068.93	1074.14	0.000918	10.40	217.22	20.00	0.56
New R. to 67th	13100	2260	1058.70	1066.04	1066.04	1069.72	0.002651	15.40	146.76	20.00	1.00
New R. to 67th	13000	2260	1058.60	1066.74	1063.21	1067.49	0.000355	6.94	325.77	40.00	0.43
New R. to 67th	12700	2880	1058.30	1065.87	1063.74	1067.27	0.000716	9.52	302.61	40.00	0.61
New R. to 67th	12575	2880	1058.20	1066.66	1061.44	1066.90	0.000088	3.94	730.68	86.40	0.24
New R. to 67th	12538	Culvert									
New R. to 67th	12500	2880	1058.15	1066.14	1061.40	1066.41	0.000105	4.17	690.46	86.40	0.26
New R. to 67th	12300	2880	1057.95	1063.37	1063.37	1066.11	0.001948	13.27	216.98	40.00	1.00
New R. to 67th	12299	2880	1054.45	1061.84	1059.89	1063.31	0.000769	9.75	295.44	40.00	0.63
New R. to 67th	9000	3240	1051.15	1058.51	1057.02	1060.39	0.000985	11.01	294.20	40.00	0.72
New R. to 67th	8500	4635	1050.90	1058.50	1056.81	1059.86	0.000629	9.36	495.28	80.39	0.66
New R. to 67th	7500	4635	1050.40	1056.30	1056.30	1058.81	0.001518	12.71	364.68	72.40	1.00

TABLE C.3
HEC-RAS Output for Bethany Home Road Outfall Channel, from New River to 67th Avenue

HEC-RAS Plan: BHROC, 100-4 River: Grand Canal Chan Reach: New R. to 67th

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
New R. to 67th	7310	4635	1050.30	1056.11	1053.90	1056.80	0.000377	6.69	693.30	122.00	0.49
New R. to 67th	7265	Culvert									
New R. to 67th	7220	4635	1043.50	1051.84	1047.11	1052.17	0.000117	4.66	993.60	119.20	0.28
New R. to 67th	7000	4635	1043.30	1050.37	1049.22	1051.99	0.000814	10.23	453.18	78.27	0.75
New R. to 67th	5300	4670	1041.60	1047.53	1047.53	1050.05	0.001533	12.72	367.00	73.73	1.01
New R. to 67th	5299	4670	1035.60	1044.06	1041.54	1045.12	0.000434	8.25	566.02	83.83	0.56
New R. to 67th	4950	4670	1035.40	1043.79	1040.86	1044.95	0.000457	8.64	540.29	64.40	0.53
New R. to 67th	4900	Culvert									
New R. to 67th	4850	4670	1035.30	1042.78	1040.77	1044.24	0.000649	9.69	481.78	64.40	0.62
New R. to 67th	4500	4700	1035.10	1042.52	1041.07	1044.00	0.000704	9.77	481.05	79.68	0.70
New R. to 67th	1500	4700	1033.00	1040.40	1038.97	1041.89	0.000701	9.81	479.23	78.00	0.70

Bethany Home Rd Outfall Channel (BHROC) - LEVEL III BHROC 100-4 (FCD 100-24 w/ on line basin) 07-10-97

Geom: BHROC 100-4 (FCD 100-24 w/ on line basin) Flow: BHROC 100-4 (FCD 100-24 w/ on line basin)

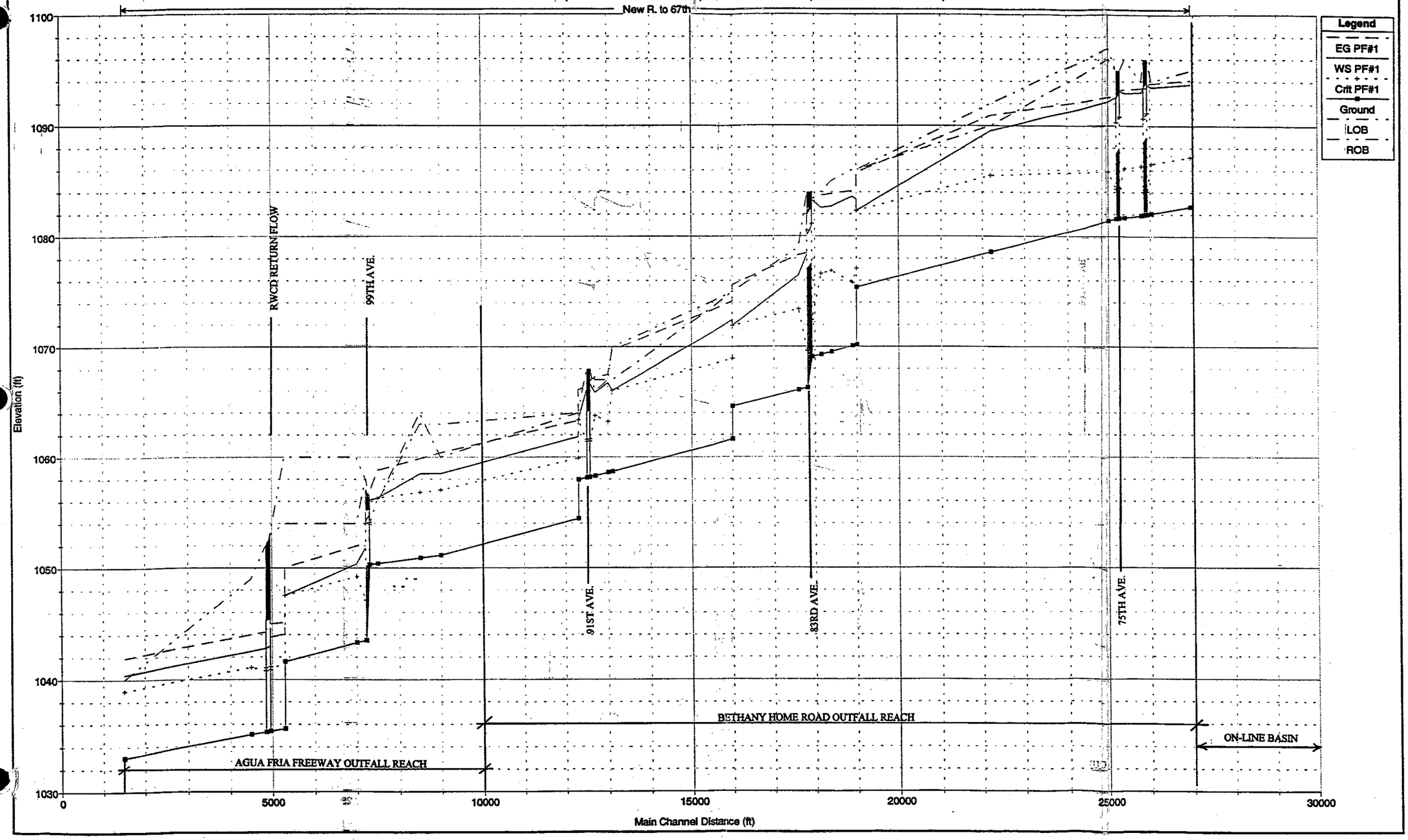

PLATE NUMBER C-3